TENDERDOCUMENT

TENDERNo: NERO/CON/753/318 Dated 05.09.2018

FOR

Design, Manufacture, Supply, Inspection, installation, Testing and Commissioning of Sewage Treatment Plant (175 KLD) of MBBR Technology, Supply of Mandatory Spare & Operation & Maintenance for 5 (five) years for the project “Construction of township at Khilpara, Udaipur, Tripura for 2X363.3 MW gas based combined cycle power plant of OTPC” on lumpsum basis.

VOLUME–II

NOTICE INVITING TENDER

ADDITIONAL CONDITIONS OF CONTRACT

TECHNICAL SPECIFICATIONS

DRAWINGS
ENGINEERING PROJECTS (INDIA) LIMITED  
(A Govt. of India Enterprise) 
North Eastern Regional Office, Guwahati  
NOTICE INVITING e-TENDER

NIT No. NERO/CON/753/318 Date: 05.09.2018

Tender for Design, Manufacture, Supply, Inspection, installation, Testing and Commissioning of Sewage Treatment Plant (175 KLD) of MBBR Technology, Supply of Mandatory Spare & Operation & Maintenance for 5 (five) years for the project “Construction of township at Khilpara, Udaipur, Tripura for 2X363.3 MW gas based combined cycle power plant of OTPC” on lumpsum basis.

Engineering Projects (India) Ltd. invites open e-Tenders on lumpsum basis through e-tendering from the eligible contractors/firms who fulfill the eligibility criteria as per the brief particulars of scope for the work of Design, Manufacture, Supply, Inspection, installation, Testing and Commissioning of Sewage Treatment Plant (175 KLD) of MBBR Technology, Supply of Mandatory Spare & Operation & Maintenance for 5 (five) years for the project “Construction of township at Khilpara, Udaipur, Tripura for 2X363.3 MW gas based combined cycle power plant of OTPC” on lumpsum basis., in single stage Two Envelope system (Technical bid & Price bid) for the following works:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of Work</th>
<th>Estimated Cost</th>
<th>Earnest Money Deposit</th>
<th>Tender Fee</th>
<th>Completion Period</th>
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<tbody>
<tr>
<td>1</td>
<td>Design, Manufacture, Supply, Inspection, installation, Testing and Commissioning of Sewage Treatment Plant (175 KLD) of MBBR Technology, Supply of Mandatory Spare &amp; Operation &amp; Maintenance for 5 (five) years for the project “Construction of township at Khilpara, Udaipur, Tripura for 2X363.3 MW gas based combined cycle power plant of OTPC” on lumpsum basis.</td>
<td>Rs.69,00,00,000.00 (Rupees Sixty-Nine Lakhs only)</td>
<td>Rs.69,000.00 (Rupees Sixty-Nine Thousand only)</td>
<td>Rs.5,900.00 (Rupees Five Thousand Nine Hundred Only)</td>
<td>06(Six) Months</td>
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</tbody>
</table>

The items works given in Bill of Quantities (BOQ) are tentative only and these works shall be carried out on lump sum basis. The successful tenderer shall be required to undertake design detail engineering for lumpsum works and get the same approved by EPI/ Owner and then enter into a mutually agreed billing break-up in line with what is agreed between EPI and owner and furnished in relevant clause(s) of Additional Conditions of Contract (ACC). Bidder must attach one unpriced list of Mandatory Spares with Technical documents for evaluation.

The detailed scope of work is given in the tender document.
Time schedule of Tender activities:

(i) Starting Date & Time for Downloading of tender documents: from 05.09.2018 (08:00 PM)
(ii) Last Date & Time for Downloading of tender documents: up to 26.09.2018 (12:00 AM)
(iii) Last Date & Time of online submission of Tenders: on or before 26.09.2018 up to 01:00 PM
(iv) Date & Time of online opening of tenders (Techno-Commercial Bid): 26.09.2018 at 03:00 PM
(v) Pre-bid meeting at 4th Floor, Hindustan Tower Block-A, Jawahar Nagar, N.H.37, Beltola, Guwahati-781022 Assam on 12.09.2018 at 4.00 PM.

The tenderers shall submit his query for the pre-bid meeting on or before 12.09.2018 by 01.00 PM to nerocontracts@gmail.com or by post to the address given at sl. no. 14 below.

1.0 Contractors who fulfill the following requirements are eligible to participate in this tender. The joint ventures/Consortium are not accepted.

a) The bidder must have experience of having satisfactorily completed following “similar works” during the last 7(seven) years ending last day of month previous to the one in which applications are invited.

Three similar works each of costing minimum 40% of the estimated cost of this work.
   OR
Two similar works each of costing minimum 50% of the estimated cost of this work.
   OR
One similar work costing minimum 80% of the estimated cost of this work.

i) The “similar works” shall mean “Project work which included Civil, Electrical and/or Electromechanical works (STP/WTP/Pumps/ETP/AC/Lift etc).

Additionally, bidder must be

(a) One of the approved agency for STP as included in the approved list of the tender documents
   Or
(b) Is an authorized associate /service provider of the agencies mentioned in (a) above
   Or
(c) Having an agreement with one of the agency mentioned in (a) above for availing Design Engineering services and supply/Erection of intended STP through the Approved Vendor
   Or
(d) Is agreed to avail Design Engineering and procurement/erection of the intended STP from one of the agencies as mentioned in (a) above if he becomes successful bidder. An undertaking in this regard shall be furnished by the Bidder in his letter head which shall form part of tender document.
ii) The cost of free issue materials shall not be included in the completion cost of works.

iii) For evaluation purpose, the completion cost of works mentioned in the completion certificate shall be enhanced by 7% per annum till the end of month prior to date of NIT.

b) Should have had average annual financial turnover of at least 30% of the estimated cost put to tender during the immediate last three consecutive financial years ending on 31.03.2017 duly supported by annual financial report (i.e. audited copies of balance sheet and profit and loss statement) or certified by Chartered Accountant along with Income Tax return for last financial year i.e. 2016-17. Turnover means income from construction works only.

c) Should not have incurred any loss in more than two years during the immediate last five consecutive financial years, ending 31.03.2017. Copies of balance sheet/Certificate from Chartered Accountant duly self attested by the tenderer shall be submitted.

d) Should have a Solvency of 40% of the estimated cost issued by his bankers in the name of the bidder. The Solvency Certificate should not have been issued earlier than one year of last date of submission of the tender.

e) Should have valid Permanent Account Number of Income Tax and GST registration certificate.

f) Should have valid PF Registration number. In case the bidder does not have this registration number, he shall remain bound to obtain them within one month from the date of LOI or before release of 1st R/A bill whichever is earlier.

g) Bid Capacity: The bidding capacity of the tenderer should be equal to or more than the estimated cost of the work put to Tender.

The Bidding capacity shall be worked out by the following formula:

\[
\text{Bidding Capacity} = (A \times N \times 2) - B
\]

Where,
A = Maximum value of construction works executed in any one year during the last five years taking into account the Completed as well as works in progress ending last day of the month previous to the one in which applications invited.
N = Number of years prescribed for completion of work for which bids have been invited.
B = Value of existing commitments and ongoing works to be completed during the period of completion of work for which bids have been invited. The Tenderer is requested to furnish the existing commitments of works under execution along with stipulated period for completion of remaining for each of the work should be furnished in an affidavit on non-judicial stamp paper of value of Rs. 100/- duly certified that the particulars furnished are correct as per the Performa in Annexure-A.

h) Site visit for the subject tender is mandatory. The bidders shall visit the site to Study/assess the tendered work and also acquaint themselves of the prevailing local conditions & detail status of the project work before submitting their bid. Bidder has to enclose a certificate counter signed by EPI official or furnish undertaking for having visited the site. Bidders must take note of the ACC Clause
40.0 and other contract clauses carefully while bidding.

i) Bidders who intend to get exemption from submission of Tender fee and EMD shall submit confirmation letter whether they are registered under MSME Act or not and if yes, then relevant copies of the registration letter (Registered under single point registration scheme of NSIC, Govt. of India, Ministry of MSME, New Delhi) vide Gazette Notification dated 26.03.2012 along with the form of Memorandum-2 (with the concerned DIC) certificate in the appropriate category and limit as applicable under the present tender to be enclosed in Technical Bid and a request letter for exemption from submission of Tender fee and EMD.

j) Even though an applicant may satisfy the eligibility criteria, EPI reserves the right for not issuing the tender document if he has record of poor performance such as abandoning work, not properly completing the work, delay in execution of work, poor quality of work, financial failure / weakness etc.

k) The experience certificates issued by Government Organizations/Semi Government Organizations/State Government / Public Works Department / Central Government/Public Sector Undertakings/ Autonomous Bodies/Municipal Bodies/Public Limited Companies listed on BSE/NSE and Private Party shall be accepted for assessing the eligibility of the tenderer. However, the certificates issued by Public Limited Company and Private Party must be supported by work order and TDS certificates. TDS certificates for full contract value as mentioned in the work order failing which the same shall not be considered.

l) Completion certificates from the client shall be in the name of the company who is submitting the tender. The contractor has to produce original documents for their verification as and when demanded by EPI. The tender of any tenderer shall be rejected if on detailed scrutiny; documents submitted along with the tender are found to be unsatisfactory / forged. The decision of EPI in this regard shall be final and the binding on the tenderer.

m) Relevant experience certificates and other documents as mentioned above fulfilling the qualifying criteria duly self-attested by the tenderer shall be enclosed in Envelope-1. Completion Certificates from clients shall be in the name of the Company who is submitting the tender. The bidder has to produce original documents for verification at the time of opening of tender or as and when demanded. The Tender of any tenderer shall be rejected if on detailed scrutiny, documents submitted along with the tender are found to be unsatisfactory. The decision of EPI in this regard shall be final and binding on the tenderer.

n) The tenderers may note that they are liable to be disqualified and not considered for the opening of Price Bid if;
   a) Representation in the forms, statements and attachments submitted in the pre-qualification document are proved to be incorrect, false and misleading.
   b) They have record of poor performance during the past 10 (ten) years such as abandoning the work, rescinding of contract for which the reasons are attributable to the non-performance of the contractor, inordinate delay in completion, consistent history of litigation / arbitration awarded against the contractor or any of its constituents or financial failures due to bankruptcy etc. in their ongoing / past projects.
   c) They have submitted incompletely filled in formats without attaching certified supporting documents and credentials to establish their eligibility to participate in
the Tender.
d) If the tenderers attempt to influence any member of the selection committee.

EPI reserves its right to take appropriate action including disqualification of tenderer(s) as may be deemed fit and proper by EPI at any time without giving any notice to the contractor in this regard. The decision of EPI in the matter of disqualification shall be final and binding on the Tenderers.

The credentials of the Bidders shall be verified and inspection of the works, if required, to be carried out by EPI. If not found satisfactory, their bid will be considered non-responsive.

2.0 Tender documents comprising of the following are available on the website of EPI: www.epi.gov.in, CPP-Portal: eprocure.gov.in/epublish and as well as on TCIL portal http://www.tcil-india-electronic.tender.com.

Volume I: Instructions to Tenderers, General Conditions of Contract (ITT&GCC) of EPI, Addendum to Instructions to Tenderers & Special instructions to Bidders for e-Tendering

Volume II: a) Notice inviting Tender.
b) Additional Conditions of Contract.
c) Technical Specifications.
d) Tender Drawings.

Volume III: Price Bid cum Bill of Quantity

3.0 In order to participate, the bidder should have Digital Signature Certificate (DSC) from one of the authorized Certifying Authorities.

4.0 Interested bidders have to necessarily register themselves on the portal https://www.tcil-india-electronic.tender.com through M/s Telecommunications Consultants India Limited, New Delhi to participate in the bidding under this invitation for bids. It shall be the sole responsibility of the interested bidders to get them registered at the aforesaid portal for which they are required to contact M/s Telecommunications Consultants India Limited, New Delhi at following address to complete the registration formalities:

M/s Telecommunications Consultants India Limited,
6th Floor, TCIL Bhawan, Greater Kailash – 1, New Delhi – 110 048
Contact No.: 011-26241790, 98683 93717/75/92
Email-ID: ets_support@tcil-india.com

They may obtain further information regarding this tender from DGM (Contracts) at the address given at Clause No.14.0 below from 10:00 hours to 17:00 hours on all working days till the last date of online submission of Bidding Documents.

For proper uploading of the bids on the portal namely https://www.tcil-india-electronic.tender.com (hereinafter referred to as the “portal”), it shall be the sole responsibility of the bidders to apprise themselves adequately regarding all the relevant procedures and provisions as detailed at the portal as well as by contacting M/s Telecommunications Consultants India Limited, New Delhi directly, as and when required, for which contact details are mentioned above. The EPI in no case shall be responsible for any issues related to timely or properly uploading/submission of the bid in accordance with the relevant provisions of Section: Instruction to Bidders of the Bidding Documents.

5.0 Bidders can download the bid document from the portal without paying document
fees in advance, any time from 20:00 Hrs on 05.09.2018 however, interested bidders have to pay tender fees for participating in the tendering and submitting the bid. For this purpose the interested bidders shall be required to pay ` 5,900 (Inclusive of GST) in the form of Demand Draft in favour of “Engineering Projects (India) Ltd.” payable at Guwahati as non-refundable document fees. The GSTIN of EPI is 18AAACE0061C1ZC.

6.0 E-Bids must be submitted/uploaded along with scanned copies of relevant documents mentioned at Clause no.2 of Addendum to Instruction to tenderers under Single Stage Two Envelope Bidding Procedure on the TCIL portal on or before last date & time of online bid submission. Late bids will not be accepted. Under the above procedure, only first envelope (Technical Part) shall be opened in the presence of the bidders’ representatives who choose to attend in person at the address given below on scheduled date & time of bid opening or may be viewed by the bidders by logging in to the portal as per features available to them. Second envelope i.e. Price part shall be opened of technically qualified bidders only.

7.0 The bid must be accompanied by an Earnest Money Deposit (EMD) of ` 69,000.00 (Rupees Sixty-Nine Thousand only). This shall be in the form of Crossed Demand Draft or Pay Order (in CTS form) of any Nationalized Bank/Scheduled Bank for the full amount of EMD payable favouring “Engineering Projects (India) Ltd.”, payable at Guwahati. The EMD shall be valid for minimum period of 150 days (one hundred fifty days) from the last day of submission of tender. Tenders submitted without EMD or inadequate amount of EMD shall be rejected. The bid shall be valid for 90 days from date of opening of Price Bid.

Tender fee, EMD (in original), Power of Attorney, NSIC/MSME certificate as per Clause No.1 (j) if bidder is claiming EMD/Tender fee exemption and Pass Phrase (Both for technical and financial bid- in separately sealed envelopes) to decrypt the bid must be submitted in physical form at the address given at Clause No. 14.0 below on or before Last date and time of online bid submission. If the above documents are not received in time then their offer shall not be considered and EPI shall not be responsible for any postal delay in respect of submission of hard copy part of the bids.

8.0 The Terms & Conditions contained in the NIT and tender document shall be applicable.

9.0 The tenderers should note that the credentials such as value and volume of works completed, as submitted by the tenderers along with their offers shall be forwarded by EPI to Client for his opinion. The offer of tenderers against whom client does not give satisfactory remarks shall be rejected by EPI.

10.0 The corrigendum or addendum, extension, cancellation of this NIT, if any, shall be hosted on the EPI’s website/CPP portal as well as on TCIL portal http://www.tcil-india-electronic-tender.com the bidders are required to check these websites regularly for this purpose, to take into account before uploading/submission of tender. All Corrigendum and addendum are to be uploaded duly signed & stamped with tender documents as bid Annexure.

11.0 The intending tenderers must not be or have been in litigation with EPI for last three years or at present. In case the participating tenderer(s) are found to have suppressed information in this respect the EMD submitted by him (they) shall be forfeited by EPI and his (their) tender shall be rejected. In case such suppression is detected after acceptance
of his (their) tender i.e. on award of the works the order/LOI shall be withdrawn and his securities forfeited.

12.0 The Price Bid of those bidders who are found to be prima-facie techno-commercially acceptable based on the documents submitted at the time of bid submission and also against fulfillment of conditions at sl. no. 10 above shall be opened with prior intimation to them. **Hence the intending bidders must furnish their e-mail id and contact phone number along with the techno-commercial part.** However, it is made clear that the offer of the bidders shall be accepted subject to the confirmation of authenticity of the PQ documents/ EMD /Tender fee from the concerned department/ bank. In case the PQ documents such as work experience certificate, bank solvency certificate etc submitted by a bidder is found to be fake the EMD submitted by him shall be forfeited by EPI without making any reference to him. Further such a tenderer shall be at a risk of losing his right to participate in any tender called by EPI for a minimum period of one year.

13.0 EPI reserves the right to accept any tender or reject any or all tenders or split the work of tender or annul this tendering process without assigning any reason and liability whatsoever and to reinvite tender at its sole discretion.

14.0 Tender documents shall be issued by and submitted to:
   DGM, Contracts
   Engineering Projects (India) Ltd.
   North Eastern Regional Office
   4th Floor, Hindustan Tower,
   Jawahar Nagar, National Highway No.37,
   Guwahati (Assam) -781022 (Tel No. 0361-2314681, Fax No.0361-2223617)

15.0 Contact details for site related quarries/ visit:
   Shri S.P. Roy, DGM
   Engineering Projects (India) Ltd.
   Phone No: +91-8974002171

   For more information on EPI, visit our website at: http://www.epi.gov.in
   For more information on the e-tender, visit website of M/s Telecommunications Consultants India Limited, New Delhi at: https://www.tcil-india-electronictender.com

DGM, Contracts
**BID CAPACITY**

**Name of the Work:** Design, Manufacture, Supply, Inspection, installation, Testing and Commissioning of Sewage Treatment Plant (175 KLD) of MBBR Technology, Supply of Mandatory Spare & Operation & Maintenance for 5 (five) years for the project “Construction of township at Khilpara, Udaipur, Tripura for 2X363.3 MW gas based combined cycle power plant of OTPC” on lumpsum basis.

**NIT No:** NERO/CON/753/318

**ESTIMATED COST PUT TO TENDER:** Rs. 69,00,000.00

Bid Capacity: The bidding capacity of the contractor should be equal to or more than the estimated cost of the work put to Tender. The bidding capacity shall be worked out by the following formula:

\[ \text{Bidding Capacity} = \left[ A \times N \times 2 \right] - B \]

Where,
A = Maximum value of construction works executed in any one year during the last five years taking into account the completed as well as works in progress
N = Number of years prescribed for completion of work for which bids have been invited
B = Value of existing commitments and ongoing works to be completed during the period of completion of work for which bids have been invited (Format enclosed)

**BID CAPACITY CALCULATION BY BIDDER**

SIGN & STAMP OF BIDDER
ANNEXURE-A

AFFIDAVIT

(To be typed on Rs. 100/- non-judicial stamp paper)

I/We .......................................aged ..............years son of .......................................do hereby solemnly affirm and declare as follows for and on behalf of the Firm:

LIST OF EXISTING COMMITMENT AND ONGOING WORKS

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of Works</th>
<th>Client Name &amp; Address</th>
<th>Work Order Value (in Rs)</th>
<th>Work Executed till Date (Rs)</th>
<th>Balance Amount of work to be completed (Rs)</th>
<th>Balance period to complete the works (Total months)</th>
<th>Work to be completed in 06 months (Rs)</th>
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Balance Commitments during 06 months as per NIT Rs.

It is certified that the above particulars furnished are true and correct. If any information given is found to be concealed at a later date, the Contract will be terminated forthwith without prejudice to the rights thereon consequent on termination and the bidder will be blacklisted. I/We agree for debarring tendering for one year if any facts are suppressed.

Signature of Notary Public

SIGN AND STAMP OF BIDDER
ADDITIONAL CONDITIONS OF CONTRACT (ACC)

1.0 The following Additional Conditions of Contract shall be read in conjunction with General Conditions of Contract (GCC) of EPI and other conditions of the tender documents. If there are any provisions in the Additional Conditions of Contract, which are at variance with the provisions of GCC and other conditions of the tender documents, the provisions in these Additional Conditions of Contract shall take precedence.

2.0 Engineering Projects (India) Limited has secured the work for Construction of Township at Khilpara, Udaipur, Tripura for 2X363.3 MW Gas Based Combined Cycle Power Plant. The tender shall include (but not limited to) providing labour, tools and plants, machineries, transport and all other components including all materials (except those which are specifically excluded from scope/present tender as spelt out elsewhere in the tender documents) as required in Design, Manufacture, Supply, Inspection, installation, Testing and Commissioning of Sewage Treatment Plant (175 KLD) of MBBR Technology, Supply of Mandatory Spare & Operation & Maintenance for 5 (five) years for the project “Construction of township at Khilpara, Udaipur, Tripura for 2X363.3 MW gas based combined cycle power plant of OTPC” on lumpsum basis.”

3.0 The site is located in Khilpara village in Gomati District on Udaipur-Kakraban Road. Udaipur, district headquarter, and one of the largest town of Tripura, is about 6 (six) kilometres from site and Palatana Power Plant is nearly 3 kms from the site. Nearest Railway station and Airport is at Agartala which is about 60 kms from site.

4.0 The word “contractor” appearing anywhere in the GCC and the other tender documents shall mean the „sub- contractor” i.e. the successful tenderer on whom the work under the present tender is awarded by EPI.

5.0 Clause no 3.0 of GCC shall stand amended as below:

The items of work given in the tender documents are for general guidance of the intending tenderers and the works shall be carried out by the successful tenderer i.e. the sub-contractor on item rate basis in conformity with the detailed drawing, scope of work, technical specifications, special conditions of the tender documents (including any addition/modification/ alteration/deletion made from time to time therein found essential for completion of works) for the scope of work (but not limited to) defined in the tender documents. The sub-contractor shall be deemed to have satisfied himself before tendering as to the sufficiency and correctness of his tender for the works and of the rates and prices quoted.
in the brief specifications, drawings, scope of work and payment (billing) schedule, which rates and prices shall, except as otherwise provided, cover all obligations under the contract and all matters and things found necessary for proper completion and maintenance of the works. It shall be the responsibility of the sub-contractor to incorporate the changes that may be different from the scope of work envisaged at the time of tendering and as actually required to be executed. The sub-contractor has to quote his rates after clearly studying the scope of work given in Tender Documents availed by him by downloading from the website or made available to him at the office of Dy. General Manager (Contracts) Engineering Projects (India) Limited, Guwahati at the tendering stage itself and getting fully satisfied with the various items and technical intricacies involved in the work under his scope of work as envisaged in the tender. EPI shall not entertain any claim of the contractor on account of error or omission by him in this respect except what is admitted by the client.

6.0 No mobilisation advance shall be paid and hence clause no. 8 of GCC shall stand deleted.

7.0 Safety Code:
   General:
   Sub-Contractor shall adhere of safe construction practice and guard against hazardous and unsafe working conditions and shall comply with Owner’s safety rules as set forth herein. Prior to start of construction, Contractor will be furnished of Owner’s Safety Code for information and guidance, if it has been prepared.

First Aid and Industrial Injuries
   (1) Sub-Contractor shall maintain first aid facilities for his employee and those associated with his work.
   (2) Sub-Contractor shall make outside arrangements for ambulance service and for the treatment of industrial injuries. Names of those providing these services shall be furnished to the Owner prior to start of construction and their telephone numbers shall be prominently posted in Contractor’s field office.
   (3) All critical industrial injuries shall be reported promptly to the Owner, and a copy of Contractor’s report covering each personal injury requiring the attention of a physician shall be furnished to the Owner.

General Rules

Smoking within the worksite is strictly prohibited. Violators of the no smoking rules shall be discharged immediately.

ACCP OF TENDER NO. NERO/CON/753/318  Page 2 of 25
Contractors Barricades

(1) Sub-Contractor shall erect and maintain barricades required in connection with his Operation to guard or protect.

(a) Excavations.
(b) Hoisting areas.
(c) Areas adjudged hazardous Sub-Contractor’s or Owner’s inspectors.
(d) Owner’s existing property subject to damage by Contractor’s operations.
(e) Rail road unloading spots.

(2) Sub-Contractor’s employee and those of his associates shall become acquainted with Owner’s barricading practices and shall respect the provisions thereof.

(3) Barricades and hazardous areas adjacent to but not located in normal routes of travel shall be marked by red flasher lanterns at nights.

Scaffolding

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

(ii) Scaffolding or staging than 4 meters above the ground or floor, swing suspended from an overhead support or erected with stationary support shall have a guard rail properly attached, bolted, braced and otherwise rewarded at least 3 ft. High above the floor or platform of such scaffolding or staging and extending along the entire length of the outside and ends thereof with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure.

(iii) Every opening the floor of a building or in a working platform shall be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be 1 metre.

(iv) Working platform, gangways and stairways should be so constructed that they should not sag unduly or unequally and if the height of the platform of the gangway or the stairway is more than 4 metres above ground level or floor level, they should be closely boarded, should have adequate width and should be
suitably fastened as described in (ii) above.

(v) Safe means of access shall be provided to all working platforms and other working places, every ladder should be securely fixed. No portable single ladder shall be over 9 metres in length while the width between side rails in rung ladder shall in no case be less than 30cms for ladder up to and including 3 metres in length. For longer ladder this width should be increased at least 5 mm for each additional foot of length. Uniform steps spacing shall not exceed 30cms. Adequate precautions shall be taken to prevent danger from electrical equipment. No materials on any of the site of work shall be so stacked or placed to cause danger or inconvenience to any person or public. The Contractor shall also provide all necessary fencing and light to protect the workers and staff from accidents, and shall be bound to bear the expenses of defence of every suit, action or other proceedings of law that may be brought by any person for injury sustained owing to neglect of the above precautions and pay any damages and costs which may be awarded in any such suit or action or proceedings to any such person or which may with the consent of the Contractor be paid to compromise any claim by any such person.

Excavation and Trenching

All trenches 1.2 metres or more in depth shall at all times be supplied with at least one ladder for each 50 metres length or fraction thereof.

Ladder shall be extended from bottom of the trench to at least 1 metre above the surface of the ground. The sides of the trenches which are 1.5 metres in depth shall be stepped back to give suitable slope or securely held by timber bracing, so as to avoid the danger of sides to collapse. The excavated materials shall not be placed within 1.5 metres of the edge of the trench or half of the trench width whichever is more. Cutting shall be done from top to bottom. Under no circumstances undermining or undercutting shall be done.

Demolition

(i) Before any demolition work is commenced and also during the progress of the work.

(a) All road and open areas adjacent to the work site shall either be closed or suitably protected

(b) No electric cable or apparatus which is liable to be a source of danger shall remain electrically charged.
(c) All practical precautions shall be taken to prevent danger to persons employed from risk of fire or explosion or flooding. No floor, roof or other part of the building shall be so over-loaded with debris or materials as to render it unsafe.

(ii) All necessary personal safety equipment as considered adequate by the Engineer-in-charge of EPI, should be kept available for the use of the persons employed on the site and maintained in condition suitable for immediate use, and the Contractor shall take adequate steps to ensure proper use of equipment by those concerned.

(a) Workers employed on mixing asphaltic materials, cement and lime mortars shall be provided with protective footwear and protective gloves.

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

(c) Those engaged in welding and cutting works shall be provided with protective face and eye shields, hand gloves etc.

(d) Stone breakers shall be provided with protective goggles and protective clothing, and seated sufficiently safe intervals.

(e) When workers are employed in sewers and manholes, which are in use, the Contractor shall ensure that the manhole covers are opened and are ventilated at least for an hour before the workers are allowed to gate in to the manholes, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or board to prevent accident to the public.

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

(1) No paint containing lead or lead product shall be used except in the form of paste or ready-made paint.

(2) Suitable face masks should be supplied for use by the workers when Paints are applied in the form of spray or a surface having lead paint dry rubbed and scrapped.

(3) Overalls shall be supplied by the Sub-Contractor to the workmen and adequate Facilities shall be provided to enable the working painters to wash them during
and on cessation of.

(iii) When the work is done near any place where there is a risk of drowning, all Necessary safety equipment should be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provision should be made for prompt first aid treatment of all injuries likely to be sustained during the course of the work.

(iv) Use of hoisting machines and tackles including their attachments, anchorage and supports shall conform to the following standards or conditions:

(a) These shall be of good mechanical construction, sound materials and adequate strength and free from patent defect and shall be kept in good working order.

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

c) Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 12 years should be in charge of any hoisting machine including any scaffolding, which or give signals to the operator.

(d) In case of every hoisting machine and of every chain ring hook, shackle, swivel, and pulley block used in hoisting or lowering or as means of suspension, the safe working load shall be ascertained by adequate means. every hoisting machine and all gears referred to above shall be plainly marked with the safe working load of the conditions under which it is applicable which shall be clearly indicated. No part of any machine or any gear referred to above in this paragraph shall be loaded beyond the safe working load except for the purpose of testing.

(e) In case of departmental machine, the safe working load shall be notified by the Engineer-in-charge of EPI. As regards Sub-Contractor’s machines, the Sub-Contractor shall notify the safe working load of the machine to the Engineer-in-charge whenever he brings any machinery to site of work and get it verified by the Engineers concerned.

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

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

(vii) These safety provisions should be brought to the notice of all concerned by displaying on a notice board at a prominent place at the work-spot. The person responsible for compliance of the safety code shall be named therein by the Contractor.

(viii) To ensure effective enforcement of the rules and regulations relating to safety precautions, the arrangements made by the Sub-Contractor shall be open to inspection by the Welfare Officer, Engineer-in-Charge of EPI or safety Engineer of the administration or their representatives.

(ix) Notwithstanding the above clauses there is nothing in these to exempt the contractor from the operations of any other Act or rules in force in the Republic of India.

The works throughout including any temporary works shall be carried out in such a manner as not to interfere in any way whatsoever with the traffic on any roads or footpaths at the site or in the vicinity thereto or any exiting works whether the property of the Administration or of a third party.

In addition to the above, the Sub-Contractor shall abide by the safety code provision as per C.P.W.D. Safety Code and Indian standard Safety Code framed from time to time.

Notwithstanding above Clause No.40 (Annexure C) titled “Safety” of the “Owner” shall be binding on the sub-contractor. Similarly, the Clause Nos. 24, 33, 34,35, 36.37, 38, 39, 41,42 of OTPC (Annexures D, E, F, G, H, I, J, K, L, M respectively) shall be binding on the Sub-contractor.

8.0 The clause no. 10.0 of GCC stands superseded by the payment terms given at clause no. 25.0 of ACC.
9.0 The following shall stand added to clause no. 11.0 of GCC:

Water: The Sub-contractor shall arrange water fit for the purpose of drinking and construction at their own cost. (Boring is permitted at site)

Power: Owner will supply power at a point within the premises, from where the sub-contractor will make his/their own arrangement for distribution. All the works of the sub-contractor shall be done as per Indian Electricity Act and Rules framed there under and approved by the Engineer-in-Charge of EPI. The temporary lines will be removed forthwith after the completion of the work or if there is any hindrance caused to the other work due to the alignment of these lines, the contractor will re-route or remove the temporary lines at his own cost. The contractor at his own cost will also provide suitable electric meters, fuses, switches etc. These shall be in the custody and control of the Owner. The cost of power supply shall be payable to the Owner every month at the prevailing rates from time to time or will be deducted from the running account bills.

Owner, however, does not guarantee uninterrupted power supply and this does not relieve the contractor of his responsibility for the timely completion of various works as stipulated, nor any compensation shall be paid to the sub-contractor for any failure or short supplies of Power. The contractor shall therefore make their own arrangement for standby power supply at his own cost.

10.0 Work in monsoon and dewatering

The completion of the work may entail working in monsoon also. The sub-Contractor must maintain minimum labour force as may be required for the job and plan and execute the construction and erection according to the prescribed schedule. No extra rate will be considered such work in monsoon. During monsoon and other period, it shall be the responsibility of the sub-Contractor to keep the construction work site free from water at his own cost.

11.0 Work on Sundays and holidays

For carrying our work on Sundays and holidays, the Sub-Contractor will approach the Engineer-in-Charge of EPI or his representative at least two days in advance and obtain permission in writing.

12.0 General conditions for construction and erection mark

The working time at the time of work is 48 hours per week. Over timework is permitted in cases of need and the Owner will not compensate for the same. Shift working at 2 or 3 shifts per day will become necessary and the sub-
contractor should take this aspect in to consideration for formulating his rates for quotation. No extra claims will be entertained by the EPI on this account.

The sub-contractor must arrange for the placement of workers in such a way that delayed completion of the work or any part thereof for any reason whatsoever will not effect their proper employment. EPI will not entertain any claim for idle time payment whatsoever.

13.0 Setting out works

The Engineer-in-Charge of EPI shall furnish the Sub-Contractor with only the four corners of the work site and a level bench mark and the Contractor shall set out the works and shall provide efficient staff for the purpose and shall be solely responsible for the accuracy of such setting out.

The Sub-Contractor shall/provide, fix and be responsible for the maintenance of all stakes, templates, level marks, profiles and other similar things and shall take necessary precautions to prevent their removal or disturbance and shall be responsible for the consequence of such removal or disturbance should the same take place and for their efficient and timely reinstatement. The Sub-Contractor shall also be responsible for the maintenance of all existing survey marks, boundary marks, distance marks and centre line marks, either existing or supplied and fixed by the Sub-Contractor. The work shall be set out to the satisfaction of the Owner. The approval thereof or joining with the Sub-Contractor by the Owner in setting out the work, shall not relieve the Contractor or any of his responsibilities.

Before beginning the works, the Sub-Contractor shall at his own cost, provide all necessary reference and level posts, pegs, bamboo, flags, ranging rods, strings and other materials for proper layout of the work in accordance with the scheme for bearing marks acceptable to the Owner. The Centre, longitudinal or face lines and cross lines shall be marked by means of small masonry pillars. Each pillar shall have distinct marks at the centre to enable a theodolite to be set over it. No work shall be started until all these points are checked and approved by the Engineer-in-Charge in writing but such approval shall not relieve the Sub-Contractor of any of his responsibility. The Sub-Contractor shall also provide all labour, material and other facilities, as necessary, for the proper checking of layout and inspection of the points during construction.

Pillars bearing geodetic marks located at the sites of units of works under construction should be protected and fenced by the Sub-Contractor.
On completion of works, the Sub-Contractor must submit the geodetic documents according to which the work was carried out.

14.0 Responsibility for level and alignment

The Sub-Contractor shall be entirely and exclusively responsible for the horizontal and vertical alignment, the levels and correctness of every part of the work and shall rectify effectually any errors or imperfections therein. Such rectifications shall be carried out by the Contractor, at his own cost, when instructions are issued to that effect by the Engineer-in-Charge.

It is highly possible that there shall be more than one agency working at the same time at the site. The sub-contractor shall at all times remain bound to co-ordinate with the agencies, deployed by EPI/Client for the above works, including providing free access and making required provisions for them in execution of works pertaining to their portion of works. He shall also remain bound to ensure uninterrupted progress of work by these agencies in a peaceful and smooth manner. He shall also remain bound to make the required changes/additions/alterations in the works done by him to accommodate the items under the scope of work of such other agencies deployed by EPI or the client. The sub-contractor is deemed to have made the estimated allowances in this respect while quoting his rates at the tendering stage.

The list of minimum tools, plant and machinery to be provided by the sub-contractor within the period mentioned against the respective item is given at Annexure-A.

15.0 The Clause no 9 of GCC shall stand amended as follows:

Within 10 (ten) days from the date of issue of letter of Intent or within such extended time as may be granted by EPI in writing, the Sub-Contractor shall submit to EPI a Security Deposit cum Performance Bank Guarantee in the form appended, from any Nationalised bank / Scheduled Bank equivalent to 10% (ten percent only) of the Contract Value for the due and proper execution of the contract. This bank guarantee shall remain valid up to 90 (Ninety) days after the end of defects liability period of 18 (eighteen) months from the taking over of works by owner.

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

16.0 The Clause no 10 of GCC shall stand replaced by Clause no 25 (A & B) of
ACC described hereinafter at relevant place. EMD deposited by the bidder
shall be released after deposit of full value Security Deposit cum performance
guarantee.

17.0 The following shall be also read with clause no 13 of GCC:

a) The bidder/contractor must be registered with GST and should have valid
GSTIN number

b) The bidder/contractor must submit as an compliance under GST Act, the
invoices in GST complaint format failing which the GST amount shall be
recovered/adjusted without any prior notice from the next invoices or available
dues with EPI.

c) The bidder/contractor are required to update/upload the GST/Taxes data
periodically so as to avail ITC credit by EPI failing which it shall be
recovered/adjusted by EPI without any prior intimation

d) The rates quoted by the contractor shall be “inclusive of all taxes and duties,
cess including GST” which shall be reimbursed to him subject to raising of tax
invoice and filing of return and payment of tax as per GST law, failing which EPI
shall not be able to honour his claims for any payment. The contractor has
quoted his rates knowing fully well that submission of return and display of the
same on GSTN portal is mandatory.

e) In case of any reduction in rate of GST or other taxes in future or the project
getting exemption status prior to the last date of Bid submission or afterwards,
the subcontractor shall pass on the benefit to EPIL immediately, failing which
EPIL shall have the right to recover the differential amount from the amounts
due to the subcontractor. Further in case of any increase in rate of GST or other
taxes in future or the project losing exemption status prior to last date of bid
submission or afterwards, the said increase of taxes shall be paid/reimbursed
to the subcontractors, subject to the condition that the client reimburses the said
increased taxes to EPIL.

18.0 The clause nos. 17.0, 18.0 & 19.0 of GCC of EPI shall stand amended as
under:

Insurance charges for insurances to be taken by EPI for the project like
Contractor’s All Risk Policy, Erection All Risk Policy, Comprehensive
Automobile Insurance, Comprehensive General Liability Insurance, Marine Insurance etc against all loss or damage that include but not limited to fire and allied risks, miscellaneous accidents (construction & erection risk), loss or damage in transit, theft, pilferage, riot and strike and malicious damages, civil commotion, weather conditions, accidents of all kinds, risk of terrorism, etc. to the materials and structures during handling, transportation, storage, construction erection, testing, putting into satisfactory operation and all activities to be performed till the successful completion of Services and taking over by the Owner including warranty period with the sum insured being on replacement value basis but in no case less than 110% (one hundred and ten percent) of the full replacement value of the materials and structures installed and constructed including transit and third party liability **shall be borne by the sub-contractor in proportion to his contract price.** Bidder may take note that proportionate cost to his portion will be around 1% of the total liability of the project as per present scope. The Comprehensive Automobile Insurance shall cover liability for a minimum amount for (Any one accident: Any One year: Rs. 10 Cr: Rs. 10 Cr) and the Comprehensive Automobile Insurance shall cover liability for the following minimum amounts subject to the Motor Vehicles Act, 1988: a) Fatal Injury: Rs 1,000,000 (Rupees One Million only) each Person &Rs 10,000,000 (Rupees Ten Million only) each occurrence and Property Damage: Rs. 10,000,000 (Rupees Ten Million only) each occurrence.

However, the sub-contractor shall take Group Personal Accident Policy and insurance cover at its own cost towards Workman Compensation Act for its own workers and employees engaged by it for the works under the present tender/sub- contract within 10 days of issuance of Letter of Intent by EPI and shall furnish documentary proof of the same to EPI. The insurance policy for Workman Compensation shall also cover the sub-contractor against claims for injury, disability, disease or death of its employees, which, for any reason, are not covered under the Workmen’s Compensation Act, 1923. The insurance policy shall protect the Contractor against all claims arising from injuries, disabilities, disease or death of any of its and its Subcontractor's employees, due to any accident. The Group Personal Accident Policy shall cover liability for a minimum amount of for (Any one accident: Any One year: Rs. 50.00 Lacs). In case the sub-contractor fails to do so, EPI shall be at liberty to withhold all payments to the sub-contractor till the submission of such documentary evidence or take the required insurance policy under the Workman Compensation Act and recover the cost of the insurance premium(s) paid in this respect by EPI to the insurance company from the sub-contractor’s bill(s). Notwithstanding payment of such insurance premiums and the resulting recovery thereto the sub-contractor shall remain bound to assist EPI in follow up with the insurance company in case of any
claim related to contractor scope of work. EPI is not liable to pay any claim of the sub-contractor if it is not paid by insurance company due to any reasons whatsoever. The insurance company providing such insurance cover must be approved by IRDAI.

Employee State Insurance Act

The Contractor agrees to and does hereby accept full and exclusive liability for compliance with all obligations imposed by the Employees State Insurance Act, 1984, and the Contractor further agrees to defend, indemnify and hold Owner harmless from any liability or penalty which may be imposed by the Central, State or Local authority by reason of any asserted, violation by Contractor or sub-contractor of the Employees State Insurance Act, 1948, and also from all claims, suits or proceeding that may be brought against the Owner arising under, growing out of or by reasons of the work provided for by this contract whether brought by employees of the Contractor, by third parties or by Central or State Government authority or any political sub-division thereof.

The Owner shall retain such sum as may be necessary from the total contract value until the Contractor shall furnish satisfactory proof that all contributions as required by the Employees State Insurance Act, 1948, have been paid.

19.0 The following shall stand added to the clause no 20 of GCC:

The sub-contractor shall keep EPI indemnified against all claims, damages, compensation and expenses payable, if any, in consequence of any accident, or injury sustained by any workman or any other person employed by the sub-contractor.

20.0 The following shall stand added to Clause no 21.0 and 23.0 including their sub-clauses of the GCC:

amendments or modifications from time to time. He shall also extend all assistance to EPI during inspection of the officials of such law enforcing agencies including the rectification of defects/ observations (if any) made/pointed out during the visit(s) of the officials.

21.0 The following shall stand added to the clause no 27.0 including its sub-clauses of GCC of EPI

The sub-contractor, on notice of EPI as per requirement pertaining to the scope of the sub-contractor shall depute one graduate civil engineer with 5 years of post-qualification experience or one diploma in civil engineering with 7 years of post-qualification experience and one graduate electrical engineer with 5 years of post-qualification experience or one diploma in electrical engineering with 7 years of post-qualification experience. Should the contractor fail to do so EPI shall be at liberty to deduct an amount of Rs 40000.00 per such engineer per month (to be computed on per day basis) till the time the sub-contractor deploys the engineers as stated hereinbefore from his payable amount and also in no way committing him or without diluting any of the contractual obligations of the sub-contractor, EPI shall be at liberty to deploy such engineers at cost of the sub-contractor.

22.0 The clause no 28.3 of the GCC stands deleted

23.0 The clause no 35.0 of GCC shall stand amended as below

There shall be no secured advance payable to the sub-contractor.

24.0 The following shall be added to the clause no 36.0 of the GCC:

The measurement of the works as certified/recorded by the owner for the portion of works executed by the sub-contractor shall be final and binding on the sub-contractor. The Sub-contractor shall remain liable to provide all assistance at the time of recording the measurements by the client.

25.0 Payments: The following shall stand added to clause no 37.0 of the GCC and shall be read in conjunction with clause 39.0 of ACC.

A) Supply Contract:
   A1) **Ten Percent** (10%) of the Contract Price excluding all taxes and duties shall be released as 1st Stage Payment within thirty (30) days of receipt of Invoice on fulfilment of the following conditions:
      A1.1 Unconditional and unequivocal acceptance of Letter of Intent (LOI).
      A1.3 Submission of detailed schedule of work in PERT Network.
A1.4 Submission of an unconditional Bank Guarantee covering the 1st Stage Payment which shall be initially kept valid till ninety (90) days after the Time of Completion.

A2) Sixty percent (60%) of the contract price including all taxes & duties (GST) shall be released on pro-rata basis against progressive dispatch of Materials duly cleared for Dispatch by Owner within thirty (30) days of receipt of following documents by Owner (Original + 2 Copies):

A2.1 Invoice
A2.2 Delivery Challan
A2.3 Consignment Note- Consignee Copy ( Negotiable copy)
A2.4 Packing List
A2.5 Transit Insurance Certificate
A2.6 Test Report and Inspection Certificate or Inspection waiver certificate issued by owner
A2.7 Material Dispatch clearance certificate issued by Owner and
A2.8 Documentary evidence of payment of taxes, duties & levies.

A3) Twenty Percent (20%) of the contract price excluding all taxes, duties and levies shall be released on pro-rata basis against progressive receipt of materials in good condition at site within thirty (30) days of receipt of following documents by the Owner in original + 2 Copies:

A 3.1 Invoice
A 3.2 Copy of consignment note/ lorry receipt having material receipt endorsed by Owner
A 3.3 Copy of way bill/ road permit used for transportation of materials and
A 3.4 Material receipt certificate issued by Owner.

A4) Ten percent (10%) of the Contract Price excluding all taxes, duties and levies (GST) shall be released after Final Acceptance of Materials evidenced by final acceptance certificate issued by Owner and submission of as-built drawings, documents, test reports & certificates and Operation & Maintenance Manuals within 30 days of submission of Invoice and supporting documents.

B) Installation Service Contract

B1) Ten Percent (10%) of the contract price excluding all taxes, duties & levies shall be released as initial advance within thirty (30) days of receipt of invoice by Owner on fulfilment of the following conditions

B1.1 Unconditional and unequivocal acceptance of Letter of Intent (LOI)
B1.2 Submission of Security Deposit cum Performance Bank Guarantee
B1.3 Submission of detailed schedule of work in PERT Network
B1.4 Submission of an unconditional Bank Guarantee covering the 1st Stage
Payment which shall be initially kept valid till ninety (90) days after the Time of Completion.

B2) **Eighty percent** (80%) of the Contract Price alongwith taxes & duties (GST) shall be released on pro-rata basis against progressive completion of Services as duly certified by EIC of EPI and Project Manager of the Owner within thirty (30) days of receipt of following documents in original + 2 copies

B2.1 Work completion & measurement certificate duly certified by EIC
B2.2 Protocols required to be filled-in after completion of work as per approved Field Quality Plan duly signed by quality control engineer of Owner
B2.3 Running Account Bill duly certified by EIC of EPI;
And
B2.4 Documentary evidence of payment of taxes, duties & levies(GST).

B3) **Ten percent** (10%) of the Contract Price excluding all taxes, duties and levies(GST) shall be released after Final Acceptance of facility evidenced by final acceptance certificate issued by Owner and submission of as-built drawings, documents, test reports & certificates and Operation & Maintenance Manuals within 30 days of submission of Invoice and supporting documents.

**NOTE:** In case the successful tenderer does not avail 1st Stage Payment, 70% of the Contract Price shall be released on pro-rata basis instead of 60% mentioned in above Clauses A2. Similarly, 90% of the Contract Price shall be released on pro-rata basis instead of 80% mentioned in Clause B2 above in case the successful tenderer does not avail 1st Stage Payment.

All payments made during the Contract shall be on-account payments only. The final payment shall be made on Final Acceptance of Services and on fulfilment by the Contractor of all its liabilities under the Contract including those in respect of warranties etc. Payments to be made hereunder are subject to any adjustment/deductions as per the provisions of this Contract. The Contract Price will be paid in Indian Rupees only.
Invoices to be raised on EPI by Sub-contractor are to be indicate the required details as prescribed under GST wherever applicable.

All bank charges shall be to the account of Contractor. Applicable income tax/withholding tax/TDS/labour cess and any other prevalent tax shall be deducted while making payment and necessary certificate as per Applicable Law shall be issued in due course of time. If the Owner disputes any item of an invoice, the Owner shall make payment for the undisputed portion of such invoice when such payment becomes due under this Contract. The Owner
shall make the balance payment within 30 (thirty) days after resolution of the
dispute as per terms of the contract free of any interest.

Notwithstanding anything stated hereinbefore or hereinafter the sub-contractor
has clearly understood that all payments for his portion of works shall be
released by EPI within seven working days of receipt of payments by EPI
from the Client for the sub-contractor’s portion of work and after making the
recoveries mentioned in relevant clause(s) and other recoveries if any.

The final bill payment to the sub-contractor shall be released only after receipt
of corresponding payment from client and when the sub-contractor submits
EPF clearance certificate, ESIC, all other clearances, approvals, certificates
etc. as per agreement of EPI with the client for the “Works” and as per statutory
requirement.

The sub-contractor shall have no claim on EPI in case the payments to EPI are
delayed by the client due to any reason whatsoever.

26.0 The clause no. 43.2 shall stand amended as below:

The sub-contractor shall execute the works so as to complete the works
within the stipulated completion time and submit a programme showing
deployment of resources for completion of the works within the said
completion time including achievement of the milestones in the programme.

27.0 The clause no 45.0 of the GCC stands modified as under:

The sub-contractor shall, at his own expense, provide all materials as
required for completion of the works under the sub-contract. The sub-
contractor shall at his own expense and without delay supply to EPI/client
samples of all materials including the materials being provided by EPI to
him to be used on the works and shall get the same approved by EPI. All
such materials shall be in conformity with the specifications laid down or
referred to in the sub-contract. In case the sub-contractor fails to submit the
samples in time, EPI shall be at liberty to finalise the type and source of the
materials and that shall be binding on the sub-contractor at no extra cost to
EPI. The sub-contractor shall at all time remain bound to provide the samples
in quantity and manner as instructed by EPI to be analysed or tested in an
approved laboratory or in the field laboratory at site. The cost of testing
charges is included in the prices of the sub-contractor. EPI shall, however, be
at liberty to get the materials tested independent of the sub-contractor and the
sub-contractor shall remain bound to render all assistance to EPI in
conducting of such tests including making available the materials in sufficient
quantity and in time and payment of the testing charges. EPI/client shall at all times have full access to the works and to all workshops and places where work is being prepared or from where materials, manufactured articles or machinery. The sub-contractor shall afford every facility and assistance and cost in obtaining the right and visit to such access.

EPI shall have full powers to require the removal from the premises of all materials which in their opinion are not in accordance with the specifications and in case of default, EPI shall be at liberty to employ at the expense of the sub-contractor, other persons to remove such materials without being answerable or accountable for any loss or damage that may happen or arise to such materials. EPI shall also have full powers to require other proper materials to be substituted thereof and in case of default by the sub-contractor, may cause the same to be supplied and all costs which may require such removal and substitution shall be to the sub-contractor's account.

28.0 The following shall be added to clause no 52,6 of GCC:

The sub-contractor shall be equipped with the minimum number of testing equipment as per Annexure-B

29.0 The following provisions shall supersede Clause no 69 of GCC wherever applicable:

No claim on account of extra / substituted / variation of items etc. pertaining to the sub-contractor’s portion of work save and except what is admitted and paid by Owner (OTPC), shall be entertained or admitted by EPI. Any claim/revision of rates etc., by the sub-contractor, if not paid by the Owner, whatsoever be the reason shall not be admitted by EPI. The amount, if at all admitted and paid by the Owner for the sub-contractor's portion of work, shall be paid to him after making a deduction of 10% (ten percent) towards EPI's overhead and administrative charges. EPI's decision in this respect shall be final and binding on the sub-contractor. But under no circumstances sub-contractor shall suspend the work on the non-settlement of rates under this clause.

30.0 In case the project execution is delayed beyond the contractual scheduled completion period due to reason attributable to the sub-contractor, the site office expenses of EPI for extended period shall be paid by him to EPI at the rate of Rs. 5,000/- per month. This shall be in addition to the facilities provided by the sub-contractor to EPI (if any) and the other recoveries, if applicable as per clause no 72 (including its sub clauses) of GCC and Penalties etc. if any, levied by Client for the works pertaining to the sub-contractor's scope of work. The decision of EPI in this regard shall be final & binding on the party.
31.0 The sub-contractor shall be responsible for obtaining all approvals from Client with regard to quality of materials & workmanship and measurements etc. for their portion of work. All such approvals shall be in the name and title of EPI. The sub-contractor shall be responsible for reconciliation of issued material with Client/EPI, if any, and the sub-contractor shall make arrangements for safe up keeping / custody of the material and final reconciliation is also to be done by the sub-contractor. In case there is any shortfall of any issued items during reconciliation, recovery at double the cost of materials prevailing at that time of recovery shall be made from the sub-contractor’s due payment.

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

33.0 Issues related to interpretation and claims, if any, related to the sub-contractor’s scope of work, arising out of contract between EPI and Client shall be referred with full justification by the sub-contractor to EPI for settlement with Client including arbitration with Client, if inescapable, and outcome of such a settlement shall be binding on the sub-contractor. EPI at its option may associate the sub-contractor in the above process of settlement for his portion of work. The cost & expenses on arbitration with Client shall be shared by EPI and the sub-contractor in proportion of his offer and EPI’s mark up towards its overheads & profits. In case the award/settlement with the Client is in favour of EPI, ninety percent of the award/settlement amount shall be shared between EPI and sub-contractor in proportion of sub-contractor’s contract price with EPI and EPI’s mark up towards its overheads & profits. The balance ten percent of the award/settlement amount shall be retained by EPI towards its administrative charges. In case the award/settlement is against EPI, the entire damages/counterclaims imposed, if any, shall be borne by the sub-contractor alone and the sub-contractor shall have no claim whatsoever against, EPI in such a settlement. Further, EPI shall have no liability towards any claim of the sub-contractor, which is not paid by the Client.

34.0 In case of non-approval of sub-contractor’s association for the Project by the Client and/or by the corporate office of EPI due to any reasons whatsoever
at any stage of the “Works”, the sub-contractor shall have no claim on EPI.

35.0 The work executed by the sub-contractor shall be subject to audit and quality control checks from Quality Control Division & Technical Audit of EPI, Client, and Inspecting Agency of the Client and Chief Technical Examiner of Central Vigilance Commission, Govt. of India. In the eventuality of any defect/ sub-standard works as brought out in the report or noticed otherwise at any time during execution, maintenance period etc., the same shall be made good by the sub-contractor without any cost to EPI. In case the sub-contractor fails to rectify the defect/sub- standard work within the time period stipulated by EPI, EPI shall get it rectified at the risk and cost of the sub-contractor and shall recover the amount from the dues of the sub-contractor.

36.0 EPI has agreed to associate the sub-contractor on the basis of details regarding his experience profile, financial standing, credentials, fulfilment of statutory obligations, etc. by him to EPI. In case, at a later stage if it is found that the sub-contractor has submitted incorrect, false details and credentials resulting in apprehensions on the capabilities of the sub-contractor with regard to quality & timely completion of works, financial capabilities etc, EPI can terminate this order solely at its option. In this eventuality the sub-contractor shall be liable for the losses suffered by EPI and further the sub-contractor shall have no claim on EPI, whatsoever.

37.0 However, if EPI is granted some concession or exempted from certain obligations by Client, by virtue of EPI being a Public Sector Company, the same concessions / exemptions shall not be applicable to the sub-contractor. The decision of EPI in this regard including interpretation of terms & conditions shall be final & binding on the sub-contractor.

38.0 ARBITRATION: Clause no. 76.1 of GCC shall stand amended as below:

Before resorting to arbitration as per the clause given below, the parties if they so agree may explore the possibility of conciliation as per the provisions of Part III of the Arbitration and Conciliation Act, 1996 as amended by Arbitration and Conciliation (Amendment) Act, 2015. When such conciliation has failed, the parties shall adopt the following procedure for arbitration:

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

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

b) Which are likely to affect his ability to devote sufficient time to the arbitration and in particular his ability to complete the entire arbitration within a period of twelve months.

The Arbitrator shall be appointed within 30 days of the receipt of letter of invocation of arbitration duly satisfying the requirements of this clause.

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

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

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

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

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

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

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

38.1 Clause no 76.2 of GCC shall stand amended as under
“In the event of any dispute or difference relating to the interpretation and application of the provisions of commercial contract(s) between Central Public Sector Enterprises (CPSE) / Port Trust inter se and also between CPSE and Government Departments / Organizations (excluding disputes concerning Railways, Income Tax, Customs and Excise Departments), such dispute or differences shall be taken up by either party for resolution through AMRCD as mentioned in DPE OM No. 4(1)/2013-DPE(GM)/FTS-1835 dated 22.05.2018”

38.2 Clause no 76.2 & 76.3 of GCC shall remain un-changed.

39.0 Signing of the Contract: Clause no.84 of GCC shall stand amended as below: Within 10 days from issuance of Letter of Intent the successful tenderer shall be required to execute following contract agreements with EPI:

a) **Supply Contract:** DESIGN, MANUFACTURE, SUPPLY, INSPECTION OF SEWAGE TREATMENT PLANT (175 KLD) OF MBBR TECHNOLOGY, SUPPLY OF MANDATORY SPARE & OPERATION & MAINTENANCE FOR 5 (FIVE) YEARS FOR THE PROJECT “CONSTRUCTION OF TOWNSHIP AT KHILPARA, UDAIPUR, TRIPURA FOR 2X363.3 MW GAS BASED COMBINED CYCLE POWER PLANT OF OTPC” ON LUMPSUM BASIS.”

b) **Installation Services Contract:** For PROVIDING TRANSPORTATION, ERECTION, TESTING & COMMISSIONING OF SEWAGE TREATMENT PLANT (175 KLD) OF MBBR TECHNOLOGY, SUPPLY OF MANDATORY SPARE & OPERATION & MAINTENANCE FOR 5 (FIVE) YEARS FOR THE PROJECT “CONSTRUCTION OF TOWNSHIP AT KHILPARA, UDAIPUR, TRIPURA FOR 2X363.3 MW GAS BASED COMBINED CYCLE POWER PLANT OF OTPC” ON LUMPSUM BASIS.”

The execution of two separate contracts for supplying the materials and installation service shall not in any way dilute the responsibility of the sub-contractor for the successful completion of the entire scope covered in these two contracts and performance of the services in accordance with this contract. The sub-contractor agrees to perform its obligations under each of supply contract and installation service contract in a manner that facilitates the due performance of his obligations under the other contract. A breach in any one of the contracts mentioned at Sl. No. 39 of ACC shall automatically be construed as a breach of the other contract which will confer a right on EPI to suspend or terminate the other contract also at the risk and cost of the sub-contractor including but not limited to rights as enumerated in cl. No. 72.2 of GCC.
40.0 The bidder shall undertake site visit as per condition of NIT and shall evaluate the tentative date of taking up his scope of work and submit work programme accordingly. The bidder undertakes that, he shall plan his portion of work accordingly and date of commencement of work shall be stipulated jointly by the successful bidder & EPI. EPI’s Decision in this regard shall be binding on the sub-contractor and in case the tentative date of commencement is preponed/postponed for project requirement or any other reason, sub-contractor shall change his plan/programme accordingly and in no case shall be entitled for any extra payment or can discharge him from any contractual obligation. The Sub-contractor is required to complete the work within the stipulated time of completion to be reckoned from the date of commencement so decided.

(Signature and seal of the Tenderer)
# ANNEXURE-A

LIST OF MINIMUM TOOLS, PLANT AND MACHINERY

<table>
<thead>
<tr>
<th>SL. No.</th>
<th>Description</th>
<th>Minimum numbers required</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Excavator/JCB</td>
<td>One nos.</td>
<td>As and when Instructed</td>
</tr>
<tr>
<td>2</td>
<td>Truck/Tractor with</td>
<td>One</td>
<td>-do-</td>
</tr>
<tr>
<td>3</td>
<td>DG Set 5 KVA (Minimum)</td>
<td>One no</td>
<td>-do-</td>
</tr>
<tr>
<td>4</td>
<td>Shuttering material (Ply/Steel)</td>
<td>50 Sqm</td>
<td>As per agreed schedule</td>
</tr>
<tr>
<td>5</td>
<td>Measuring Boxes for Weight to Volume Conversion of Aggregates</td>
<td>Two Sets</td>
<td>-do-</td>
</tr>
<tr>
<td>6</td>
<td>Power Hacksaw</td>
<td>One no</td>
<td>-do-</td>
</tr>
<tr>
<td>7</td>
<td>Full Bag Capacity Concrete mixer and concrete Pouring Trolley</td>
<td>One no</td>
<td>-do-</td>
</tr>
<tr>
<td>8</td>
<td>Diesel 5 HP &amp; Electric 2 HP Pump</td>
<td>One Each</td>
<td>-do-</td>
</tr>
<tr>
<td>9</td>
<td>Portable Electric Blowers</td>
<td>Two nos.</td>
<td>-do-</td>
</tr>
<tr>
<td>10</td>
<td>Reinforcement cutting machine</td>
<td>One</td>
<td>-do-</td>
</tr>
<tr>
<td>11</td>
<td>Slide wrench, pipe wrench etc</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>12</td>
<td>Scaffolding materials</td>
<td>Adequate</td>
<td>-do-</td>
</tr>
</tbody>
</table>

**Note:**

(a) The period mentioned above shall be reckoned from the date of start of commencement of work as mentioned under this tender.

(b) The quantities and list of equipment mentioned above indicative only and can be changed/increased as per the requirement of work OR as per the direction of Engineer-in-Charge. The contractor has to deploy all the required equipment to complete all the works within stipulated specifications & time period as contract documents.

(c) The sub-contractor will not be allowed to take out equipment from the site without the written permission of Engineer-in-Charge.

(Signature and seal of the Tenderer)
# ANNEXURE-B

## LIST OF MINIMUM TESTING EQUIPMENT

<table>
<thead>
<tr>
<th>SL. No.</th>
<th>Description</th>
<th>Minimum numbers required</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CC Mould 15cmx15cmx15cm</td>
<td>Two Sets</td>
<td>As per agreed schedule</td>
</tr>
<tr>
<td>2</td>
<td>Sieve Set (Course/Fine)</td>
<td>One Set Each</td>
<td>-Do-</td>
</tr>
<tr>
<td>3</td>
<td>Tray/Measuring Cylinder, Steel Tape etc as required</td>
<td>One Each</td>
<td>-Do-</td>
</tr>
</tbody>
</table>

**Note:**

a) The period mentioned above shall be reckoned from the date of start of commencement of work as mentioned under this tender.

b) The quantities of equipment indicative only and can be changed/increased as per the requirement of work OR as per the direction of Engineer-in-Charge. The above equipment list is indicative and not complete. The contractor has to deploy all the required equipment to complete all the works within stipulated specifications & time period as contract documents.

c) The sub-contractor will not be allowed to take out equipment from the site without the written permission of Engineer-in-Charge.

(Signature and seal of the Tenderer)
40.0 SAFETY

40.1 The Contractor shall at all times comply with the HES Policy while performing the Services. In addition, the Contractor shall ensure proper safety of all the workmen, materials, plant and equipment belonging to it or to the Owner or to others working at the Site. The Contractor shall also be responsible for provision of all safety notices and safety equipment required both under Applicable Law and any additionally required by the Owner.

40.2 The Contractor shall notify well in advance to the Owner of its intention to bring to the Site any container filled with liquid or gaseous fuel or explosive or petroleum substance or such Hazardous Materials. The Owner shall have the right to prescribe the conditions, under which such container is to be stored, handled and used during the performance of the Services and the Contractor shall strictly adhere to and comply with such instructions. The Owner shall have the right, at its sole discretion, to inspect any such container or such plant/equipment for which material in the container is required to be used and if in its opinion, its use is not safe, it may forbid the use of such material contained in such container(s). No claim due to such prohibition shall be entertained by the Owner nor shall the Owner entertain any claim of the Contractor towards additional safety provisions/conditions to be provided for/constructed as per Owner’s instructions. Further any such decision of Owner shall not, in any way, absolve the Contractor of its responsibilities and, in case, use of such a container or entry thereof into the Site is forbidden by Owner, the Contractor shall use alternative methods, with the approval of Owner, without any cost implication to the Owner.

40.3 Where it is necessary to provide and/or store petroleum products or petroleum mixtures and explosives, the Contractor shall be responsible for carrying out such provision and/or storage in accordance with the rules and regulations laid down under Applicable Laws (such as Petroleum Act, 1934, Explosives Act, 1948, and Petroleum and Carbide of Calcium Manual published by the Chief Inspector of Explosives of India). All such storage shall be with prior written approval of the Owner. In case any approval is necessary from the Chief Inspector (Explosives) or any other Government Agency, the Owner shall provide reasonable assistance to the Contractor in obtaining the same.

40.4 All tools, tackles and equipments used in performing Services by the Contractor shall meet the prescribed Indian/international standards and where such standards do not exist, the Contractor shall ensure these to be absolutely safe/best industry standards. All equipment, tools, tackles and Plants shall be strictly operated and maintained by the Contractor in accordance with manufacturer’s operation manual and safety instructions and as per procedures/guidelines/rules of the Owner in this regard.
40.5 Periodical examinations and all tests for all lifting/hoisting equipment and tackle shall be carried out in accordance with the relevant provisions of Applicable Laws (such as Factories Act, 1948). A register of such examinations and tests shall be properly maintained by the Contractor and will be promptly produced as and when required by Owner or by Owner’s representative.

40.6 The Contractor shall be fully responsible for the safe storage of its and its Subcontractors radio-active sources in accordance with BARC/DAE Rules and other applicable provisions. All precautionary measures stipulated by BARC/DAE Rules in connection with use, storage and handling of such material will be taken by the Contractor.

40.7 The Contractor shall provide suitable safety equipment of prescribed standard to all employees and workmen according to the need, as may be directed by Owner who will also have right to examine these safety equipment to determine their suitability, reliability, acceptability and adaptability.

40.8 Where explosives are to be used, the same shall be used under the direct control and supervision of an expert, experienced, qualified and competent Person strictly in accordance with the codes of practice/rules framed under Indian Explosives Act, 1948 pertaining to handling, storage and use of explosives.

40.9 The Contractor shall provide safe working conditions to all workmen and employees at the Site including safe means of access, railings, stairs, ladders, scaffoldings, etc. The scaffoldings shall be erected under the control and supervision of an experienced and competent Person. For construction and erection, good and standard quality of material only shall be used by the Contractor.

40.10 The Contractor shall not interfere or disturb electric fuses, wiring and other electrical equipment belonging to other contractors under any circumstance, whatsoever, unless expressly permitted in writing by the Owner to handle such fuses, wiring or electrical equipment.

40.11 Before the Contractor connects any electrical appliance to any plug or socket belonging to the other contractor, it shall:

40.11.1 satisfy the Owner that the appliance is in good working condition;

40.11.2 inform the Owner of the maximum current rating, voltage and phases of the appliances; and

40.11.3 obtain permission of the Owner detailing the sockets to which the appliances may be connected.
<table>
<thead>
<tr>
<th>Clause</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>40.12</td>
<td>The Owner will not grant permission to connect until it is satisfied that:</td>
</tr>
<tr>
<td>40.12.1</td>
<td>the appliance is in good condition and is fitted with a suitable plug; and</td>
</tr>
<tr>
<td>40.12.2</td>
<td>the appliance is fitted with a suitable cable having 2 (two) earth conductors, 1 (one) of which shall be an earthed metal sheath surrounding the cores.</td>
</tr>
<tr>
<td>40.13</td>
<td>No electric cable used by the other contractor/Owner will be disturbed without prior permission of the Owner. No weight of any description will be imposed on any cable and no ladder or similar equipment will be rested against or attached to it.</td>
</tr>
<tr>
<td>40.14</td>
<td>No repair work shall be carried out on any live equipment. The equipment must be declared safe by the Contractor before any repair work is carried out. While working on electric lines/equipment, whether live or dead, suitable and sufficient quantity of tools shall be provided by the Contractor to electricians/workmen/officers.</td>
</tr>
<tr>
<td>40.15</td>
<td>The Contractor shall employ adequate number of qualified, licensed, full time electricians/electrical supervisors to maintain electrical installations, to the satisfaction of the Owner.</td>
</tr>
<tr>
<td>40.16</td>
<td>The Contractor shall employ at least 1 (one) full time officer exclusively as safety officer to supervise safety aspects of the equipment and workmen. Such safety officer shall co-ordinate with the project safety officer appointed by the Owner in respect of all matters relating to the safety of area and material at Site. In case of work being carried out through Subcontractors, the Subcontractor's workmen/employees will also be considered as the Contractor's employees/workmen for the above purpose. The name and address of such safety officer of the Contractor will be promptly informed in writing to the Owner before the Contractor commences Services at Site or immediately after any change of the Contractor's safety officer is made during the Term.</td>
</tr>
<tr>
<td>40.17</td>
<td>In case any accident occurs during the performance of the Services, thereby causing any minor or major or fatal injury to Contractor's employees due to any reason, whatsoever, it shall be responsibility of the Contractor to promptly inform the same to the Owner, in prescribed form, and also to all the authorities envisaged under the Applicable Laws.</td>
</tr>
<tr>
<td>40.18</td>
<td>The Owner shall have the right, at its sole discretion, to stop the work, if in its opinion the work is being carried out in such a way that it may cause accidents and/or endanger the safety of the Person(s) and/or property and/or equipment. In such cases, the Contractor shall be informed in writing about the nature of hazards and possible injury/accident and it shall comply to remove the shortcomings promptly. The Contractor after stopping the specific work may, if necessary, appeal against the order of stoppage of work to the Owner within 3 (three) days of such stoppage of work and decision of the Owner in this respect shall be conclusive and binding on the Contractor.</td>
</tr>
<tr>
<td>40.19</td>
<td>The Contractor shall not be entitled to any damages/compensation for stoppage of work due to safety reasons as provided in Clause 40.18 above.</td>
</tr>
</tbody>
</table>
40.20 The Contractor shall follow and comply with all safety rules, prescribed by the Owner, relevant provisions of Applicable Laws pertaining to the safety of workmen, employees, plant and equipment as may be prescribed from time to time without any demur, protest or contest or reservation. In case of any discrepancy between the statutory requirements and the prescribed safety rules referred above, the more stringent provisions shall be applicable and binding upon the Contractor.

40.21 The Contractor acknowledges that providing a safe working environment at the Site is a material requirement of the HES Policy and this Contract. If the Contractor fails in providing safe working environment as per the provisions of Clause 40.20 above or continues the work even after being instructed to stop work by the Owner as provided in Clause 40.18 above, then it would be a breach of the HES Policy and this Contract. In case of such a breach, the Contractor shall promptly pay to the Owner, on demand, compensation at the rate of Rs. 50,000/- (Rupees fifty thousand only) per day or part thereof till the instructions are complied with and so certified by the Owner. However, in case of accident taking place causing injury, to any individual, the provisions contained in Clause 40.22 shall also apply in addition to compensation mentioned in this Clause 40.21.

40.22 The Contractor acknowledges that having a zero fatality rate at the Site is important for the Owner and a material requirement of the HES Policy. If the Contractor does not take all safety precautions and/or fails to comply with the HES Policy, the prescribed safety rules or Applicable Laws for the safety of the equipment and plant and for the safety of personnel and the Contractor does not prevent hazardous conditions which cause injury to its own employees or employees of other contractors, or employees of the Owner or any other Person who may be present at Site or adjacent thereto, the Contractor shall be responsible for payment of compensation to the Owner as per the following schedule:

<table>
<thead>
<tr>
<th>Injury Type</th>
<th>Compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Fatal injury or accident causing death:</td>
<td>Rs. 1,000,000/- (Rupees One Million only) per Person.</td>
</tr>
<tr>
<td>b. Major injuries or accident causing 25% (twenty five percent) or more permanent disablement to workmen or employees:</td>
<td>Rs. 250,000/- (Rupees Two Hundred Fifty Thousand only) per Person.</td>
</tr>
</tbody>
</table>

Permanent disability shall have the same meaning as indicated in Workmen's Compensation Act, 1923. The compensation mentioned above shall be in addition to the compensation payable to the workmen/employees under the relevant provisions of the Workmen's Compensation Act, 1923 and rules framed there under or any other Applicable Laws as applicable from time to time. In case the Owner is made to pay such compensation then the Contractor shall be liable to pay to the Owner such amount in addition to the compensation indicated above.

The amounts paid to the Owner by the Contractor pursuant to Clause 40.21 and/or Clause 40.22 shall be deposited by the Owner in a labour welfare fund which will be utilized by the Owner for the welfare of the labour.
40.23 **Safety Code**

40.23.1 The Contractor shall, at its own expense, arrange for the minimum safety provisions listed in Annexure 9 (Safety Code) to this Contract or as required by the Owner, in respect of all labour directly or indirectly employed for performance of the Services and shall provide all facilities in connection therewith. In case the Contractor fails to make arrangements and provide necessary facilities as aforesaid, the Owner shall be entitled to do so and recover the cost thereof from the Contractor.

40.24 Contractor shall not, under any circumstances apply to or enter into negotiations with any Government Agency for acceptance of variations from or revisions to safety or health, or air, water or noise pollution laws or regulations relating to this Contract, or to the performance of Services, without Owner's prior written approval.

40.25 Contractor shall not, under any circumstances, cause or permit, in connection with the Services to be performed hereunder, the discharge, emission or release of any Hazardous Materials and/or waste, pollutant, contaminant or other substance in violation of any Applicable Laws. Contractor shall comply with all Applicable Laws (including Environmental Law) requirements applicable to the Services and shall be responsible for compliance with all such requirements relating to the Hazardous Materials, health and safety, notice and training.
TOWNSHIP AT KHI LPARA, TRIPURA

ANNEXURE-D

24.0 FIELD QUALITY ASSURANCE AND INSPECTIONS

24.1 To ensure the conformance of the Services, whether performed at the Site, by Contractor or by its Subcontractors, with the provisions of this Contract, Contractor shall adopt, as well as ensure adoption by its Subcontractor, suitable Field Quality Program. The Owner or its representative(s) shall have the right to inspect and/or to test the Services to check their conformity with the provisions of this Contract.

24.2 The Field Quality Program, proposed for adoption by the Contractor, shall be submitted for review and approval of the Owner, within 30 (thirty) days of the Effective Date. It shall inter alia specify required inspection and tests to be carried out by Contractor as per Contract and applicable codes for all phases of construction, the procedures involved, acceptance basis, acceptance criteria and customer hold points (CHPs) beyond which work shall not proceed, without the specific clearance of the Owner. The approved Field Quality Program shall form part of this Contract and shall be strictly adhered to.

24.3 In case of stage inspection, the Contractor shall proceed from one stage to another only after the component of the work is inspected and tested by the Owner or their representative(s) and permission given to proceed further. The procedure shall be adopted for any rectifications/repairs suggested by the Owner or their representative(s).

24.4 No part of the work shall be covered up without carrying out inspection and tests specified in the Field Quality Program. Contractor shall uncover such part of the work which have been covered up without carrying out inspection and tests specified in Field Quality Program and cover them up after carrying out inspection and tests specified in Field quality Program. Cost for such uncovering and covering up shall be borne by Contractor.

24.5 Contractor shall provide reasonable advance notice to Owner for witnessing inspection and tests specified in Field Quality Program.

24.6 Contractor shall provide at his own cost all facilities including labour, materials, electricity, fuel, water, stores, apparatus, instruments etc reasonably required by Owner and/or their representative for effectively carrying out such inspection and tests in accordance with the Contract and applicable codes.

24.7 Owner may ask Contractor to perform any such inspection and tests which are not specified in Contract and Field Quality Program. Contractor shall perform such inspection and tests and Owner shall pay to the Contractor reasonable cost incurred in carrying out such inspection and tests.

24.8 Contractor shall also be responsible for monitoring each Subcontractor's compliance with the Field Quality Program. The Owner shall have the right to conduct audits of the Contractor's Field Quality Program. Contractor shall cooperate with and extend all support to Owner in carrying out such audits.

24.9 Price for all inspection and tests to be carried out till Final Acceptance of Services and during Warranty Period are included in Contract Price.
24.10 Inspection and acceptance of the Services by the Owner and / or their representative shall not limit the liabilities and responsibilities of the Contractor in any manner and shall not prejudice the right of the Owner to reject the Services if it is found to be defective subsequently or if Facility fails to achieve performance guarantee under the Contract. Nothing in this Article 24.0 shall, in any way, release the Contractor from any of its Warranty or other obligations under this Contract.
33.0 **FIRE PROTECTION**

33.1 The Contractor shall at all times comply with the HES Policy while performing the Services during the Term. Without prejudice to the obligation under the preceding sentence, the work procedures that are to be used during the performance of the Services shall be those which minimize fire hazards to the extent practicable. The Contractor shall ensure that combustible materials, combustible waste, rubbish and any Hazardous Material shall be collected and removed from the Site at least once each day. Fuel, oils and volatile or flammable materials shall be stored away from the equipment and materials storage areas in safe containers. Untreated canvas, paper, plastic or other flammable flexible materials shall not at all be used at Site for any purpose unless otherwise specified. If any such material is received with any other equipment/material at the Plant, the same shall be removed and replaced with acceptable material before moving into the construction or storage area.

33.2 The Contractor shall ensure that corrugated paper, fabricated cartons, etc. will not be permitted at the Site either for storage or for handling of materials. All such materials used shall be of water proof and flame resistant type. All other materials such as working drawings, plans, etc. which are combustible but are essential for the Services to be performed shall be protected against combustion resulting from welding sparks, cutting flames and other similar fire sources.

33.3 The entire supervisory personnel and sufficient number of workers of the Contractor shall be trained for fire-fighting and shall be assigned specific fire protection duties. Adequate number of such trained personnel must be available at the Site during the entire Term at all times.

33.4 The Contractor shall provide fire fighting equipments in adequate numbers and capacity and shall ensure that such fire fighting equipments placed at various locations at the Site are easily accessible at all times.
34.0 SECURITY

34.1 Contractor shall be solely responsible for all equipment and materials in its custody, stores, loose, semi-assembled and/or installed by it at Site. The Contractor shall make suitable security arrangements including employment of security personnel to ensure protection of all materials, equipment and Services from theft, fire, pilferage and any other damage and loss. All materials of the Contractor shall enter and leave the project site only with the written permission of the Owner.
ANNEXURE-G

35.0 CONTRACTOR’S AREA LIMITS

35.1 The Owner will mark-out the boundary limits of access roads, parking spaces, storage and operational areas for the Contractor and the Contractor shall not trespass the areas which are outside the boundary limits so marked out. The Contractor shall be responsible to ensure that none of the Contractor Staff move out of the areas marked out for its operations. In case of a need for the Contractor Staff to work in areas other than those marked out for it, written permission of the Owner shall be obtained before proceeding to work in such areas.
TOWNSHIP AT KHILPARA, TRIPURA

ANNEXURE-H

36.0 TRASPORTATION, MATERIALS HANDLING AND STORAGE

36.1 Transportation of Materials

36.1.1 Responsibility

36.1.1.1 The Contractor shall be fully responsible for the transportation and insurance of all the materials to the Site, including for the payment of all transportation and handling costs and expenses.

36.1.1.2 It is acknowledged by the Contractor that the responsibilities for transportation set out in this Clause are included in the Contract Price.

36.1.2 Mode of Transport

The Contractor shall at its own risk and expense, transport the materials to the Site by the mode of transport that the Contractor in its reasonable judgment considers most suitable. Unless otherwise provided in this Contract, the Contractor shall have the right to select any safe mode of transport operated by any Person to transport the materials to the Site. The Contractor shall ensure that such mode of transport is in full compliance with Applicable Laws. Contractor shall preferably transport materials without allowing transshipment enroute to the Site.

36.1.3 Information and Documents

All relevant documents pertaining to any materials, as may be necessary for the transportation of the same, shall be arranged by the Contractor.

36.1.4 Approvals

The Contractor shall be responsible for obtaining, if necessary, approvals from any Government Agency for transportation of the materials to the Site. The Owner shall use reasonable endeavours to assist the Contractor in obtaining such approvals, if requested by the Contractor.

36.2 All the materials arriving at the Site shall be promptly received, unloaded, transported and stored in the storage spaces by the Contractor. Such materials shall be used by the Contractor for performance of the Services under this Contract.

36.3 The Contractor shall be responsible for examining all the consignments and notifying the Owner immediately of any damage, shortage, discrepancy, etc. This notification shall be for the purpose of Owner's information only. The Contractor shall submit to the Owner every week a report detailing all receipts during the week.

36.4 Contractor shall be solely responsible for any shortage or damage in handling and/or in storage and use of the materials at the Site.

36.5 The Contractor shall maintain an accurate and exhaustive record detailing out the list of all the materials received by it for the purposes of use in performing the Services and shall keep such records open for the inspection of the Owner.
36.6 All the materials shall be handled very carefully to prevent any damage or loss. No bare wire ropes, slings, etc. shall be used for unloading and/or handling of the materials without the specific written permission of the Owner. The materials stored shall be properly protected to prevent damage either to the Materials or to the floor where they are stored. The materials from the store shall be moved to the actual location at the appropriate time so as to avoid damage to such materials.

36.7 The Contractor shall ensure that all the packing materials and protection devices used for packing the materials during transit and storage are removed before the materials are installed.

36.8 The materials likely to deteriorate due to storage shall be thoroughly protected and stored in a suitable manner so as to prevent damage or deterioration in quality by storage.

36.9 All the materials stored in the open or dusty locations shall be covered with suitable weather-proof and flameproof covering material, wherever applicable.

36.10 If the materials belonging to the Contractor are stored in areas other than those earmarked for it, the Owner will have the right to get it moved to the area earmarked for the Contractor at the Contractor’s cost.

36.11 The Contractor may store materials, appropriate for storage in open, in open storage yard. However, Owner may direct the Contractor to move certain materials which in its opinion will require indoor storage, to indoor storage areas (with or without air-conditioning facility, as per recommendations of the OEM) which the Contractor shall strictly comply with.

36.12 All materials which are to be supplied by the Owner, if any, shall also be promptly received, unloaded and transported and stored in the storage spaces by the Contractor. The Contractor shall be responsible for examining all the shipment and notifying the Owner immediately of any damage, shortage, discrepancy, etc. The Contractor shall maintain separately an accurate and exhaustive record detailing out the list of all materials received by it on behalf of Owner for the purpose of use in the Services and shall keep such records open for the inspection by the Owner.
ANNEXURE-I

37.0 COOPERATION AND COORDINATION AT THE SITE

37.1 Contractor shall co-operate with Owner's contractors and Owner's Engineer and freely exchange with them such technical information as is necessary to perform the Services most efficiently and economically and to avoid unnecessary duplication of efforts. Owner shall be provided with a copy of all correspondence addressed by the Contractor to such other contractors and Owner's Engineer in respect of such exchange of technical information.

37.2 In case where the performance of the Services by the Contractor affects the performance of work of other contractors, such Services of the Contractor shall be scheduled to be performed only in the manner stipulated by the Owner and the same shall be acceptable at all times by the Contractor. The Owner may impose such restrictions on the facilities provided to the Contractor as it may think fit in the interest of the Owner and the Contractor shall strictly adhere to such restrictions and co-operate with the Owner.

37.3 The field activities of the contractors working at Site will be coordinated by the Owner and the Owner's decision shall be final in resolving any dispute or conflict between the Contractor and other contractors of the Owner regarding scheduling and co-ordination of Services. Such decision by the Owner shall not be a cause for extra compensation for the Contractor.

37.4 The Parties expressly agree that the procedures in relation to implementation of the terms of this Contract shall be discussed mutually between the Parties forthwith after the Effective Date.

37.5 Meetings

37.5.1 The Owner shall hold weekly meetings (or meetings at such shorter duration as it may deem necessary) of all contractors working at Site, at a time and place to be designated by the Owner. The Contractor shall attend such meetings and take notes of discussions during the meeting and the decisions of the Owner and shall strictly adhere to those decisions in performing the Services. In addition to the above meetings, the Owner may call for other meetings either with individual contractors or with selected number of contractors and in such a case the Contractor, if called, will also attend such meetings.

37.5.2 On Owner's invitation, Contractor shall participate in discussions with other parties including Lenders, Owner's consultants, Owner's insurers, Owner's advisors, Promoters, and Government Agencies, etc.
38.0 CONTRACTOR’S MATERIALS BROUGHT ON TO SITE

38.1 The Contractor shall bring to Site all equipment, components, parts, materials, including materials handling equipment, tools and tackle for the purpose of performing the Services with prior written notice to the Owner. Ownership of such materials shall remain with Contractor. All such goods shall be used for the purpose of providing the Services only and shall not on any account be removed or taken away by the Contractor without the written permission of the Owner. The Contractor shall nevertheless be solely liable and responsible for any loss or destruction thereof and damage thereto.

38.2 After the completion of Term, the Contractor shall remove from the Site under the direction and with written permission of the Owner the materials brought by it for performing the Services which are not property of the Owner. If the Contractor fails to remove such materials, within 15 (fifteen) days of issue of a notice by the Owner to do so then the Owner shall have the liberty to dispose of such materials and credit the proceeds thereto to the account of the Contractor.
39.0 **PROTECTION OF MATERIALS, PROPERTY AND PERSONNEL**

39.1 The Services shall remain in care and custody of Contractor and the Contractor shall be responsible for any loss or damage resulting from any act or omission of the Contractor or its Sub contractors till Taking-Over of the Services by the Owner. It shall also be responsible for protection of all Persons including members of public and employees of the Owner and the employees of other contractors and Subcontractors and all public and private properties in the vicinity of the Site including structures, buildings, other plants and equipment and utilities either above or below the ground.

39.2 The Contractor shall protect existing structures, roads, drains, pipes, cables, overhead wires and other similar infrastructure existing at or in the vicinity of the Site from any loss or damage while performing Services. Contractor shall make good at his own cost all loss or damage to such infrastructures existing at or in the vicinity of the Site.

39.3 The Contractor shall ensure provision of necessary safety equipment as specified under the HES Policy including but not limited to barriers, sign-boards, warning lights and alarms, etc., to provide adequate protection to materials, Persons and property. The Contractor shall be responsible to give reasonable notice to the Owner and the owners of public or private properties and utilities when such properties and utilities are likely to get damaged or injured during the performance of the Services and shall make all necessary arrangements with such owners, in relation to removal and/or replacement or protection of such properties and utilities.

39.4 The Owner shall not be responsible or held liable for any damage to materials, Person or property consequent upon the use, misuse or failure of any tools and equipments used by the Contractor Staff, even though such tools and equipments may be furnished, rented or loaned to the Contractor Staff. The acceptance and/or use of any such tools and equipments by Contractor Staff shall be construed to mean that the Contractor accepts all responsibility for and agrees to indemnify and hold the Owner harmless from any and all claims for damages resulting from use, misuse or failure of such tools and equipments.

39.5 Contractor shall be responsible during performance of the Services for protection of the work which has been completed by other contractors of the Owner. Necessary care shall be taken by the Contractor to see that no damage to the work is caused by it and/or the Contractor Staff during the course of performance of the Services.
**STATUTORY APPROVALS, PERMITS AND FRAUDULENT PRACTICES**

41.0

**Statutory Approvals**

41.1.1 The Contractor shall obtain all clearances, approvals, licenses, permits etc in accordance with applicable rules of Government Agency which are required for performing Services including transportation, construction etc. Price for obtaining clearances, approvals, licenses, permits etc including payment of statutory fees is included in Contract Price.

41.1.2 The Contractor shall submit to concerned authorities, on behalf of Owner, duly filled-in application form along with required certificates and other documents well in time. Contractor shall coordinate and liaise with concerned authorities and ensure that performance of Services are not adversely affected for want of clearances, approvals, licenses, permits etc.

41.1.3 The Contractor shall carryout all modifications, additions, and deletions to the Services as asked by concerned authorities for granting clearances, approvals, licenses, permits etc. Price for modifications, additions and deletions to the Services is included in Contract Price.

41.2

**Permits for Performing Services**

41.2.1 The Contractor shall in its name obtain any and all Permits necessary for the Contractor to do business and to be authorized to provide the Services (in the jurisdictions where the Services are to be performed) as contemplated by this Contract. Contractor shall also obtain such Permits required, for any employees, contractors or Subcontractors who are not citizens of India, to work, reside or otherwise perform the Services in India. Owner shall provide reasonable assistance to Contractor in obtaining, renewing and replacing all such Permits.

41.3

**Corrupt / Fraudulent Practices**

41.3.1 The Contractor shall not, directly or indirectly, engage in any Corrupt Practice, Fraudulent Practice, Coercive Practice or Obstructive Practice during the negotiation of this Contract or at any time during the Term.
42.0  **EMERGENCIES**

42.1  Notwithstanding anything to the contrary contained herein, the Contractor shall take any action as the Contractor deems to be necessary in the case of an Emergency Event affecting the Facility or the performance of Services to counteract the effects where the Contractor considers immediate action is required to safeguard life or property.

42.2  In the event of occurrence of an Emergency Event, the Contractor shall notify the Owner by telephone as soon as reasonably practicable, and in any case within 8 (eight) hours, and in writing within 24 (twenty four) hours of the occurrence of any Emergency Event, providing details of the Emergency Event and Contractor's actions taken in an effort to prevent any threatened damage, injury or loss to the Facility or Persons or property located on or in the vicinity of the Facility. Following such notification, at the request of the Owner, the Parties shall discuss without delay the further actions which should be taken in relation to the Emergency Event.

42.3  If the Owner considers that any Emergency Event has occurred in relation to the Site, the Owner may give notice (which may be oral notice and confirmed with subsequent written notice) to the Contractor specifying the nature of the Emergency Event which it has identified and the manner in which such Emergency Event should be rectified. The Contractor shall rectify such defect with all due diligence. If the Contractor fails to comply with such notice promptly, the Owner shall be entitled to take such actions as may be necessary to remedy such breach by the Contractor at Contractor's expense.
TECHNICAL SPECIFICATIONS
FOR
CONSTRUCTION OF TOWNSHIP AT
KHILPARA, UDAIPUR, TRIPURA

Annexure-2 to Supply Contract
Annexure-4 to Installation Services Contract
Annexure-2 to Civil Works Contract

(This document is meant for the exclusive purpose of bidding against this specification and shall not be transferred, reproduced or otherwise used for purposes other than that for which it is specifically issued).
TECHNICAL SPECIFICATIONS FOR CONSTRUCTION OF TOWNSHIP AT KHILPARA, udaipur, Tripura

TABLE OF CONTENT

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Civil Work (Internal &amp; External)</td>
<td>3-142</td>
</tr>
<tr>
<td>2.0</td>
<td>Electrical Work (Internal &amp; External)</td>
<td>143-255</td>
</tr>
<tr>
<td>3.0</td>
<td>Plumbing Work (Internal &amp; External)</td>
<td>256-291</td>
</tr>
<tr>
<td>4.0</td>
<td>HVAC Work</td>
<td>292-322</td>
</tr>
<tr>
<td>5.0</td>
<td>List of Approved Makes</td>
<td>323-329</td>
</tr>
</tbody>
</table>
SECTION – 1.0

DETAILED TECHNICAL SPECIFICATION – CIVIL WORKS
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Clause No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Carriage of Material</td>
</tr>
<tr>
<td>2.0</td>
<td>Earth Work</td>
</tr>
<tr>
<td>3.0</td>
<td>Concrete Work</td>
</tr>
<tr>
<td>4.0</td>
<td>Reinforced Cement Concrete</td>
</tr>
<tr>
<td>5.0</td>
<td>Steel Reinforcement</td>
</tr>
<tr>
<td>6.0</td>
<td>Form Work</td>
</tr>
<tr>
<td>7.0</td>
<td>Brick Masonry Work</td>
</tr>
<tr>
<td>8.0</td>
<td>Marble &amp; Granite Stone Work</td>
</tr>
<tr>
<td>9.0</td>
<td>Wood &amp; PVC Work</td>
</tr>
<tr>
<td>10.0</td>
<td>Steel Work</td>
</tr>
<tr>
<td>11.0</td>
<td>Flooring &amp; Cladding</td>
</tr>
<tr>
<td>12.0</td>
<td>Roofing</td>
</tr>
<tr>
<td>13.0</td>
<td>Finishing</td>
</tr>
<tr>
<td>14.0</td>
<td>Pile Work</td>
</tr>
<tr>
<td>15.0</td>
<td>Aluminum Work</td>
</tr>
<tr>
<td>16.0</td>
<td>Water Proofing</td>
</tr>
<tr>
<td>17.0</td>
<td>Swimming Pool</td>
</tr>
</tbody>
</table>
1.0 CARRIAGE OF MATERIAL

1.1 GENERAL

The carriage and stacking of materials shall be done as directed by the Engineer-in-Charge. Any tools and plants, required for the work shall be arranged by the Contractor. The carriage of materials includes loading within a lead of 50 metres, unloading and stacking within a lead of 50 metres.

1.1 RESPONSIBILITY FOR LOSS OR DAMAGE

Loading, carriage, unloading and stacking shall be done carefully to avoid loss or damage to the materials. In case of any loss or damage, recovery shall be effected from the Contractor at twice the Departmental issue rates of the materials. If the departmental issue rates of the materials are not available then the recovery shall be effected at twice the prevailing market rates as determined by the Engineer-in-Charge.

1.2 MODE OF CARRIAGE

Depending upon the feasibility and economy, the Engineer-in-Charge shall determine the mode of carriage viz. whether by mechanical or animal transport or manual labour.

1.3 LEAD

1.3.1 All distances shall be measured over the shortest practical route and not necessarily the route actually taken. Route other than shortest practical route may be considered in cases of unavoidable circumstances and as approved by Engineer-in-Charge along with reasons in writing.

1.3.2 Carriage by manual labour shall be reckoned in units of 50 metres or part thereof.

1.3.3 Carriage by animal and mechanical transport shall be reckoned in one km unit. Distances of 0.5 km or more shall be taken as 1 km and distance of less than 0.5 km shall be ignored. However, when the total lead is less than 0.5 km, it will not be ignored but paid for separately in successive stages of 50 metres subject to the condition that the rate worked on this basis does not exceed the rate for initial lead of 1 km by mechanical/ animal transport.

1.4 GENERAL CONSIDERATION FOR STACKING AND STORAGE

1.4.1 Planning of Storage Layout

For any site, there should be proper planning of the layout for stacking and storage of different materials, components and equipments with proper access and proper manoeuvrability of the vehicles carrying the material. While planning the layout, the requirements of various materials, components and equipments at different stages of construction shall be considered. The storage & stacking check list is given in Table 1.1. For further details refer IS- 4082.

1.4.2 Material shall be stored in such a manner as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work.
1.5 PROTECTION AGAINST ATMOSPHERIC AGENCIES

Materials stored at site, depending upon the individual characteristics, shall be protected from atmospheric actions, such as rain, sun, winds and moisture to avoid deterioration.

1.6 PROTECTION AGAINST FIRE AND OTHER HAZARDS

1.6.1 Materials like timber, coal, paints, etc. shall be stored in such a way that there may not be any possibility of fire hazards. Inflammable materials like kerosene and petrol, shall be stored in accordance with the relevant rules and regulations so as to ensure the desired safety during storage. Stacks shall not be piled so high as to make them unstable under fire fighting conditions and in general they shall not be more than 4.5 m in height. The provisions given in IS 13416 (part 5) shall be followed.

1.7 STACKING AND STORAGE OF MATERIALS

1.7.1 Cement

1.7.1.1 In case cement is received in bags. Cement shall be stored at the work site in a building or a shed which is dry, leakproof and as moisture proof as possible. The building or shed for storage should have minimum number of windows and close fitting doors and these should be kept closed as far as possible.

1.7.1.2 Cement shall be stored and stacked in bags and shall be kept free from the possibility of any dampness or moisture coming in contact with them. Cement bags shall be stacked off the floor on wooden planks in such a way as to keep about 150 mm to 200 mm clear above the floor. The floor may comprise of lean cement concrete or two layers of dry bricks laid on well consolidated earth. A space of 600 mm minimum shall be left around between the exterior walls and the stacks. In the stacks the cement bags shall be kept close together to reduce circulation of air as much as possible. Owing to pressure on the bottom layer of bags sometimes ‘warehouse pack’ is developed in these bags. This can be removed easily by rolling the bags when the cement is taken out for use. Lumbed bags, if any should be removed and disposed off.

1.7.1.3 The height of stack shall not be more than 10 bags to prevent the possibility of lumping up under pressure. The width of the stack shall be not more than four bags length or 3 metres. In stacks more than 8 bags high, the cement bags shall be arranged alternately length-wise and cross-wise so as to tie the stacks together and minimize the danger of topping over. Cement bags shall be stacked in a manner to facilitate their removal and use in the order in which they are received; a label showing date of receipt of cement shall be put on each stack to know the age of cement.

1.7.1.4 For extra safety during the monsoon, or when it is expected to store for an unusually long period, the stack shall be completely enclosed by a water proofing membrane such as polyethylene, which shall close on the top of the stack. Care shall be taken to see that the waterproofing membrane is not damaged any time during use.

1.7.1.5 Cement in gunny bags, paper bags and polyethylene bags shall be stored separately.

1.7.2 In case cement is received in drums

These shall be stored on plane level ground, as far as possible near the concrete mixing place. After taking out the required quantity of cement, the lid of the drum shall be securely tied to prevent ingress of moisture.
1.7.3 In case cement is received in silos
The silos shall be placed near the concrete batching plant. Proper access shall be provided for the replacement of silos.

1.7.4 Different types of cements shall be stacked and stored separately.

1.8 BRICKS

1.8.1 Bricks shall be stacked in regular tiers as and when they are unloaded to minimize breakage and defacement. These shall not be dumped at site.

1.8.2 Bricks stacks shall be placed close to the site of work so that least effort is required to unload and transport the bricks again by loading on pallets or in barrows. Building bricks shall be loaded or unloaded a pair at a time unless palletized. Unloading of building bricks or handling in any other way likely to damage the corners or edges or other parts of bricks shall not be permitted.

1.8.3 Bricks shall be stacked on dry firm ground. For proper inspection of quality and ease in counting the stacks shall be 50 bricks long, 10 bricks high and not more than 4 bricks in width, the bricks being placed on edge, two at a time along the width of the stack. Clear distance between adjacent stacks shall not be less than 0.8 m. Bricks of each truck load shall be put in one stack.

1.8.4 Bricks of different types, such as clay bricks, clay fly ash bricks, fly ash lime bricks, sand lime (calcium silicate) bricks, auto-clave bricks etc. shall be stacked separately. Bricks of different classification and size consideration (such as, conventional and modular) shall be stacked separately. Also bricks of different types, such as, solid, hollow and perforated shall be stacked separately.

1.9 BLOCKS

1.9.1 Blocks are available as hollow and solid concrete blocks, hollow and solid light weight concrete blocks, autoclaved aerated concrete blocks, concrete stone masonry blocks and soil based blocks.

1.9.2 Blocks shall be unloaded one at a time and stacked in regular tiers to minimize breakage and defacement. These shall not be dumped at site. The height of the stack shall not be more than 1.2 m. The length of the stack shall not be more than 3.0 m, as far as possible and the width shall be of two or three blocks.

1.9.3 Normally blocks cured for 28 days only should be received at site. In case blocks cured for less than 28 days are received, these shall be stacked separately. All blocks should be water cured for 10 to 14 days and air cured for another 15 days; thus no blocks with less than 28 days curing shall be used in building construction.

1.9.4 Blocks shall be placed close to the site of work so that least effort is required for their transportation.

1.9.5 Blocks manufactured at site shall be stacked at least for required minimum curing period as given in 1.9.3.
1.9.6 The date of manufacture of the blocks shall be suitably marked on the stacks of blocks manufactured at factory or site.

1.10 FLOOR, WALL AND ROOF TILES

1.10.1 Floor, wall and clay roof tiles of different types, such as, cement concrete tiles (plain, coloured and terrazzo) and ceramic tiles (glazed and unglazed) shall be stacked on regular platform as far as possible under cover in proper layers and in tiers and they shall not be dumped in heaps. In the stack, the tiles shall be so placed that the mould surface of one faces that of another. Height of the stack shall not be more than one metre. During unloading, these shall be handled carefully so as to avoid breakage.

1.10.2 Tiles of different quality, size and thickness shall be stacked separately to facilitate easy removal for use in work. Tiles when supplied by manufacturers packed in wooden crates, shall be stored in crates. The crates shall be opened one at a time as and when required for use.

1.10.3 Ceramic tiles and clay roof tiles are generally supplied in cartons which shall be handled with care. It is preferable to transport these at the site on platform trolleys.

1.11 AGGREGATES

1.11.1 Aggregates shall be stored at site on a hard dry and level patch of ground. If such a surface is not available, a platform of planks or old corrugated iron sheets, or a floor of bricks, or a thin layer of lean concrete shall be made so as to prevent contamination with clay, dust, vegetable and other foreign matter.

1.11.2 Stacks of fine and coarse aggregates shall be kept in separate stock piles sufficiently removed from each other to prevent the material at the edges of the piles from getting intermixed. On a large job, it is desirable to construct dividing walls to give each type of aggregates its own compartment. Fine aggregates shall be stacked in a place where loss due to the effect of wind is minimum.

1.11.3 Unless specified otherwise or necessitated by site conditions stacking of the aggregates should be carried out in regular stacks. The suggested sizes for stacks are as follows:

<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Material</th>
<th>Size of Stack (in m)</th>
</tr>
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<tbody>
<tr>
<td>(i)</td>
<td>Soling stone</td>
<td>Length</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.0</td>
</tr>
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<td></td>
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<td>Or</td>
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<td>(ii)</td>
<td>Coarse aggregates</td>
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<td></td>
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<td></td>
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<td>Or</td>
</tr>
<tr>
<td>(iii)</td>
<td>Fine aggregates</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
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<tr>
<td></td>
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</table>

1.12 FLY ASH

Fly ash shall be stored in such a manner as to permit easy access for proper inspection and identification of each consignment. Fly ash in bulk quantities shall be stored in stack similar to
fine aggregates as specified in 1.11 to avoid any intrusion of foreign matter. Fly ash in bags shall be stored in stacks not more than 10 bags high.

1.13 STEEL

1.13.1 For each classification of steel, separate areas shall be earmarked. It is desirable that ends of bars and sections of each class be painted in distinct separate colours.

1.13.2 Steel reinforcement shall ordinarily be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. It is desirable to coat reinforcement with cement wash before stacking to prevent scaling and rusting.

1.13.3 Bars of different classification, sizes and lengths shall be stored separately to facilitate issues in such sizes and lengths so as to minimize wastage in cutting from standard lengths.

1.13.4 In case of long storage, reinforcement bars shall be stacked above ground level by at least 150 mm. Also in coastal areas or in case of long storage a coat of cement wash shall be given to prevent scaling and rusting.

1.13.5 Structural steel of different classification, sizes and lengths shall be stored separately. It shall be stored above ground level by at least 150 mm upon platforms, skids or any other suitable supports to avoid distortion of sections. In coastal areas or in case of long storage suitable protective coating of primer paint shall be given to prevent scaling and rusting.

1.14 ALUMINIUM SECTIONS

Aluminium sections of different classification, sizes and lengths shall be stored separately, on a level platform under cover. The aluminium sections shall not be pulled or pushed from the stack nor shall be slid over each other, to protect the anodizing layer.

1.15 DOORS, WINDOWS AND VENTILATORS

1.15.1 General
While unloading, shifting handling and stacking timber or other lignocellulosic material based, metal and plastic door and window frames and shutters, care shall be taken that the material is not dragged one over the other as it may cause damage to the surface of the material particularly in the case of decorative shutters. The material should be lifted and carried preferably flat avoiding damage of corners or sides.

1.15.2 Metal and plastic doors, windows and ventilators shall be stacked upright (on their sills) on level ground preferably on wooden battens and shall not come in contact with dirt and ashes. If received in crates they shall be stacked according to manufacturer’s instructions and removed from the crates as and when required for the work.

1.15.3 Metal and plastic frames of doors, windows and ventilators shall be stacked upside down with the kick plates at the top. These shall not be allowed to stand for long in this manner before being fixed so as to avoid the door frames getting out of shape and hinges being strained and shutters drooping.

1.15.4 During the period of storage all metal doors, windows and ventilators shall be protected from loose cement and mortar by suitable covering such as tarpauline. The tarpauline shall be hung loosely on temporary framing to permit circulation of air to prevent condensation.
1.15.5 All timber and other lignocellulosic material based frames and shutters shall be stored in a dry and clean covered space away from any infestation and dampness. The storage shall preferably be in well ventilated dry rooms. The frames shall be stacked one over the other in vertical stacks with cross battens at regular distances to keep the stack vertical and straight. These cross battens should be of uniform thickness and placed vertically one above the other. The door shutters shall be stacked in the form of clean vertical stacks over the other and at least 80 mm above ground on pallets or suitable beams or rafters. The top of the stack shall be covered by a protecting cover and weighted down by means of scantlings or other suitable weights. The shutter stack shall rest on hard and level ground.

1.15.6 If any timber or other lignocellulosic material based frame or shutter becomes wet during transit, it shall be kept separate from the undamaged material. The wet material may be dried by stacking in shade with battens in between adjacent boards with free access of dry air generally following the guidance laid down in IS 1141.

1.15.7 Separate stacks shall be built up for each size, each grade and each type of material. When materials of different sizes grades and types are to be stacked in one stack due to shortage of space, the bigger size shall be stacked in the lower portion of the stacks. Suitable pallets or separating battens shall be kept in between the two types of material.

1.16 ROOFING SHEETS

1.16.0 Roofing sheets shall be stored and handled in such a manner as not do damage them in any way.

1.16.1 Plain and corrugated asbestos cement sheets shall be stacked horizontally to a height of not more than one meter on a firm and level ground, with timber or other packing beneath them. If stacked in exposed position, they shall be protected from damage by the winds. Asbestos cement sheets of same variety and size shall be stacked together. Damage sheets shall not be stacked with sound materials. All damaged sheets shall be salvaged as early as possible.

1.16.2 Corrugated galvanized iron sheets and aluminium sheets shall be stacked horizontally to a height of not more than 0.5 m on a firm and level ground, with timber or other packing beneath them. To protect them from dust and rain water, these shall be covered with tarpaulin or polyethylene sheets.

1.16.3 Plastic sheets and glass reinforced plastic (GRP) sheets shall be stacked under a shed to a height of not more than 0.5 m on a firm and level ground with timber or other packing beneath them.

1.17 GYPSUM BOARDS, PLYWOOD, FIBREBOARD, PARTICLE BOARD, BLOCK BOARD, ETC.

1.17.1 These boards shall be stored flat in a covered clean and dry place. Different sizes and types of each of these boards shall be stacked separately. The board shall be stacked on a flat platform on which a wooden frame shall be constructed with 50 mm x 25 mm battens in such a way that it will give support to all four edges and corners of the boards with intermediate battens placed at suitable intervals to avoid warping. The boards shall be stacked in a solid block in a clear vertical alignment. The top sheet of each stack shall be suitably weighed down to prevent warping wherever necessary. The boards shall be unloaded and stacked with utmost care.
avoiding damage to the corners and surface. In case of decorative plywood and decorative boards, the surfaces of which are likely to get damaged by dragging one sheet over another it is advisable that these are lifted as far as possible in pairs facing each other.

1.18 GLASS SHEETS
1.18.1 It is important that all glass sheets whether stored in crates or not shall be kept dry. Suitable covered storage space shall be provided for the safe storage of the glass sheets. In removing glass sheets from crates, great care shall be taken to avoid damages. The glass sheets shall be lifted and stored on its long edges against a vertical wall or other support with the first sheet so placed that its bottom edge is 25 mm from the vertical support. The stacks shall be of not more than 25 panes and shall be supported at two points by fillets of wood at 300 mm from each end. The whole stack shall be as close and as upright as possible. The glass sheets of different sizes, thickness and type shall be stacked separately. The distance between any two stacks shall be of the order of 400 mm.

1.19 CAST IRON, GALVANIZED IRON AND ASBESTOS CEMENT PIPES AND FITTINGS
1.19.1 The pipes shall be unloaded where they are required when the trenches are ready to receive them.

1.19.2 Storage shall be done on firm, level and clear ground and wedges shall be provided at the bottom layer to keep the stack stable.
1.19.3 The stack shall be in pyramid shape or the pipes length-wise and cross-wise in alternate layers. The pyramid stack is advisable in smaller diameter pipes for conserving space in storing them. The height of the stack shall not exceed 1.5 m.
1.19.4 Each stack shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible.
1.19.5 Cast iron detachable joints and fittings shall be stacked under cover separately from the asbestos cement pipes and fittings.
1.19.6 Rubber rings shall be kept clean, away from grease, oil heat and light.

1.20 POLYETHYLENE PIPES
1.20.1 Natural polyethylene pipe should be stored under cover and protected from direct sunlight. However, black polyethylene pipes may be stored either under cover or in the open.
1.20.2 Coils may be stored either on edges or stacked flat one on top of the other, but in either case they should not be allowed to come into contact with hot water or steam pipes and should be kept away from hot surface.
1.20.3 Straight lengths should be stored on horizontal racks giving continuous support to prevent the pipe taking on a permanent set.
1.20.4 Storage of pipes in heated areas exceeding 270 C should be avoided.

1.21 UNPLASTICIZED PVC PIPES
1.21.1 The pipe should be given adequate support at all times. Pipes should be stored on a reasonably flat surface free from stones and sharp projections so that the pipe is supported throughout its length. In storage, pipe racks should be avoided. Pipe should not be stacked in large piles, especially under warm temperature conditions as the bottom pipes may distort, thus giving rise to difficulty in jointing. Socket and spigot pipes should be stacked in layers with sockets placed at alternate ends of the stacks to avoid lopsided stacks.
1.21.1.1 It is recommended not to store pipe inside another pipe.
1.21.1.2 On no account should pipes be stored in a stressed or bent condition or near the sources of heat.
1.21.1.3 Pipes should not be stacked more than 1.5 m high. Pipes of different sizes and classes should be stacked separately.
1.21.2 The ends of pipe should be protected from abrasion particularly those specially prepared for jointing either spigot or socket solvent welded joints or shouldered for use with couplings.
1.21.3 In tropical conditions, pipes should be stored in shade. In very cold weather, the impact strength of PVC is reduced making it brittle and more care in handling shall be exercised in wintry condition.
1.21.4 If due to unsatisfactory storage of handling a pipe becomes kinked, the damaged portion should be cut out completely. Kinking is likely to occur only on very thin walled pipes.

1.22 BITUMEN, ROAD TAR, ASPHALT, ETC.
1.22.1 All types of bitumen, road tar, asphalt, etc, in drums or containers shall be stacked vertically on their bottoms in up to 3 tiers. Leaky drums shall be segregated. Empty drums shall be stored in pyramidal stacks neatly in rows.

1.23 WATER
1.23.1 Wherever water is to be stored for construction purposes this shall be done in proper storage tanks to prevent any organic impurities getting mixed up with it.

1.24 OIL PAINTS
1.24.1 All containers of paints, thinners and allied materials shall preferably be stored in a separate room on floors with sand cushions. The room shall be well-ventilated and free from excessive heat, sparks of flame and direct rays of sun. The containers of paint shall be kept covered or properly fitted with lid and shall not be kept open except while using. The containers of paints have expiry date marked by the manufacturers, which should be highlighted so as to facilitate use of paint within due period.

1.25 SANITARY APPLIANCES
1.25.1 All sanitary appliances shall be carefully stored under cover to prevent damage. When accepting and storing appliances, advance planning shall be made regarding the sequence of removal from the store to the assembly positions. Supporting brackets shall be so stored as to be readily accessible for use with the appliances.

1.26 OTHER MATERIALS
1.26.1 Small articles like nails, screws, nuts and bolts, door and window fittings, polishing stones, protective clothing, spare parts of machinery, linings, packing, water supply and sanitary fittings, electrical fittings, insulation board, etc, shall be kept in suitable and properly protected store rooms. Valuable small material such as, copper pipes and fittings shall be kept under lock and key.

1.27 MEASUREMENTS

Length, breadth and height of stacks shall be measured correct to a cm. The quantity shall be worked out in cubic metre correct to two place of decimal. The volume of stacks shall be reduced by percentages as shown against each for looseness in stacking to arrive at the net quantity for payment. No reduction shall be made in respect of articles or materials for which mode of payment is by length or weight or number.

1.27.1 Earth
1.27.1.1 In loose stacks such as cart loads, lorry loads, etc. – 20%
1.27.1.2 In fills consolidated by light mechanical machinery – 10%
1.27.1.3 In fills consolidated by heavy mechanical machinery but not under OMC (Optimum Moisture Content) – 5%
1.27.1.4 In fills consolidated by heavy mechanical machinery at OMC – Nil
1.27.1.5 Consolidated fills in confined situation such as under floors, etc. – Nil

1.27.2 Other Materials
1.27.2.1 Manure or sludge – 8%
1.27.2.2 Moorum, building rubbish Lime and sand – Nil
1.27.2.3 Stone metal, 40 mm nominal size and above – 7.5%
1.27.2.4 Coarse aggregate/stone metal below 40 mm nominal size – Nil
1.27.2.5 Soling stone/Boulder 100 mm and above – 15%
1.27.2.6 Excavated rocks – 50%

1.28 RATE
The rate for carriage of materials is inclusive of all the operations described above.
### Technical Specifications for Construction of Township

#### TABLE 1.1
Storage and Stacking Check List
*(Clause 1.4.1)*

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Material/ Component</th>
<th>Base</th>
<th>Stack</th>
<th>Type of Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Firm Level Ground</td>
<td>Hard Floor</td>
<td>Off Floor</td>
</tr>
<tr>
<td>1.</td>
<td>Cement</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2.</td>
<td>Stone and Aggregates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a)</td>
<td>Stones, aggregates, fly ash and cinder</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>Veneering stones</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Bricks and Blocks</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Tiles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a)</td>
<td>Clay and concrete floor, wall and roof tiles</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>Ceramic tiles</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Steel</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Aluminum Sections</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Door, windows and Ventilators</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Roofing Sheets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a)</td>
<td>AC</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>GI and Aluminum Sheets</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>Plastic Sheets</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Boards like Plywood, Particle Boards, Fibre Boards, Blockboards and Gypsum Board</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Glass Sheets</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>CI, GI and AC Pipes &amp; fittings</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a)</td>
<td>Pipes</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>CI and GI fittings</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>AC Fittings</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Polyethylene Pipes</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Unplasticized PVC Pipes</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Bitumen, Road Tar, Asphalt, etc in Drums</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Oil Paints</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Sanitary Appliances</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.00 EARTH WORK

2.0 DEFINITIONS

Deadmen or Tell Tales: Mounds of earth left undisturbed in pits dug out for borrowing earth
Burjis: Short pillars of brick/stonework having top surface finished with cement plaster for marking etc.
Formation or Profile: Final shape of the ground after excavation or filling up.
Foul condition: Filthy and unhygienic conditions where physical movements are hampered such as soil mixed with sewage or night soil.

Lead: All distances shall be measured over the shortest practical route and not necessarily the route actually taken. Route other than shortest practical route may be considered in cases of unavoidable circumstances and approved by Engineer-in-charge along with reasons in writing. Carriage by manual labour shall be reckoned in units of 50 metres or part thereof. Carriage by animal and mechanical transport shall be reckoned in one km. unit. Distances of 0.5 km. or more shall be taken as 1 km. and distance of less than 0.5 km. shall be ignored. However, when the total lead is less than 0.5 km., it will not be ignored but paid for separately in successive stages of 50 metres subject to the condition that the rate worked on this basis does not exceed the rate for initial lead of 1 km. by mechanical/animal transport.

Lift: The vertical distance for removal with reference to the ground level. The excavation up to 1.5 metres depth below the ground level and depositing the excavated materials up to 1.5 metres above the ground level are included in the rate of earth work. Lifts inherent in the lead due to ground slope shall not be paid for.

Safety rules: Safety rules as laid down by the statutory authority and as provided in National Building Code (NBC) shall be followed.

2.1 CLASSIFICATION OF SOILS

2.1.0 The earthwork shall be classified under the following categories and measured separately for each category:
(a) All kind of soils: Generally any strata, such as sand, gravel, loam, clay, mud, black cotton moorum, single, river or nallah bed boulders, siding of roads, paths etc. and hard core, macadam surface of any description (water bound, grouted tarmac etc.), lime concrete, mud concrete and their mixtures which for excavation yields to application of picks, showels, jumper, sacrificers, ripper and other manual digging implements.
(b) Ordinary rock: Generally any rock which can be excavated by splitting with crow bars or picks and does not require blasting, wedging or similar means for excavation such as lime stone, sand stone, hard laterite, hard conglomerate and un-reinforced cement concrete below ground level. If required light blasting may be resorted to for loosening the materials but this will not in any way entitle the material to be classified as ‘Hard rock’. 
(c) Hard rock: Generally any rock or boulder for the excavation of which blasting is required such as quartzite, granite, basalt, reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level and the like.
(d) Hard rock (blasting prohibited): Hard rock requiring blasting as described under (c) but where the blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging, use of rock hammers and cutters or any other agreed method.
2.2 ANTIQUITIES AND USEFUL MATERIALS
2.2.1 Any finds of archaeological interest such as relics of antiquity, coins, fossils or other articles of value shall be delivered to the Engineer-in-Charge and shall be the property of the Government.
2.2.2 Any material obtained from the excavation which in the opinion of the Engineer-in-Charge is useful shall be stacked separately in regular stacks as directed by the Engineer-in-Charge and shall be the property of the Government.

2.3 PROTECTIONS
2.3.1 Excavation where directed by the Engineer-in-Charge shall be securely barricaded and provided with proper caution signs, conspicuously displayed during the day and properly illuminated with red lights and/or written using fluorescent reflective paint as directed by engineer in charge during the night to avoid accident.
2.3.2 The Contractor shall take adequate protective measures to see that the excavation operations do not damage the adjoining structures or dislocate the services. Water supply pipes, sluice valve chambers, sewerage pipes, manholes, drainage pipes and chambers, communication cables, power supply cables etc. met within the course of excavation shall be properly supported and adequately protected, so that these services remain functional. However, if any service is damaged during excavation shall be restored in reasonable time.
2.3.3 Excavation shall not be carried out below the foundation level of the adjacent buildings until Underpinning, shoring etc. is done as per the directions of the Engineer-in-Charge for which payment shall be made separately.
2.3.4 Any damages done by the contractor to any existing work shall be made good by him at his own cost. Existing drains pipes, culverts, over head wires, water supply lines and similar services encountered during the course of execution shall be protected against damage by the contractor. The contractor shall not store material or otherwise occupy any part of the site in manner likely to hinder the operations of such services.

2.4 SITE CLEARANCE
2.4.1 Before the earth work is started, the area coming under cutting and filling shall be cleared of shrubs, rank vegetation, grass, brushwood and rubbish removed up to a distance of 50 metres outside the periphery of the area under clearance.
2.4.2 Existing structures and services such as old buildings, culverts, fencing, water supply pipe lines, sewers, power cables, communication cables, drainage pipes etc. within or adjacent to the area if required to be diverted/removed, shall be diverted/dismantled as per directions of the Engineer-in-Charge and payment for such diversion/dismantling works shall be made separately.
2.4.3 In case of archaeological monuments within or adjacent to the area, the contractor shall provide necessary fencing around such monuments as per the directions of the Engineer-in-Charge and protect the same properly during execution of works. Payment for providing fencing shall be made separately.
2.4.4 Lead of 50 m mentioned in the 'Schedule Of Quantities' is the average lead for the disposal of excavated earth within the site of work. The actual lead for the lead for the disposal of earth may be more or less than the 50 m for which no cost adjustment shall be made in the rates.
2.4.5 Disposal of Earth shall be disposed off at the specified location or as decided by the Engineer-in-Charge. The contractor has to take written permission about place of disposal of earth before the earth is disposed off, from Engineer-in-Charge.

2.5 EXCAVATION IN ALL KINDS OF SOILS
2.5.1 All excavation operations manually or by mechanical means shall include excavation and ‘getting out’ the excavated materials. In case of excavation for trenches, basements, water tanks etc. ‘getting out’ shall include throwing the excavated materials at a distance of at least one
metre or half the depth of excavation, whichever is more, clear off the edge of excavation. In all other cases 'getting out' shall include depositing the excavated materials as specified. The subsequent disposal of the excavated material shall be either stated as a separate item or included with the items of excavation stating lead.

2.5.2 During the excavation the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or undercutting shall not be done.

2.5.3 In firm soils, the sides of the trenches shall be kept vertical upto a depth of 2 metres from the bottom. For greater depths, the excavation profiles shall be widened by allowing steps of 50 cms on either side after every 2 metres from the bottom. Alternatively, the excavation can be done so as to give slope of 1:4 (1 horizontal : 4 vertical). Where the soil is soft, loose or slushy, the width of steps shall be suitably increased or sides sloped or the soil shored up as directed by the Engineer-in-Charge. It shall be the responsibility of the contractor to take complete instructions in writing from the Engineer-in-Charge regarding the stepping, sloping or shoring to be done for excavation deeper than 2 metres.

2.5.4 The excavation shall be done true to levels, slope, shape and pattern indicated by the Engineer-in-Charge. Only the excavation shown on the drawings with additional allowances for centering and shuttering or as required by the Engineer-in-Charge shall be measured and recorded for payment.

2.5.5 In case of excavation for foundation in trenches or over areas, the bed of excavation shall be to the correct level or slope and consolidated by watering and ramming. If the excavation for foundation is done to a depth greater than that shown in the drawings or as required by the Engineer-in-Charge, the excess depth shall be made good by the contractor at his own cost with the concrete of the mix used for levelling/ bed concrete for foundations. Soft/defective spots at the bed of the foundations shall be dug out and filled with concrete (to be paid separately) as directed by the Engineer-in-Charge.

2.5.6 While carrying out the excavation for drain work care shall be taken to cut the side and bottom to the required shape, slope and gradient. The surface shall then be properly dressed. If the excavation is done to a depth greater than that shown on the drawing or as required by the Engineer-in-Charge, the excess depth shall be made good by the contractor at his own cost 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. In case the drain is required to be pitched, the back filling with clay puddle, if required, shall be done simultaneously as the pitching work proceeds. The brick pitched storm water drains should be avoided as far as possible in filled-up areas and loose soils.

2.5.7 In all other cases where the excavation is taken deeper by the contractor, it shall be brought to the required level by the contractor at his own cost by filling in with earth duly watered, consolidated and rammed.

2.5.8 In case the excavation is done wider than that shown on the drawings or as required by the Engineer-in-Charge, additional filling wherever required on the account shall be done by the contractor at his own cost.

2.5.9 The excavation shall be done manually or by mechanical means as directed by Engineer-in-charge considering feasibility, urgency of work, availability of labour/mechanical equipments and other factors involved. Contractor shall ensure every safety measures for the workers. Neither any deduction will be made nor any extra payment will be made on this account.

2.6 EARTH WORK BY MECHANICAL MEANS

Earth work by mechanical means involves careful planning keeping in view site conditions i.e. type of soil, nature of excavation, distances through which excavated soil is to be transported and working space available for employing these machines. The earth moving equipment should
be accordingly selected. The earth moving equipment consists of excavating and transporting equipment. Excavating equipments may be further classified as excavators and tractor based equipments.

### 2.6.1 Excavators

Excavators generally used at site are as follows:

(i) **Dipper-shovel**: It is used for excavating against a face or bank consisting of open-top bucket or dipper with a bottom opening door, fixed to an arm or dipper stick which slides and pivots on the jib of the crane. It is suitable for excavating all clay chalk and friable materials and for handling rock and stone. However, it is not suitable for surface excavation for which a skimmer is used.

(ii) **Backhoe**: It is similar to face shovel except that the dipper stick pivots on the end of the jib and the dipper or bucket works towards the chassis and normally has no bottom door but is emptied by swinging away from the chassis to invert the bucket. It may be designed to carry both a front-mounted bucket loading mechanism and a rear mounted backhoe. It is mainly used to excavate trenches and occasionally used for the excavation of open areas such as small basements. In the backhoe mode the bucket lifts, swings and discharges materials while the undercarriage is stationary. When used in the 'loader' mode, the machine loads or excavated through forward motion of the machine, and lifts, transports and discharges materials.

(iii) **Skimmer**: This arrangement is similar to the face shovel except that in this case the bucket slides on rollers directly along the jib and thus has a more restricted movement. It is used for surface excavation and levelling in conjunction with transport to haul away the excavated material.

(iv) **Dragline**: It is usually fitted with a long slender boom or jib and the bucket, which in operation faces towards the machine and has no door, is supported by cable only as on a crane. It works from the side of the excavation at normal ground level and is used for excavating large open excavations such as basements when the depth is beyond the limit of the boom of a backhoe. It is commonly used for open cast mining operations.

(v) **Clamshell**: It consists of two hinged half-buckets or jaws pivoted to a frame which is suspended by cable from a long jib of an excavation. The grab is used for deep excavations of limited area on all types of soil except rock. Crane and Grab is a variant of this type of equipment.

### 2.6.2 Tractor-based Equipment

It is a self–propelled crawler or wheeled machine used to exert a push or pull force through mounted equipment. It is designed either as attachments to normal tracked or wheeled tractors or as machines in which the earth moving attachments and the tractor are designed as a single integrated unit. A tractor, which is hydraulically operated, can be rigged as:

(i) **Loaders**: It is used for loading, light dozing, scraping and grabbing operations, lifting and transporting the materials (loose earth, rubble, sand, gravel aggregate etc) at various sites through forward motion of the machine.

(ii) **Tractor Shovel**: This consists of a tipping bucket at the front attached by strong pivoted arms or booms to the frame of the machine. It is used for stripping top soil, excavating against a face, bulldozing and for loading spoil or loose materials. It is similar to crawler dipper-shovel.

(iii) **Trench Digger**: It operates on the same principle as a backhoe excavator except that the bucket is controlled by hydraulic rams instead of cables and pulleys.

(iv) **Scraper**: Scrapers provide unique capability to excavate, load, haul and dump materials. Scrapers are available in various capacities by a number of manufacturers with options such as self – loading with elevators, twin engines or push-pull capability. They are cost effective where the haul distance is too long for bulldozers, yet too short for trucks. This distance typically ranges from 120 m to 1200 m; however, the economics should be evaluated for each project. Scraper
has an open bowl with a cutting edge positioned between the axles, which cuts, loads, transports, discharges and spreads through forward motion of the machine. Loading through forward motion of the machine can be assisted by a powered mechanism (elevator) fixed to the scraper bowl.

(v) **Bulldozer and Angle-dozer** : The most common equipment used for clearing and levelling activities is a bulldozer. The terms bulldozer is used to define a tractor mounted with a dozing blade. The bulldozer consists of a rectangular steel blade with renewable cutting edge set at right angles (capable of only tilting but not angling) to the direction of travel and attached by steel arms to the side frames of a crawler tractor. It may be used for excavating natural soil or for moving loose soil or debris, which is pushed forward as the tractor forces it ahead.

(vi) **Angledozer** is capable of both tilting and angling.

### 2.6.3 Transporting Equipment

This implies horizontal movement primarily but it can involve some vertical movement too.

(i) **Dumpers** : These are self-propelled wheeled machines, having an open body. It is designed for the transport of excavated materials and consists of a shallow tipping hopper or skip mounted on a wheeled chassis, such as, power barrow, dumper, multi-skip dumpers, high discharge dumpers, dump truck, etc. These can be rear dump, side dump or bottom dump.

(ii) **Vibratory Roller** : It is a single Drum Vibratory Roller for compaction of embankments, etc. The smooth drum version is for compaction of granular and mixed soil. The sheepfoot Roller consists of a hallow cylindrical steel drum or drums on which projecting feet are mounted. These feet penetrate into the fill as a roller moves forward and cause compaction. The geometry of the foot may be sheep, club pyramid, cone or cylinder foot. Such rollers are employed for compaction (densification) of cohesive and semi-cohesive soils.

### 2.7 FILLING

2.7.1 The earth used for filling shall be free from all roots, grass, shrubs, rank vegetation, brushwood, tress, sapling and rubbish.

2.7.2 Filling with excavated earth shall be done in regular horizontal layers each not exceeding 20 cm in depth. All lumps and clods exceeding 8 cm in any direction shall be broken. Each layer shall be watered and consolidated with steel rammer or ½ tonne roller. Where specified, every third and top must layer shall also be consolidated with power roller of minimum 8 tonnes. Wherever depth of filling exceeds 1.5 metre vibratory power roller shall be used to consolidate the filling unless otherwise directed by Engineer-in-charge. The top and sides of filling shall be neatly dressed. The contractor shall make good all subsidence and shrinkage in earth fillings, embankments, traverses etc. during execution and till the completion of work unless otherwise specified.

### 2.8 MEASUREMENTS

2.8.1 The length and breadth of excavation or filling shall be measured with a steel tape correct to the nearest cm. The depth of cutting or height of filling shall be measured, correct to 5 mm, by recording levels before the start of the work and after the completion of the work. The cubical contents shall be worked out to the nearest two places of decimal in cubic metres.

2.8.1.1 In case of open footings up to the depth of 1.5 metres, alround excavation of 30 cm. beyond the outer dimension of footing shall be measured for payment to make allowances for centering and shuttering. Any additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment.

2.8.1.2 In case of open footings/Rafts at a depth of more than 1.5 metre, alround excavation of 75 cm shall be measured for payment to make allowance for centering and shuttering. Additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment.
2.8.2 In case the ground is fairly uniform and where the site is not required to be levelled, the Engineer in-Charge may permit the measurements of depth of cutting or height of filling with steel tape, correct to the nearest cm. In case of borrow pits, diagonal ridges, cross ridges or dead-men, the position of which shall be fixed by the Engineer-in-Charge, shall be left by the contractor to permit accurate measurements being taken with steel tape on the completion of the work. Deduction of such ridges and dead men shall be made from the measurements unless the same are required to be removed later on and the earth so removed is utilized in the work. In the latter case nothing extra will be paid for their removal as subsequent operation.

2.9.6. Recording Measurements for Earth Levelling Work

2.9.6.1 Level Books: In case of levelling operations and earthwork, measurements are required to be recorded in level books in addition to Measurement Books. The Level Books should be numbered, accounted for and handled like Measurement Books.

2.9.6.2 Preparatory Works: Before starting the earth work, following steps should be taken:

1. Original ground levels should be recorded in the Level Book in the presence of the contractor or his authorized representative, and should be signed by him and the Department Officer who records the levels. All the local mounds and depressions should be indicated clearly in the drawing and the field Level Book and should be checked by the Assistant Engineer/Executive Engineer before the levelling work is started.

2. A suitable baseline should be fixed with permanent masonry pillars at distances not exceeding 150 metres to provide a permanent reference line for facilitating check work. The base line (s) should be entered in the Level Book with co-ordinates. These baselines should be maintained till the final payment for the work has been made.

3. While recording the levels, it should be ensured that the circuit is closed by taking final levels of the starting point or any other point, the R.L. of which was previously determined.

4. Plans showing initial levels, location of bench marks and reduced levels, should be prepared and signed by both the parties and attached to the agreement before commencement of the work.

2.10 RATES

2.10.1 Rates for Earthwork shall include the following:

(a) Excavation and depositing excavated material as specified.
(b) Handing of antiquities and useful material.
(c) Protection as specified.
(d) Site clearance as specified.
(e) Setting out and making profiles as specified.
(g) Bailing out or pumping of rain water from excavations.
(h) Initial lead of 50 m and lift of 1.5 m.

2.11 SURFACE EXCAVATION

2.11.1 Excavations exceeding 1.5 m in width and 10 sqm. on plan but not exceeding 30 cm. in depth in all types of soils and rocks shall be described as surface excavation and shall be done as specified in before.

2.11.3 Rate shall be as specified in 2.10

2.12 EXCAVATION OVER AREA (ALL KINDS OF SOIL)

2.12.1 This shall comprise:

(a) Excavation exceeding 1.5 m in width and 10 sqm on plan and exceeding 30 cm in depth.
(b) Excavation in trenches exceeding 1.5 m in width and 10 sqm on plan.
2.12.2 Excavation shall be done as specified in 2.5.
2.12.3 Measurements shall be as specified in 2.8.
2.12.4 Rates shall be as specified in 2.10.

2.13 EXCAVATION IN TRENCHES FOR FOUNDATIONS AND DRAINS (ALL KINDS OF SOIL)
2.13.1 This shall comprise excavation not exceeding 1.5 m in width or 10 sqm on plan and to any depth in trenches (excluding trenches for pipes, cables, conduits etc.)
2.13.2 Excavation shall be done as specified in 2.5.
2.13.3 Measurements shall be as specified in 2.8.
2.13.4 Rates shall be as specified in 2.10.

2.14 FILLING IN TRENCHES, PLINTH, UNDER FLOOR ETC.
2.14.1 Earth
Normally excavated earth from same area shall be used for filling. Earth used for filling shall be free from shrubs, rank, vegetation, grass, brushwood, stone shingle and boulders (larger than 75mm in any direction), organic or any other foreign matter. Earth containing deleterious materials, salt peter earth etc. shall not be used for filling. All clods and lumps of earth exceeding 8 cm in any direction shall be broken or removed before the earth is used for filling.

2.14.2 Filling
The space around the foundations and drains in trenches shall be cleared of all debris, brick bats etc. The filling shall be done in layers not exceeding 20 cm in depth. Each layer shall be watered, rammed and consolidated. Ramming shall be done with iron rammers where possible and with blunt end of crow bars where rammers cannot be used. Special care shall be taken to ensure that no damage is caused to the pipes, drains, masonry or concrete in the trenches. In case of filling under floor, the finished level of filling shall be kept to the slope intended to be given to the floor.

2.14.3 Measurements
2.14.3.1 Filling Side of Foundations: The cubical contents of bed concrete levelling course and masonry/ concrete in foundations upto the ground level shall be worked out and the same deducted from the cubical contents of earthwork in excavation for foundations already measured under the respective item of earth work to arrive at the quantity for filling sides of foundation. The quantity shall be calculated correct to two places of decimal.
2.14.3.2 Filling in Plinth and under Floors: Depth of filling shall be the consolidated depth. The dimensions of filling shall be on the basis of pre-measurement correct to the nearest cm and cubical content worked out in cubic metres correct to two places of decimal.

2.14.4 Rates
The rates include cost of all the operations described above.

2.15 SAND FILLING IN PLINTH
2.15.1 Sand
Sand shall be clean and free from dust organic and foreign matter and its grading shall be within the limits of grading zone IV or V.

2.15.2 Filling
Sand filling shall be done in a manner similar to earth filling in plinth specified in 2.17.3.2. except that consolidation shall be done by flooding with water. The surface of the consolidated sand filling shall be dressed to the required level or slope and shall not be covered till the Engineer-in-Charge has inspected and approved the sand filling.

2.15.3 Measurements
The length, breadth and depth of consolidated sand shall be measured with steel tape correct to the nearest cm and cubical contents worked out in cubic metres correct to two places of decimal.

2.15.4 Rates
The rates include the cost of material and labour involved in all the operations described above.

2.16 SURFACE DRESSING.
2.16.1 Surface dressing shall include cutting and filling upto a depth of 15 cm and clearing of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth upto 30 cm measured at a height of one metre above the ground level and removal of rubbish and other excavated material upto a distance of 50 metres outside the periphery of the area under surface dressing. High portions of the ground shall be cut down and hollows depression filled upto the required level with the excavated earth so as to give an even, neat and tidy look.

2.16.2 Measurements
Length and breadth of the dressed ground shall be measured correct to the nearest cm and the area worked out in square metres correct to two places of decimal.

2.16.3 Rates
The rates shall include cost of labour involved in all the operations described above.

2.17 ANTI-TERMITE TREATMENT
2.17.0 Subterranean termites are responsible for most of the termite damage in buildings. Typically, they form nests or colonies underground. In the soil near ground level in a stump or other suitable piece of timber in a conical or dome shaped mound. The termites find access to the super-structure of the building either through the timber buried in the ground or by means of mud shelter tubes constructed over unprotected foundations.

Termite control in existing as well as new building structures is very important as the damage likely to be caused by the termites to wooden members of building and other household article like furniture, clothing, stationery etc. is considerable. Anti-termite treatment can be either during the time of construction i.e. pre-constructional chemical treatment or after the building has been constructed i.e. treatment for existing building. Prevention of the termite from reaching the super-structure of the building and its contents can be achieved by creating a chemical barrier between the ground, from where the termites come and other contents of the building which may form food for the termites. This is achieved by treating the soil beneath the building and around the foundation with a suitable insecticide.

2.17.1 Materials
2.17.1.0 Chemicals: Any one of the following chemicals in water emulsion to achieve the percentage concentration specified against each chemical shall be used:
(i) Chlorphriphos emulsifiable concentrate of 20%
(ii) Lindane emulsifiable concentrate of 20%

Anti-termite treatment chemical is available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the specified percentage of concentration, Chemical should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the required proportion to achieve the desired percentage of concentration. For example, to dilute chemical of 20% concentration.

Engineer-in-Charge shall procure the chemical of required concentration in sealed original containers directly from the reputed and authorized dealers, chemical shall be kept in the custody of the Engineer-in-Charge or his authorized representatives and issued for use to meet the day's
requirements. Empty containers after washing and concentrated chemical left unused at the end of the day’s work shall be returned to the Engineer-in-Charge or his authorized representative.

2.17.1.1 Measurement: Concentrated chemical in sealed containers shall be measured in litres. Chemicals of different types and concentration shall be measured separately.

2.17.1.2 Rate: The Rate for the concentrated chemical shall include the cost of material, containers and all the operations involved in transportation and delivery at the place specified.

2.17.2 Safety Precautions

Chemical used for anti-termite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed.

The containers having emulsifiable concentrates shall be clearly labelled and kept securely closed in stores so that children or pet cannot get at them. Storage and mixing of concentrates shall not be done near any fire source or flame. Persons using these chemical shall be warned that absorption though skin is the most likely source of accidental poisoning. Particular care shall be taken to prevent skin contact with concentrates and prolonged exposure to dilute emulsion shall also be avoided. After handling the concentrates or dilute emulsion. Workers shall wash themselves with soap and water and wear clean clothing, especially before eating. In the event of severe contamination, clothing shall be removed at once and the skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention shall be sought. Care should be taken in the application of chemicals to see that they are not allowed to contaminate wells or springs which serve as source of drinking water.

3.1 Grades of cement concrete: The concrete shall be in grade designated as under:

**TABLE-3.1**

<table>
<thead>
<tr>
<th>Group</th>
<th>Grade Designation</th>
<th>Specified characteristic compressive strength of 150mm cube at 28 Days in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Ordinary Concrete</td>
<td>M10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>M15</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>M20</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>M25</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>M30</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>M35</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>M40</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>M45</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>M50</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>M55</td>
<td>55</td>
</tr>
<tr>
<td>Standard Concrete</td>
<td>M60</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>M65</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>M70</td>
<td>70</td>
</tr>
</tbody>
</table>
Notes:
1. In the designation of concrete mix M refers to the mix and the number to the specified compressive strength of 150 mm size cube at 25 days, expressed in N/mm².
2. For concrete of compressive strength greater than M55, design parameters given in the standard may not be applicable and the values may be obtained from specialized literatures and experimental results.
3. The characteristic strength is defined as the strength of material below not more than 5 percent of the test results are expected to fall.

3.2 Minimum Cement Content, Maximum Water-Cement Ratio and Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal; Maximum Size.

<table>
<thead>
<tr>
<th>SI NO</th>
<th>Exposure</th>
<th>Plain Concrete</th>
<th>Maximum Free Water Ratio</th>
<th>Minimum Grade of Concrete</th>
<th>Reinforced Concrete</th>
<th>Maximum Grade of Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Minimum Cement Content kg/m³</td>
<td></td>
<td>Minimum Cement Content Ratio kg/m³</td>
<td>Maximum Free Water Cement Ratio</td>
<td>Minimum Grade of Concrete</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>I</td>
<td>Mild</td>
<td>220</td>
<td>0.60</td>
<td>M20</td>
<td>300</td>
<td>0.55</td>
</tr>
<tr>
<td>II</td>
<td>Moderate</td>
<td>240</td>
<td>0.60</td>
<td>M15</td>
<td>300</td>
<td>0.50</td>
</tr>
<tr>
<td>III</td>
<td>Severe</td>
<td>250</td>
<td>0.50</td>
<td>M20</td>
<td>320</td>
<td>0.45</td>
</tr>
<tr>
<td>IV</td>
<td>Very Severe</td>
<td>260</td>
<td>0.45</td>
<td>M20</td>
<td>340</td>
<td>0.45</td>
</tr>
<tr>
<td>V</td>
<td>Extreme</td>
<td>280</td>
<td>0.40</td>
<td>M25</td>
<td>360</td>
<td>0.4</td>
</tr>
</tbody>
</table>
3.2.1. Concrete of grades lower than those given in Table 3.2 may be used for lean concrete, foundation for masonry walls or temporary reinforced concrete construction.

3.3. Workability of Concrete
3.3.1. The concrete mix proportion chosen should be such that the concrete is of adequate workability for the placing conditions of the concrete and can properly be compacted with the means available.
Suggested ranges of workability of concrete measured in accordance with IS 1199 are given below:

### TABLE 3.3

<table>
<thead>
<tr>
<th>Placing Conditions</th>
<th>Degree of Workability</th>
<th>Slump (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) (2)</td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>Blinding concrete: shallow sections: Paverements using pavers</td>
<td>Very Low</td>
<td>–</td>
</tr>
<tr>
<td>Mass concrete: Lightly reinforced sections in slabs, beams, walls, columns: Floors</td>
<td>Low 25-75</td>
<td></td>
</tr>
<tr>
<td>Hand placed paverements: canal lining; Strip footing</td>
<td>Medium 50-100</td>
<td></td>
</tr>
<tr>
<td>Heavily reinforced sections in slabs, beams, walls, columns: Pumped concrete</td>
<td>Medium 75-100</td>
<td></td>
</tr>
<tr>
<td>Trench fill</td>
<td>High</td>
<td>100-150</td>
</tr>
<tr>
<td>Trench Concrete</td>
<td>Very High</td>
<td>–</td>
</tr>
</tbody>
</table>

**Note:** For most of the placing conditions, internal vibrators (needle vibrators) are suitable. The diameter of the needle shall be determined based on the density and spacing of reinforcement bars and thickness of sections. For tremie concrete, vibrators are not required to be used.

3.4. Concrete Mix Proportioning
3.4.1 The determination of the proportion of cement, aggregate and water to attain the required strength shall be made as follows:
(a) **By designing the concrete mix:** such concrete shall be called ‘Design mix concrete’
(b) **By adopting nominal concrete mix:** such concrete shall be called ‘Nominal mix concrete’.
Design mix concrete is preferred to nominal mix. If design mix concrete cannot be used for any reason on the work for grades of M20 or lower, nominal mixes may be used with the permission of Engineer-in-Charge, which, however, is likely to involve a higher cement content.

3.4.2 **Nominal Mix Concrete:** Nominal Mix Concrete may be used for concrete of M20 or lower.
3.5 Batching
To avoid confusion and error in batching, consideration should be given to using the smallest practical number of different concrete mixed on any site or in any one plant. In batching concrete, the quantity of both cement and aggregate shall be determined by mass. Ready-mixed concrete supplied by ready-mixed concrete plant shall be preferred. For large and medium project sites the concrete shall be sourced from ready-mixed concrete plants or from on site or off site batching and mixing plants (see IS 4926).

3.5.1 Except where it can be shown to the satisfaction of the Engineer-in-Charge that supply of properly graded aggregate of uniform quality can be maintained over a period of work, the grading aggregate should be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions when required, the different sizes being stocked in separate stock-piles. The material should be stock-piled for several hours preferably a day before use. The grading of coarse and fine aggregate should be checked as frequently as possible, the frequency for a given job being determined by the Engineer-in-Charge to ensure that the specified grading is maintained.

3.5.2 The accuracy of the measuring equipment shall be within + 2 percent of the quantity of cement being measured and within + 3 percent of the quantity of aggregate, admixtures and water being measured.

3.5.3 Proportion/Type and grading of aggregates shall be made by trial in such a way so as to obtain densest possible concrete. All ingredients of the concrete should be used by mass only.

3.5.4 Volume batching may be allowed only where weigh-batching is not practicable and provided accurate used in concrete have earlier been established. Allowance for bilking shall be made in accordance with IS 2386 (Part 3). The mass volume relationship should be checked as frequently as necessary, the frequency for the given job being determined by Engineer-in-Charge to ensure that the specified grading is maintained.

3.5.5 It is important to maintain the water cement ratio constant at its correct value. To this end, determination of moisture contents in both fine and coarse aggregates shall be made as frequently as possible, the frequency for a given job being determined by the Engineer-in-Charge according to weather conditions. The amount of the added water shall be adjusted to compensate for any observed variations in the moisture contents. For the determination of moisture content in the aggregates, IS 2386 (Part 3) may be referred to. To allow for the variation in mass for aggregate due to variations in their moisture content, suitable adjustments in the masses of aggregates shall be made. In the absence of exact data, only in the case of nominal mixes, the amount of surface water may be estimated from the values given in Table 3.4.

<table>
<thead>
<tr>
<th>SI No.</th>
<th>Aggregate</th>
<th>Approximate Quantity of Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Percent by mass</td>
</tr>
<tr>
<td>(1)</td>
<td></td>
<td>(3)</td>
</tr>
<tr>
<td>(i)</td>
<td>Very wet sand</td>
<td>7.5</td>
</tr>
<tr>
<td>(ii)</td>
<td>Moderately wet sand</td>
<td>5.0</td>
</tr>
<tr>
<td>(iii)</td>
<td>Moist sand</td>
<td>2.5</td>
</tr>
<tr>
<td>(iv)</td>
<td>Moist gravel or crushed rock</td>
<td>1.25-2.5</td>
</tr>
</tbody>
</table>
Courser the aggregate lesser the water it will carry.

3.5.6 Mixing
Concrete shall be mixed in mechanical batch type concrete mixers conforming to IS 1791 having two blades and fitted with power loader (lifting hopper type). Half bag mixers and mixers without lifting hoppers shall not be used for mixing concrete. In exceptional circumstances, such as mechanical break down of mixer, work in remote areas or power breakdown and when the quantity of concrete work is very small, hand mixing may be done with the specific prior permission of the Engineer-in-Charge in writing subject to adding 10% extra cement. When hand mixing is permitted, it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the concrete is uniform in colour and consistency. Before mixing the brick aggregate shall be well soaked with water for a minimum period of two hours and stone aggregate or gravel shall be washed with water to remove dirt, dust and other foreign materials. For guidance, the mixing time may be 1 1/2 to 2 minutes, for hydrophobic cement it may be taken as 21/2 to 3 minutes.

3.5.6.1 Machine Mixing: The mixer drum shall be flushed clean with water. Measured quantity of coarse aggregate shall be placed first in the hopper. This shall be followed with measured quantity of fine aggregate and then cement. In case fine aggregate is damp, half the required quantity of coarse aggregate shall be placed in the hopper, followed by fine aggregate and cement. Finally the balance quantity of coarse aggregate shall be fed in the hopper, & then the dry materials are slipped into the drum by raising the hopper. The dry material shall be mixed for atleast four turns of the drum. While the drum is rotating, water shall be added gradually to achieve the water cement ratio as specified or as required by the Engineer-in-Charge. After adding water, the mixing shall be continued until concrete of uniform colour, uniformly distributed material and consistency is obtained. Mixing shall be done for atleast two minutes after adding water. If there is segregation after unloading from the mixer, the concrete should be remixed.

The drum shall be emptied before recharging. When the mixer is closed down for the day or at any time exceeding 20 minutes, the drum shall be flushed cleaned with water.

3.5.6.2 Hand Mixing: When hand mixing has been specifically permitted in exceptional circumstances by the Engineer-in-Charge in writing, subject to adding 10% extra cement, it shall be carried out on a smooth, clean and water tight platform of suitable size. Measured quantity of sand shall be spread evenly on the platform and the cement shall be dumped on the sand and distributed evenly. Sand and cement shall be mixed intimately with spade until mixture is of even colour throughout. Measured quantity of coarse aggregate shall be spread on top of cement sand mixture and mixing done by showlling and turning till the coarse aggregate gets evenly distributed the cement sand mixture. Three quarters of the total quantity of water required shall be added in a hollow made in the middle of the mixed pile and the material is turned towards the middle of pile with spade. The whole mixture is turned slowly over and again and the remaining quantity of water is added gradually. The mixing shall be continued until concrete of uniform colour and consistency is obtained. The mixing platform shall be washed and cleaned at the end of the day.

3.5.6.3 Transportation and Handling: Concrete shall be transported from the mixer to the place of laying as rapidly as possible by methods which will prevent the segregation or loss of any of the ingredients and maintaining the required workability.

3.6 Placing
The concrete shall be deposited as nearly as practicable in its final position to avoid rehandling. It shall be laid gently (not thrown) and shall be thoroughly vibrated and compacted before setting commences and should not be subsequently disturbed. Method of placing shall be such as to preclude segregation. Care shall be taken to avoid displacement of reinforcement or movement of form work and damage due to rains. As a general guidance, the maximum free fall of concrete may be taken as 1.5 metre.

3.7 Compaction
Concrete shall be thoroughly compacted and fully worked around embedded fixtures and into corners of the form work. Compaction shall be done by mechanical vibrator of appropriate type till a dense concrete is obtained. The mechanical vibrators shall conform to IS 2505, IS 2506, IS 2514 and IS 4656. To prevent segregation, over vibration shall be avoided. Compaction shall be completed before the initial setting starts. For the items where mechanical vibrators are not to be used, the contractor shall take permission of the Engineer-in-Charge in writing before the start of the work. After compaction the top surface shall be finished even and smooth with wooden trowel before the concrete begins to set.

3.8 Construction Joints
Concreting shall be carried out continuously upto construction joints. The position and arrangement of construction joints shall be as shown in the structural drawings or as directed by the Engineer-in-Charge. Number of such joints shall be kept minimum. Joints shall be kept as straight as possible. Construction joints should comply with IS 11817.

3.8.1 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, of workable consistency by using 2 kgs of cement per sqm shall be applied on the surface before it is dry. For horizontal joints, the surface shall be covered with a layer of mortar about 10-15 mm thick composed of cement and sand in the same ratio as the cement and sand in concrete mix. This layer of cement slurry of mortar shall be freshly mixed and applied immediately before placing of the concrete.

3.8.2 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 coarse aggregate. The surface shall be thoroughly wetted and all free water removed. The surface shall then be coated with neat cement slurry @ 2 kgs of cement per sqm. On this surface, a layer of concrete not exceeding 150 mm in thickness shall first be placed and shall be well rammed against old work particular attention being paid to corners and close spots; work, thereafter, shall proceed in the normal way.

3.9 Curing
Curing is the process of preventing loss of moisture from the concrete. The following methods shall be employed for effecting curing.

3.9.1 Moist Curing: Exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacking, canvas, Hessian or similar materials and kept constantly wet for at least 7 days from the date of placing concrete in case of ordinary Portland cement and at least 10 days where mineral admixtures or blended cements are used. The period of curing shall not be less than 10 days for concrete exposed to dry and hot weather conditions. In the case of concrete where mineral admixtures or blended cements are used, it is recommended that above minimum periods may be extended to 14 days.

3.9.2 Membrane Curing: Approved curing compounds may be used in lieu of moist curing with the permission of the Engineer-in-Charge. Such compound shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set. Impermeable membrane such as polythene sheet covering the concrete surface may also be used to provide effective barrier against the evaporation.

3.9.3 Freshly laid concrete shall be protected from rain by suitable covering.
3.10 Measurements

3.10.1 Dimensions of length, breadth and thickness shall be measured correct to nearest cm. except for the thickness of slab and partition which shall be measured to nearest 5 mm. Areas shall be worked out to nearest 0.01 sq.m and the cubic contents of consolidated concrete shall be worked out to nearest 0.01 cum. Any work done in excess over the specified dimension or sections shown in the drawing shall be ignored.

3.10.2 Concrete work executed in the following conditions shall be measured separately:
   (a) Work in or under water
   (b) Work in liquid mud
   (c) Work in or under foul positions

3.10.3 *Cast-in-situ concrete* and or precast concrete work shall be measured in stages described in the item of work, such as:
   (a) At or near the ground level
   (b) Upto specified floor level
   (c) Between two specified floor levels
   (d) Upto specified height above or depth below plinth level/ defined datum level.
   (e) Between tow specified heights or depths with reference to plinth/defined datum level.

3.10.4 No deduction shall be made for the following:
   (a) Ends of dissimilar materials for example beams, posts, girders, rafters, purlins, trusses, corbels and steps upto 500 sq cm in cross sections.
   (b) Opening upto 0.1 sq metre (1000 sq.cm)
   (c) Volume occupied by pipes, conduits, sheathing etc. not exceeding 100 sq cm each in cross sectional areas.
   (d) Small voids such as shaded portions when these do not exceed 40 sq cm each in cross section.

   **Note:** In calculating area of opening, the thickness of any separate lintel or sill shall be included in the height. Nothing extra shall be payable for forming such openings or voids.

3.11 DAMP PROOF COURSE

3.11.1 Cement Concrete Layer
This shall consist of cement concrete of specified proportions and thickness. The surface of brick or stone masonry work shall be levelled and prepared before laying the cement concrete. Edge of damp proof course shall be straight, even and vertical. Side shuttering shall consist of steel forms and shall be strong and properly fixed so that it does not get disturbed during compaction and the mortar does not leak through. The concrete mix shall be of workable consistency and shall be tamped thoroughly to make a dense mass. When the sides are removed, the surface should come out smooth without honeycombing. Continuity shall be maintained while laying the cement concrete layer and laying shall be terminated only at the predetermined location where damp proof course is to be discontinued. There shall be no construction joints in the Damp Proof Course.

3.11.2 Curing
Damp proof course shall be cured for at least seven days, after which it shall be allowed to dry.

3.11.3 Water Proofing Materials
Where so specified, water proofing material of approved quality shall be added to the concrete mixture in accordance with the manufacturer’s specification stating the quantity of water proofing material in litres or kg per 50 kg or cement and will be paid for separately.
3.11.4 Measurements
The length and breadth shall be measured correct to a cm and its area shall be calculated in square metres correct to two places of decimal. The depth shall not be less than the specified thickness at any section.

3.11.5 Rate
The rate is inclusive of the cost of materials and labour involved in all the operations described above except for the applications of a coat of hot bitumen and addition of water proofing materials which shall be paid for separately, unless otherwise specified.
4.0 REINFORCED CEMENT CONCRETE

4.1 General

Reinforced cement concrete work may be cast-in-situ or Precast as may be directed by Engineer-in-Charge according to the nature of work. Reinforced cement concrete work shall comprise of the following which may be paid separately or collectively as per the description of the item of work.
(a) Form work (Centering and Shuttering)
(b) Reinforcement
(c) Concreting: (1 – Cast-in-situ), (2 – Precast)

4.1.1
   (i) IS 456- 2000 Code of Practice for Plain and Reinforced Concrete (as amended up to date) shall be followed in regard to Concrete Mix Proportion and its production.
   (a) The concrete mix design shall be done as “Design Mix Concrete” as prescribed in clause-9 of IS 456 mentioned above.
   (b) Concrete shall be manufactured in accordance with clause 10 of above mentioned IS 456 covering quality assurance measures both technical and organizational, which shall also necessarily require a qualified Concrete Technologist to be available during manufacture of concrete for certification of quality of concrete.

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

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

PART— I

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

Submittals
Material Report

Prior to start of delivery of materials required, the following shall be submitted by the contractor to the Consultant / Engineer-in-charge for approval:

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

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

4.2 Plant And Equipment

The contractor shall submit the following to the Consultant well in advance:

The proposed program, methods and details of plant and equipment for use in testing of ingredients and concrete samples.

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

4.3 Reports For Inspection And Testing

During concreting operations, the contractor shall conduct inspection and testing as described in subsection 3.15.2 herein, and all reports thereon shall be submitted in summary form to the Consultant / Engineer-in-charge.

4.4 Schedules

Before commencement of the work the contractor shall prepare working schedules of concreting giving dates and rate of pour for each item of work and submit the same to the Consultant / Engineer-in-charge for their approval.

4.5 MATERIALS

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

Fresh samples shall be deposited with the Consultant / Engineer-in-charge whenever type or source of any material changes. The contractor shall check each fresh consignment of materials as it is brought on to the works to ensure that they conform to the specification and / or approved samples.

The Consultant / Engineer-in-charge shall have the option to have any of the materials tested to find whether they are in accordance with specifications at the contractor’s expense. All bills vouchers and test certificates which in the opinion of the Consultant / Engineer-in-charge are necessary to convince him as to the quality of materials or their suitability shall be produced for his inspection when required.

Any materials which have not been found to the specification and not approved by the Consultant / Engineer-in-charge shall be rejected forthwith and shall be removed from the site by the
Contractor’s at his own cost within the time stipulated by the Consultant / Engineer-in-charge. The Consultant / Engineer-in-charge shall have the powers to cause the contractors to purchase and use materials from any particular source, as may in their opinion be necessary for the proper execution of work.

4.5.1 Cement

Cement shall be provided by the Contractor

On the following types of cement as specified shall be used

a) Ordinary Portland Cement 43 grade confirming to BIS 8112-1987

b) Ordinary Portland Cement 53 grade confirming to BIS 12269-1987

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

4.5.2 AGGREGATES

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

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

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

The grading of sand as determined by the method prescribed in IS: 2386 part I shall be within the limits of grading zone III given in Table 1. When the grading falls outside the percentage limits given for sieves other than 600 micron, 300 micron, and 150 micron (I.S) sieves by not more 5 percent, it shall be regarded as falling within this zone. The 5 percent can be excess submission on one more sieves.
TABLE 4.1

FINE AGGREGATE

<table>
<thead>
<tr>
<th>I. S. Sieve</th>
<th>ZONEI</th>
<th>ZONEII</th>
<th>ZONEIII</th>
<th>ZONE IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mm</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>4.75 MM</td>
<td>90-95</td>
<td>90-100</td>
<td>90-100</td>
<td>95-100</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>60-95</td>
<td>75-100</td>
<td>85-100</td>
<td>95-100</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>30-70</td>
<td>55-90</td>
<td>75-100</td>
<td>90-100</td>
</tr>
<tr>
<td>600 micron</td>
<td>15-34</td>
<td>35-59</td>
<td>35-60</td>
<td>80-100</td>
</tr>
<tr>
<td>300 micron</td>
<td>5-20</td>
<td>8-30</td>
<td>8-30</td>
<td>20-65</td>
</tr>
<tr>
<td>150 micron</td>
<td>0-10</td>
<td>0-10</td>
<td>0-10</td>
<td>0-15</td>
</tr>
</tbody>
</table>

The maximum quantity of silt as determined by the method prescribed in IS: 2386 Part II shall not exceed 8%.

Stone dust shall be within the limits of Grading Zone III given in table 1. When the grading falls outside the percentage limits given for the sieves other than 600 micron and 300 micron (IS) sieves by not more than 5 percent and on 150 micron sieves by not more than 20 percent it shall be regarded as falling within this zone. The 5 percent can be excess summation on one or more sieves.

4.5.2.1 Coarse Aggregate

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

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

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

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

4.5.3 Water

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

Water shall be from the source approved by the Consultant / Engineer-in-charge and shall be in accordance with Clause 4.3 of IS: 456.
Before starting any concreting work and whenever the source of water changes, the water shall be tested for its chemical and other impurities to ascertain its suitability for use in concrete for approval of the Consultant. No water shall be used until tested and found satisfactory. Cost of all such tests shall be borne by the contractor.

4.5.4 Admixtures And Additives

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

The contractor shall further provide the following information concerning each admixture to the Consultant/Engineer-in-charge.

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

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

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

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

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

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

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

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

Regarding admixtures when used shall be based on lingo-sulphonates with due consideration to clause 5.2 and 5.30 of IS: 7861.

Waterproofing admixtures shall comply with IS: 2645.

4.6 Plant

The contractor shall obtain the approval of the Consultant/Engineer-in-charge for all plant items he proposes to use for the manufacture and placing of concrete.

The arrangement shall maintain all items of plant at all times in a clean and efficient working condition.

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

4.7.1 Cement

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

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

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

Consignments of cement shall be used in order of delivery A record shall be kept of the batch numbers of cement deliveries in such a form that the part of the works in which the cement is used can be readily identified. If during delivery or by test, the cement is found to be defective, the same shall be returned back forthwith.

The contractor shall be responsible for the storage of cement at the site and no claim will be entertained in the event of any damage occurring to cement due to faulty storage by the contractors or on account of his negligence.

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

**STORING OF AGGREGATE**

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

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

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

4.8 Grades of Concrete

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

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

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

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

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

<table>
<thead>
<tr>
<th>Grade</th>
<th>Qty (in kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-20</td>
<td>300</td>
</tr>
<tr>
<td>M-25</td>
<td>300</td>
</tr>
<tr>
<td>M-30</td>
<td>320</td>
</tr>
<tr>
<td>M-35</td>
<td>340</td>
</tr>
</tbody>
</table>

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

4.9 Mix Design

General

At the commencement of the contract, the Contractor shall make preliminary tests to determine the proportions by weight of cement, fine aggregates, coarse aggregates and water necessary to produce required grades of concrete. The mix proportions shall be selected to ensure that workability of the fresh concrete is suitable for the conditions of handling and placing and when
concrete hardens, it shall have the required strength, durability and surface finish. The Contractor shall get approval of the Engineer to such proportions before start of concreting. However, such approval shall not relieve the Contractor of his responsibility to produce concrete having compressive strengths as laid down in the foregoing table.

No departure from the approved proportions will be permitted during the works unless and until the Engineer gives written authorization for any change in proportion. The Engineer shall have authority at any time to check whether the mixing of concrete is being carried out according to the approved proportions.

For the major and important RC works and for all special works, the design of mixes shall be made by the Contractor at his own cost, for each grade of concrete as well as for various workability. The design of mixes shall be made according to relevant I.S. codes or to approved standard methods.

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

The Contractor shall use only design mix and weigh batching for RCC. Only if specially permitted by the Engineer, he will be allowed to use nominal mix or volume batching. The Contractor shall make available at least two concrete mixers with weigh batching facility. He shall also make available concrete cube, testing machine, cube moulds etc. to test the crushing strength of concrete at site. He shall also indicate while submitting the Bid, the methods proposed to carry out the designs for the mix.

4.10 Water/Cement Ratio

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

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

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

4.11 Workability

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

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

Normally, in the condition of low water cement ratio as well as for medium/high workability, the workability shall be achieved by increasing the cement content.
In cases where the cement content is to be limited to reduce the heat of hydration, and the water / cement ratio is also to be kept low to reduce the permeability or due to other requirements the desired workability may be achieved with the use of limited doses of plasticizer or air entraining agent. In such cases, the method of mixing and dosage of the plasticiser / air entraining agent shall be according to the manufacturer's specification and with the approval of the Engineer.

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

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

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

<table>
<thead>
<tr>
<th>Various types of construction</th>
<th>Slump (in mm)</th>
<th>Max.</th>
<th>Min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforced foundation walls and footings</td>
<td>75</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Plain footings, caissons and structure walls</td>
<td>75</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Compressor foundations and for heavy mass constructions</td>
<td>75</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Pumps and other misc. equipment foundations</td>
<td>75</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Columns, slabs, beams and reinforced walls</td>
<td>100</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

4.12 Durability

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

4.13 Trial Mixes

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

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

Each trial mix shall be handled and compacted by the method which the Contractor proposes to use for that mix in the works and the mixes shall not show tendency of inadequate compaction by the method proposed.
The compacting factor and the slump of each trial mix shall be determined immediately after mixing and the values shall not exceed the maximum value obtained in the mix design.

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

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

The entire cost of all the trial mixes including all the preparatory works for trial mixes, preparation of test cubes and their testing shall be borne by the Contractor.

4.14 Nominal Mix Concrete

Nominal mix concrete may be used for all concrete of grade M-20 and below. If design mix concrete cannot be used for any reason for grade M-15 and M-20, nominal mix concrete may be used with the permission of the Engineer. Nominal mix concrete shall be in accordance with Table-3 of clause 8.3 of I S 456. The stipulations of clauses 8.3.1 and 8.3.2 of IS: 456 shall also be taken into consideration.

4.15 Volumetric Mix Concrete

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

4.16 Batching of Concrete

4.16.1 Cement

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

4.16.2 Aggregates

For both design mix concrete and nominal mix concrete, the aggregates, (coarse and fine) shall be batched by weight.

In particular cases, or where weight-batching is not possible, proportioning by volume batching may be allowed by the aggregates throughout the period of construction. For this purpose, the Contractor shall submit to the Engineer sufficient data indicating the weight/volume relationship of the aggregates shall be made by the Contractor to the satisfaction of the Engineer. Where aggregates are moist and volume batching is adopted, allowance shall be bulking in accordance with IS (Part III).

Suitable adjustments shall be made for the variation in the weight of aggregates due to variation in their moisture contents.
4.17 **Water**

4.17.1 **General**

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

4.17.2 **Adjustment of Water Due to Moisture Contents in Coarse and Fine Aggregates**

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

4.17.3 **Determination of Moisture Content in the Aggregates**

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

<table>
<thead>
<tr>
<th>Aggregates</th>
<th>Surface water carried by Aggregates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% by weight</td>
</tr>
<tr>
<td>Very wet sand</td>
<td>7.50</td>
</tr>
<tr>
<td>Moderately wet sand</td>
<td>5.00</td>
</tr>
<tr>
<td>Moist Sand</td>
<td>2.50</td>
</tr>
<tr>
<td>Moist gravel stone chips *</td>
<td>1.25-2.5</td>
</tr>
</tbody>
</table>

coarser the aggregate, less the water it will carry

4.17.4 **Admixtures**

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

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

4.17.5 **Accuracy of Batching**

The accuracy of batching shall be within the following tolerance:

1. Cement within -2% to +2% by weight
2. Aggregate, admixture and water within -3% to +3% by quantity.

4.18 **Mixing of Concrete**

4.18.1 **Machine Mixing**

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

4.18.2 **Hand Mixing**

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

4.19 **Transportation of Concrete**

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

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

4.20 **Preparatory Works/Surface Preparation**

4.20.1 **For Concrete Directly on Earth Foundation**

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

The earth foundation, over which concrete is to be placed directly, shall not be kept abandon at the specified level and concrete shall be placed immediately following otherwise suitable measures shall be taken, as directed by the Engineer without extra cost.

4.20.2 **For Construction Joints**

Concrete shall be cast, as far as possible, continuously until the parts of structure to be built are finished. Should this not be feasible, the type, number and location of construction joints shall be approved by the Engineer prior to placing concrete.
All such joints shall have continuous square bond grooves to produce substantial and water-tight-key and the exposed faces of joints shall be monolithic with the main mass of concrete formed and completed under substantially shattered faces. The Contractor shall take all the necessary steps by means of timber edgings etc. to ensure an exact horizontal straight finish to outside edge of any lift of concrete. Subject to the approval of the Engineer, the Contractor is at liberty to arrange his own construction joints but the following restrictions are to be observed:

1. There shall be no vertical construction joints

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

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

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

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

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

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

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

4.20.3 On Vertical Surfaces of Masonry

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

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

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

4.21 Placing and Compaction of Concrete

Before placing the concrete, the Contractor shall ensure that:

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

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

- Design Index
- Date
- Slump
- Workability
- Work test specimen
- Type of finishing and admixtures used (if any)
- Period of removal of shuttering/props/forms.
The concrete pouring method shall be submitted to the Engineer for approval and shall always be such as to avoid any possibility of segregation of the components or shifting of the reinforcement.

Special grout or mix shall be used for difficult and intricate locations as specified by the Engineer. During placing, the concrete shall be thoroughly worked around reinforcement, embedded parts and corners of the formwork.

Greatest possible care shall be taken by the Contractor that reinforcement and embedded parts, particularly foundation bolts and sleeves, are not displaced during placement of concrete. While concreting mats and other such locations where top and bottom reinforcement are adopted, top reinforcement shall be thoroughly cleaned of all slurry and mortar sticking to them at the time of concreting top layers.

The concrete shall be placed and compacted before setting commences and should not be subsequently disturbed. No water shall be mixed with the concrete after it has left the mixer. Method of placing should be such as to preclude segregation. Approved mechanical vibrator shall be used for compacting concrete, and concrete shall not be non vibrated or under vibrated. No concrete shall be placed until the place of deposit has been thoroughly inspected and approved by the Engineer, all inserts and embedment properly secured in position and checked and forms properly oiled. No concrete shall be placed in the absence of the Engineer.

Concrete shall be placed on clean bed having the designed level. The bed shall be cleaned of all debris and other objectionable materials. Seepage water, if any, shall be controlled or diverted.

Concreting shall not be carried on during rains unless all precautions have been taken by the Contractor and necessary permission has been given by the Engineer. Suitable measures shall be taken to control the temperature of concrete. Where plums are permitted in massive concrete, they shall be washed and carefully placed. No stone shall be closer than 30 cm to an exposed face, nor nearer than 15 cm to an adjacent stone.

Concrete shall not be dropped from a height of more than 2 m except through a chute, the design and type of which shall be subjected to approval of the Engineer.

The concrete shall be placed, spread and compacted by approved mechanical vibrator. Vibrators shall not be used for pushing concrete to adjoining areas.

For members involving vertical placing of concrete (e.g. columns, walls etc.), each lift shall be deposited in horizontal layer extending for the full width between shuttering and of such depth that each layer can be easily and effectively vibrated and incorporated with the layer below by means of compaction being employed.

For members involving horizontal placing of concrete (e.g., slabs, beams etc.), the concrete shall be placed along the line of starting point in such quantities as will allow members to be cast to their full depth along the full width between side shuttering and then gradually brought towards the finishing point along its entire front parallel to the starting line. Vibration and surface finish shall follow behind the placement as closely as possible.

Utmost care shall be taken to avoid the displacement of reinforcements/ embedded parts or movement of form work or damage to faces of the form work or transmission of any harmful vibration/shocks to the concrete which has not yet hardened sufficiently.
All members shall be concreted at such a rate that no cold joint is formed and fresh concrete is placed always against green concrete, which is still plastic and workable.

Should any unforeseen occurrence result in a stoppage of concreting for one hour or such other time as might allow the concrete, already placed, to begin to set before the next batches can be placed, the Contractor shall make at his own cost, suitable tongue, and groove construction joint, as approved by the Engineer. Any additional reinforcement required as directed by the Engineer shall also be provided by the Contractor at his own cost. Before placement of new batches of concrete over that construction joint, the surface preparation according to this specification stipulated earlier, shall be done by the Contractor.

The concrete shall be worked well up against whatever surface it adjoins and compacted to such a degree that it reaches its maximum density as a homogeneous mass, free from air and water holes and penetrates to all corners of moulds and shuttering and completely surrounds the reinforcement. All measures shall be taken to make the shape, size, and location of the finished concrete including its embedment, holes, openings etc, well within the accepted tolerance limit.

4.22 **Sub-standard concrete**

Should the work strength of controlled concrete fall below the specified strength, Engineer shall decide:

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

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

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

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

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

If the structure is certified as failed by the Engineer, the cost of the load test shall be borne by the Contractor.
4.23 **Optional Tests**

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

Tests on cement shall include

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

Tests on sand shall include

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

Tests on coarse aggregates shall include

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

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

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

4.24 Concrete for Equipment or steel structures foundations

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

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

4.25 Requirements for Concreting in Special Cases

4.25.1 Concreting in Deep Lifts

Placing of concrete in lifts exceeding 3 m in columns and 2 m in walls is in the category of deep lifts.

Before commencement of work, the Contractor shall submit for the approval of the Engineer, the details of the methods he proposes to adopt for concreting. The placement of concrete shall preferably be by tremie chute or any other approved method.

In structures of heavy/complicated reinforcement or in complicated form works, the Contractor shall provide sufficient number of windows in the form works as directed by the Engineer to
Technical Specifications for Construction of Township

check the placement and compaction of concrete in different stages. Such windows shall be closed as soon as the concreting reaches the bottom level of the same.

4.25.2 Cold Weather Concreting

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

4.25.3 Hot Weather Concreting

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

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

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

4.25.4 Concreting in Large Pours (Mass Concrete)

The aim of controlling the concreting in large pours is to reduce cracking caused by shrinkage due to heat of hydration. The Contractor shall submit detailed proposal to the Engineer for approval about the method of pouring and the measures to reduce heat of hydration, which he proposes to adopt.

The maximum height of lifts will depend on the type of cement used. The use of cement having low heat of hydration, could allow greater lifts.

The Contractor shall provide all the necessary arrangements like pre-cooling of aggregates, cooling of fresh concreting by passing cold water through pipes placed inside the concrete or such other measures at least 38 hours before the placement of concrete and also provide the facility for recording of temperature at least 24 hours prior to placement of concrete.

The minimum interval between concreting of successive lifts, separated by horizontal construction joint, shall be six days or as directed by the Engineer.

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

4.26 Finishes to Exposed Surface of Concrete
The Contractor is to include his quoted rate for concrete, the provision of normal finishes in both formed and unformed surfaces as and where required by the Engineer without any extra cost.

Some common finishes are indicated below:

4.26.1 Surfaces which do not require Plastering

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

4.26.2 Faces of Foundations which will be Back Filled

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

4.26.3 Exposed Surfaces

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

4.26.4 Surface for Non-integral Finish

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

4.26.5 for Monolithic Finish

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

4.27 Curing of Concrete

4.27.1 General

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

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

a) Curing by Direct Water

This is done either by pounding or spraying water.

Pounding

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

By Spraying Water

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

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

b) Curing of Concrete with Absorbent Material Kept Damp

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

c) Curing by Covering Concrete Surface with an Impressive Sheet

This is achieved by covering the entire concrete surface with water proof paper or plastic sheets specially manufactured for this purpose. The waterproof papers are stuck together by adhesive compound and the plastic sheets can be welded at site.

Such type of covering shall be kept at least for 24 days after the final setting. It is preferable to have sheet as white in appearance since the white colour will reflect hot sunrays and keep the concrete temperature at reasonable level.

d) Curing by Providing Protective Membrane by Applying curing compound

This is achieved by applying a membrane forming compound (curing compound) over the concrete surface. Generally, these are available in the emulsion form. The application of the curing compound should be started immediately after stripping off the shuttering in case of formed surface and after the surface has hardened in case of unformed surface.

The curing compound membrane forming emulsions dry up within 3 to 4 hours after application and forms a continuous coherent adhesive membrane over the concrete surface. Such membrane serves as a physical barrier to prevent the loss of moisture from the concrete itself. Membrane forming emulsions are generally coloured black or white to improve visibility for ensuring uniform application. Black colour shall never be used for curing in very hot weather. In order to prevent glare, a colouring pigment may be added to white compounds.
Black curing compounds are either Bituminous or Asphaltic emulsions and shall be used to surfaces which are to be covered by back filling or on the floor which is to be covered with tiles and linoleum.

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

e) Curing by Chemical Coating

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

4.28 Testing of Concrete

4.28.1 General

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

4.28.2 Consistency Test (Tests of Fresh Concrete)

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

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

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

For any particular batch of concrete, if the results do not conform to the requirements as specified in IS 456, the Engineer has the right to reject that batch and the Contractor shall remove the same immediately from the site.

4.28.3 Strength Test of Concrete

While placing concrete, the Contractor shall make six (6) 150 mm test cubes from particular batches of concrete as desired by the Engineer. The frequency of taking test cubes shall be either according to clause 14.2 of IS:456 or as directed by the Engineer.
The cubes shall be prepared, cured and tested according to IS 516. Out of the six (6) test cubes, 3 shall be tested for compressive strength at 7 days after casting and the remaining 3 at 28 days after casting.

A register shall be maintained at site by the Contractor with the following details entered and signed by both the Contractor and the Engineer.

- Reference to the specific structural member
- Mark on cubes
- The grade of concrete
- The mix of concrete
- Date and time
- Crushing strength at 7 days
- Crushing strength at 28 days
- Any other information directed by the Engineer.

### 4.28.4 Acceptance Criteria for Test Cubes

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

### 4.28.5 Non-destructive Tests on Hardened Concrete

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

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

### 4.28.6 Concrete below Specified Strength

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

1. Reject the work and instruct that section of the works to which the failed cubes relate shall be cut out and replaced at the Contractor's expense.

2. Instruct the Contractor to carry out additional tests and/or works to ensure the soundness of the structure at the Contractor's expense.

3. Accept the work with reduction in the rate in appropriate item.

### 4.28.7 Concrete failed in Non-destruction Tests

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

4.29  Cracks

If any cracks develop in the reinforced cement concrete construction which in the opinion of the Consultant may be determined to the strength of the construction, the contractor at his own expense shall test the structural element in question. If under these test loads the cracks shall develop further the contractor at his own expense shall dismantle the construction, cart away the debris, replace the construction and carry out all consequential work there to at no extra cost.

If the cracks are not detrimental to the stability of the construction in the opinion of the Consultant, the contractor at his own expense shall grout the cracks with pneumatically applied mortar. At his own expense and risk he shall also make good all other building works such as plaster, molding, surface finish of floods, roofs, ceiling etc. which in the opinion of the Consultant have suffered damage either in appearance or stability owing to such cracks.

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

4.30  Supervision

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

Special attention shall be paid to the following:-

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

4.31  QUALITY CONTROL

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

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

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

a) Variation from plumb for -
   i. Columns and walls to be rendered 6 mm in 3 meters
   ii. Exposed columns and walls 3 mm in 3 meters

b) Variation in cross sectional dimensions of columns and beams and in the thickness of slabs and walls: - 6 mm & + 12 mm

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

4.33 **TESTING ROOM**

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

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

2. Weighing
   a) Physical balance cap. 200 gms with weigh box (accuracy 0.5 gm)
   b) Counter Scale cap 20 Kg
   c) Weights
      5 kg      1 No    500 gms  1 No.
      2 kg      2 Nos   200 gms  1 No.
      1 kg      1 No.   100 gms  1 No.

3. Slump Cones       2 Nos
4. 15 cms moulds     18 no.
5. Electric/Kerosene Heater
6. pans etc. as directed by the Consultant
7. Measuring Cylinders of 1000 ml., 500 ml and 100ml.
8. Wash bottles of the Capacity of 500 ml., 2 Nos.
9. Sink
10. Work benches, shelves, desks and any other furniture and lighting as required by the Consultant.
11. Spring balance dial type cap. 100 kg
12. Litre measures
   a) 10 Lit  1 No.
   b) 5 Lit   1 No.
   c) 2 Lit   2 Nos
   d) 1 Lit   1 No.
   e) 1/2 Lit 1 No.
14. Oven.

4.34 CO-ORDINATION OF WORK

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

5.1 GENERAL

5.1.1 Description

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

5.1.2 Related Work Specified Elsewhere

Applicable Codes and Standards:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>IS: 280</td>
<td>Mild wire for general engineering purpose</td>
</tr>
<tr>
<td>IS: 432</td>
<td>Part I Mild steel and medium tensile steel bars</td>
</tr>
<tr>
<td>IS: 456</td>
<td>Part II Hard drawn steel wire</td>
</tr>
<tr>
<td>IS: 1139</td>
<td>Code of practice for plain and reinforced concrete</td>
</tr>
<tr>
<td>IS: 1566</td>
<td>Hot rolled mild steel, medium tensile steel and high yield strength steel deformed bars for concrete reinforcement</td>
</tr>
<tr>
<td>IS: 2502</td>
<td>Hard drawn steel wire fabric for concrete reinforcement</td>
</tr>
</tbody>
</table>

The codes and standards generally applicable to the work this section is listed in this section. The following clauses are intended to amplify the requirements of the reference documents listed above and the contractor/Engineer-in-charge shall comply with these clauses.

5.2 Submittals

5.2.1 Bar Bending Schedule

The Contractor shall prepare Bar Bending Schedule for reinforcement before fabrication.

5.3 Materials

5.3.1 Steel Reinforcement

Steel reinforcement to be procured by the Contractor for works shall be either of the following types:

(a) Hard drawn steel wire fabric conforming to IS 1566
(b) Structural steel conforming to Grade A of IS 2062
(c) Thermo-mechanically treated (TMT) Bars.

All reinforcement shall be stored horizontally above ground level on supports, skids or other approved supports, clear of any running or standing water. Contact with soil should be avoided. Proper drainage and protection from the elements shall be provided to minimize corrosion.
Before steel reinforcement is placed in position, the surface of the reinforcement shall be cleaned of rust, dust, grease and other objectionable substances. In order to confirm them self the quality periodical tests as specified as the relevant IS shall be conducted by the contractor at his own cost for the materials procured by the Contractor.

5.3.2 Binding Wire

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

5.4 Storage

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

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

Bars of different classifications and diameters shall be stored separately.

A record shall be kept of the batch numbers of reinforcement deliveries in such a form that the part of the works in which particular reinforcement is used can be readily identified.

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

5.5 Fabrication

Reinforcement steel shall be carefully and accurately cut, bent or formed to the dimensions and configurations shown on the drawings and as per bar bending schedules approved by the Consultant / Engineer-in-charge.

All reinforcement shall be bent cold using appropriate pin size. Bars may be preheated only on approval of the Consultant. Quenching shall not cool hot bars. Bends shall be in accordance with IS: 2502.

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

Reinforcement steel having a reduced section, visible transverse cracks in bends, or otherwise damaged in anyway shall not be used.

Spiral reinforcement shall be accurately fabricated to the diameter and pitch shown on the drawings. One and one half finishing turns shall be provided at both top and bottom unless shown otherwise.
Cut ends of galvanized rods shall be given a protective coat of an approved zinc paint immediately after cutting.

5.6 Lapping

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

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

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

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

5.7 Placement

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

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

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

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

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

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

Walkways and borrow runs for placing and compacting the concrete shall be independent of the reinforcement.
Loose binding wire and other extraneous metal shall be removed from inside the form work prior to concrete placing.

Without relieving the Contractor of the responsibilities for the correctness thereof, the reinforcement shall be inspected and approved by the Consultant in writing before any concrete is placed and the contractor shall allow sufficient time for such inspecting and any subsequent remedial action to be carried out.

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

5.8 Cover To Reinforcement

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

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

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

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

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

5.9 Cleaning

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

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

5.10 Work Will Include

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

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

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

d) Work at all levels.
e) All the above mentioned works shall be included in the quoted rates, Nothing extra shall be payable to the contractor on this account

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

6.1 General

6.1.0 Description

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

6.1.1 Related Work Specified Elsewhere

a) Cast-in-place Reinforced Concrete

6.1.2 Applicable Codes And Standards

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

IS: 4990 Ply wood for concrete shuttering work.

6.2 Submittals

6.2.1 Type Of Form Work

Prior to start of delivery of material for formwork, the contractor shall prepare samples of different types of formwork for about 10 sqm and obtain approval of the Consultant/Engineer-in-charge.

6.2.2 Design Of Forms

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

6.2.3 Tie Bolts

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

6.3 Materials

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

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

6.3.3 Plywood

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

6.3.4 Steel

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

6.4 Design Criteria

Formwork shall be designed for the loads and lateral pressures due to dead weight of concrete, superimposed live loads of workmen, materials and plants and for other loads as indicated on the drawings.

Forms shall be designed to have sufficient strength to carry on the hydrostatic head of concrete as a liquid without deflection tolerances exceeding the acceptable limits.

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

<table>
<thead>
<tr>
<th>Types of member</th>
<th>Compression Steel As % of tensile steel</th>
<th>Camber Co-efficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple span</td>
<td>0%</td>
<td>0.066</td>
</tr>
<tr>
<td>Continuous Restrained span Cantilever</td>
<td>50%</td>
<td>0.037</td>
</tr>
<tr>
<td>Cantilever</td>
<td>0%</td>
<td>0.032</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td>0%</td>
<td>0.086</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>0.046</td>
</tr>
</tbody>
</table>

Camber in cms Where \(K = \frac{(K \times L \times 2.54)/D}{K\times L} \)
\(K\) = Camber coefficient
\(L\) = Length of member in meter
\(D\) = Depth of member in meter

6.5 Erection Of Formwork

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

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

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

If form work is held together by bolts or wires, those shall be so fixed that no reinforcement bar is exposed on surface against which concrete is to be laid. The Consultant may at his discretion allow the contractor to use tie bolts running through the concrete at his own cost.

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

Formwork shall be constructed so as to facilitate loosening and permit removal without jarring the concrete. Wedges, clamps and bolts shall be used wherever practicable instead of nails.

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

6.6 Cleaning And Oiling Of Forms

At the time concrete is placed in the forms, the surface of the forms in contact with the concrete shall be free from encrustations of mortar, grout or other foreign materials. Temporary openings shall be left at the bottom of formwork to enable, sawdust, shavings, wire cuttings and other foreign material to be worked out from the interior of the forms before the concrete is placed.

The surface of the forms to be in contact with the concrete shall be coated with an approved coating that will effectively prevent sticking and will not stain the concrete surfaces. After each use the surfaces of forms in contact with concrete shall be cleaned, well settled and treated with form oil approved by the Consultant Engineer-in-charge. Lubricating (machine) oils shall not be used.

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

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

6.7 Removal Of Form Work

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

Unless otherwise permitted by the Consultant, the forms shall not be stripped in less than the minimum periods specified in IS: 456. However the Consultant may increase the above period if the considers if necessary for structural stability.

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

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

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

6.7.1 Hacking:

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

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

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

6.7.2 Pockets And Openings:

Where boxes, pockets or openings are required (not exceeding 0.1 sqm) to be formed in the concrete. No deduction shall be made for the area of box or pockets in measuring the area of concrete surface shuttered. In other words the area of shuttering shall be reckoned as if box of pocket or openings were not present.

However, on measuring the concrete quantity, the volume of the box or pocket shall be deducted. If the area of box or pocket or openings against the shuttered faces exceeds 0.1 sqm. It shall be paid not as a box or pocket or opening but as formwork at the rates for formwork.

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

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

The contractor shall not be permitted reuse of any forms which in the opinion of the Consultant has worn out and has become unfit for formwork.

The Consultant/Engineer-in-charge may in his absolute discretion, order rejection of any forms he considers unfit for use in the works, and order their removal from the site.

6.9 **Form Work For Sloped Surfaces**

Forms for sloped surfaces shall be built so that the formwork can be placed board-by-board immediately ahead of concrete placement so as to enable ready access for placement, vibration, inspection and repair of the concrete.

The form work shall also be built so that the boards can be removed one by one from the bottom up as soon as the concrete has attained sufficient stiffness to prevent sagging. Surfaces of construction joints and finished surfaces with slopes steeper than 4 horizontal: 1 vertical shall be formed as required herein.

6.10 **Form Work For Curved Surfaces**

6.11 The contractor shall interpolate intermediate sections as necessary and shall construct the forms so that the curvature will be continuous between sections. Where necessary to meet requirements for curvature, the form lumber shall be built up of laminated splines cut to make tight, smooth form surfaces.

After the forms have been constructed, all surface imperfections shall be corrected and all surfaces irregularities at matching faces of form material shall be dressed for the specified curvature.

6.12 **Form Work For Exposed Concrete Surfaces**

Where it is desired, directed or shown on the drawings to have original fair finish of concrete surface without any rendering or plastering, formwork shall be carried out by using wood planks, plywood or steel plates of approved quality and as per direction of the Consultant.

The Contractor shall use one type of material for all exposed concrete surfaces and the forms shall be constructed so as to produce a uniform and consistent texture and pattern on the face of the concrete. Patches on forms for these surfaces will not be permitted. The formwork shall be placed so that all horizontal formworks are continuous across the entire surface If forms are constructed of lumber and are not paneled the formwork shall be staggered.

To achieve finish which shall be free of board marks, the formwork shall be faced with plywood or equivalent material in large sheets. The sheets shall be arranged in an approved pattern. Wherever possible, joints between sheets shall be arranged.

To achieve a finish which shall give the rough in appearance of concrete cast against swan boards, formwork boards unless otherwise stated shall be in an average be 150 mm wide,
securely jointed with tongued and grooved joints if required to prevent grout loss with tie rod positions and direction of boards carefully controlled Sawn boards shall be set horizontally, vertically or at an inclination as shown in the drawings. All bolts holes shall be accurately aligned horizontally and vertically and shall be filled with matching mortar recessed 5 mm back from the surroundings concrete face.

For exposed concrete surfaces shall be constructed with grade strips (the underside of which indicates top of pour) at horizontal construction joints, unless the use of groove strips is specified on the drawings. Such forms shall be removed and reset from lift to lift. Sheathing of reset forms shall be tightened against the concrete so that the forms will not spread and permit abrupt irregularities or loss of mortar. Supplementary from ties shall be used as necessary to hold the reset forms tight against the concrete.

For fair faced concrete, the position of through bolts will be restricted and generally indicated in the drawings.

Chamfer strips shall be paced in the corners of forms for exposed exterior corners so as to produce 20 mm beveled edges except where otherwise shown in the drawings. Interior corners edges at formed joints shall not be beveled unless shown on the drawings. Mouldings for grooves, drip courses and bands shall be made in the form itself.

The wood planks, plywood and steel plates used in formwork for obtaining exposed surfaces shall not be used for more than 3 times in case of wood planks, 6 times for plywoods and 10 times for steel plates respectively. However no forms will be allowed for reuse, if in the opinion of the Consultant/Engineer-in-charge it is doubtful to produce desired texture or irregularities of exposed concrete.

In order to obtain exposed concrete work of uniform color it shall be necessary to ensure that the sand used for all exposed concrete work shall be of approved uniform color. Moreover, the cement used in the concrete for any complete element shall be from single consignment.

No exposed concrete surface shall be rendered or painted with cement or otherwise. Plastering of defective concrete as a means of achieving the required finish shall not be permitted, except in the case of minor porosity on the surface, the Consultant/Engineer-in-charge may allow a surface treatment by rubbing down with cement and sand mortar of the same richness and color as for the concrete. This treatment shall be made immediately after removing the formwork.

The contractor shall also take all precautionary measures to prevent breaking and chipping of corners and edges of completed work until the building is handed over.

7 BRICK WORK

7.1 Classification:
The brick work shall be classified according to the class designation of brick used.

7.2 Mortar:
The mortar for the brick work shall be as specified, and conform to accepted standards. Lime shall not be used where reinforcement is provided in brick work.
7.3 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. The bricks required for masonry work using mud mortar shall not be soaked. When the bricks are soaked they shall be removed from the tank sufficiently early so that at the time of lying 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 I:

The period of soaking may be early found at site by field test in which the bricks are soaked in water for different periods 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 construction work.

Note II:

If the brick are soaked for required time water that is frequently changed the soluble salt in the bricks will be leached out, and subsequently efflorescence will be reduced.

7.4 Laying

Bricks shall be laid in English Bond unless otherwise specified. For brick work in half brick wall, bricks shall be laid in stretcher bound. Half or cut bricks shall not be used except as closer where necessary to complete the bound. Half or cut bricks shall not be used except as closer where necessary to complete the bound. Closers in such cases, shall be cut to the required size and used near the ends of the wall. Header bound shall be used preferably in all courses in curved plan for ensuring better alignment.

Note:

Header bound shall be used in foundation footings unless thickness of walls (width of footings) makes the use of headers impracticable. Where thickness of footing is uniform for a number of courses, the top courses of footing shall be headers. All loose materials, dirt and set lumps of mortar which may be laying over the surface on which brick work is to be freshly started, shall be removed with a wire brush and surface wetted. Bricks shall be laid on a full bed of mortar. When laying, each brick shall, be properly bedded and set in position by gently pressing with the handle of trowel. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. Joints shall be fully filled and packed with mortar such that no hollow apace are left inside the joints.

The walls shall be taken up truly in 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 course shall come directly one over the other. Quoin, jamb and other angles shall be properly plumbed as the work proceeds. Care shall be taken to keep the preten ds properly aligned within following maximum permissible tolerances.

Deviation from vertical within a storey shall not exceed 6 mm per 3m height.
Deviation in verticality in total height of any wall of building more than one storey in height shall not exceed 12.5 mm.

Deviation from position shown on plan of any brick work shall not exceed 12.5 mm.

Relative displacement between load bearing wall in adjacent storey intended to be vertical alignments shall not exceed 6mm.

A set of tools comprising of wooden straight edge, Masonic spirit levels, square, 1 meter rule line and plumb shall be kept on the site of work for every 3 masons for proper check during the progress of work.

All quoins shall be accurately constructed and the height of brick courses shall be kept uniform. This will be checked using graduated wooden straight edge or storey rod indicating height of each course including thickness of joints. The position of damp proof course, window sills, bottom of lintels, top of the wall etc. along the height of the wall shall be marked on the graduated straight edge or storey rod. Acute and obtuse quoins shall be bounded, where practicable in the same way as square quoins. Obtuse quoins shall be formed with squint showing there quarters brick on one face and quarter brick on the other.

The brick work shall be built in uniform layers.

No part of the wall during its construction shall rise more than one meter above the general construction level. Parts of wall left at different levels shall be raked back at an angle of 45 degree or less with the horizontal. Toothing shall not be permitted as an alternative to ranking back. For half brick partition to be keyed into main walls, indents shall be left in the main walls.

All pipe fittings and specials, spouts, hold fasts and other fixtures which are required to be built into the walls shall be embedded, as specified in their correct position as the work proceeds unless otherwise directed by the Engineer-In-Charge.

Top courses of all plinths, parapets, steps and top of walls below floor and roof slabs shall be laid with brick on edge, unless specified otherwise. Brick on edge, unless specified otherwise. Brick on edge laid in the top courses at corner of walls shall be properly radiated and keyed into position to from cut(maru) corners, cement concrete 1:2:4( 1 Cement: 2 Coarse sand : 4 graded stone aggregate 20 mm nominal size) equal to thickness of course shall be provided in lieu of cut bricks.

Bricks shall be laid with frog( where provided) up. However when top course is exposed, brick shall be laid with frog down. For the bricks to be laid with frog down, the frog shall be filled with mortar before placing the brick in position.

In case of walls on e brick thick and under, one face shall be kept even and in proper plane, while the other face may be slightly rough. In case of walls more than one brick thick, both the faces shall be kept even and proper plane.

To facilitate taking service lines later without excessive cutting of complete work sleeves (to be paid separately) shall be provided, where specified, while raising the brick work. Such sleeves in external walls shall be sloped down outward so as to avoid passage of water inside.
Top of briskness in coping and sills in external walls shall be slightly tilted. Where brick coping and sills are projecting beyond the face of the wall, drip course/throat (to be paid separately) shall be provided where indicated.

Care shall be taken during construction that edges of jambs, sills and projections are not damaged in case of rain. New built work shall be covered with gunny bags or tarpaulin so as to prevent the mortar from being washed away. Damage, if any, shall be made good to satisfaction of the Engineer-In-Charge.

Vertical reinforcement in the form of bars (high strength deformed bars), considered necessary at the corners and junction of walls and jamb opening doors, windows etc. shall be encased with cement mortar not leaner than 1:4 (1 cement : 4 coarse sand) or cement concrete mix as specified. The reinforcement shall be suitably tied, properly embedded in the foundation and at roof level. The diameter of bars shall not be less than 8mm and concrete grade shall be minimum 1:3:6 (1 Cement : 3 Coarse sand : 6 graded stone aggregate 20 mm nominal size)

In retaining walls and like, where water is likely to accumulate, weep holes, 50 to 75 mm square shall be provided at 2m vertically and horizontally unless otherwise specified. The lowest weep hole shall be at about 30 cm above the ground level. All weep holes shall be surrounded by loose stones and shall have sufficient fall to drain out the water quickly (Note: work of providing loose stone will be payable extra).

Work of cutting chases, wherever required to be made in the walls for housing G.I. pipes, CI pipe or any other fixtures shall be carried out in various locations as per guidelines given below:

(a) Cutting of chases in one brick thick and above load bearing walls

i) As far as possible services should be planned with the help of vertical chases. Horizontal chases should be avoided.

ii) The depths of vertical chases and horizontal chases shall not exceed one third and one sixth of the thickness of the masonry respectively.

iii) When narrow stretches of masonry (Or short lengths of walls) such as between doors and windows, cannot be avoided they should not be pierced with opening for soil pipes or waste pipes or timber joints, etc. where there is a possibility of load concentration such narrow lengths of walls shall be checked for stresses and high strength brick in mortar or concrete walls provided, if required.

iv) Horizontal chases when unavoidable should be located in the upper or lower one third of height of storey and not more than three chases should be permitted in any stretch of a wall. No continuous horizontal chase shall exceed one metre in length. Where unavoidable, stress in the affected area should be checked and kept within the permissible limits.

v) Vertical chases should not be closer than 2m in any stretch of a wall. These shall be kept away from bearings of beams and lintels. If unavoidable, stresses in the affected are should be checked and kept within permissible limits.

vi) Masonry directly above a recess, if wider than 30 cm horizontal dimension should be supported on lintel. Holes in masonry may be provided up to 30 cm width and 30 cm high without any lintel. In the case of circular holes in the masonry, no lintel need be provided for holes up to 40 cm in diameter.
(b) Cutting of chases in half brick load bearing walls:

No chase shall be permitted in half brick load bearing walls and such no recessed conduits and concealed pipes shall be provided with half brick thick load bearing walls.

(c) Cutting of chases in half brick non load bearing wall:

Services should be planned with the help of vertical chases. Horizontal chase should be provided only when unavoidable.

7.5 Joints

The thickness of all types of joints including brick wall joints and cross joints shall be such that four course and three joints taken consecutively shall measure as follows:

(I) In case of F.P.S bricks, it shall be equal to 31 cm.

(II) In case of non-modular bricks, it shall be equal to 31 cm.

7.6 Finishing of joints:

The face of brick work may be finished flush or by pointing. In flush finishing either the face joints of the mortar shall be worked out while still green to given a finished surface flush with the face of the brick work or the joints shall be squarely raked out to a depth of 1 cm while the mortar is still green for subsequently plastering. The faces of brick work shall be cleaned with wire brush so as to remove any splashes of mortar during the course of raising the brick work. In pointing, the joints shall be squarely raked out to a depth of 1.5 cm while the mortar is still green and ranked joints shall be brushed to remove dust and loose particles and well wetted and shall be later refilled with mortar to give ruled finish. Some such finishes are ‘flush’ ‘weathered’, ruled, etc.

7.7 Curing

The brick work shall be constantly kept moist on all faces for a minimum period of seven days. Brick work done during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

7.8 Scaffolding:

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.

7.8.1 Single Scaffolding:

Where plastering, pointing or any other finishing has been indicated for brick work, single scaffolding may be provided, unless otherwise specified. In single scaffolding, one end of the specified. In single scaffolding, one end of the put-logs/ pole shall rest in the hole provided in the header course of brick masonry. Not more than one header for each put-log/ pole shall be left
out. Such holes shall not be allowed in the case of pillars, brick work less than one meter in length between the openings or near the skew backs of arches or immediately under or near the structural member supported by the walls. The holes left for put-logs / poles shall be made good with brick work and wall finishing as specified.

7.8.2 Double-Scaffolding:-

Where the brick work or tile work is to be exposed and not to be finished with plastering etc. double scaffolding having two independent supports, clear of the work, shall be provided,

7.9 Measurements:-

Brick work shall be measured in cubic metres unless otherwise specified. Any extra work over the specified dimensions shall be ignored. Dimensions shall be measured correct to the nearest 0.01m i.e 1 cm. Area shall be calculated to the nearest 0.01 sqmts. and the cubic contents shall be worked out to the nearest 0.01 cubic metres.

Brick work shall be measured separately in the following stages:

(a) From foundation to floor one level( Plinth level)
(b) Plinth (floor one ) level to floor two level
(c) Between two specified floor levels above floor two level

Note :- Brick work in parapet walls, mumty, lift machine room and water tanks constructed on the roof upto 1.2m height above roof shall be measured tighter with the corresponding work of the floor next below:

Note :
Where minimum area is defined for deduction of an opening, void or both, such areas shall refer only to opening or void within the space measured.

a) Ends of dissimilar materials (that is, joints, beams, lintels, posts, girdes, rafters, purlins, trusses, corbels, steps etc.); up to 0.1 m$^2$ in section.

b) Opening up to 0.1m$^2$ in area ( see Note).

c) Wall plates, bed plates and bearing of slabs, chajjas and the like , where thickness does not exceed 10cm and bearing does not extend over the full thickness of wall.

d) Cement concrete blocks as for hold fasts and holding down bolts.

e) Iron fixtures, such as wall ties, pipes up to 300 mm diameter and hold lots for doors and windows, and

f) Chases of section not exceeding 50 cm in girth

g) Bearing portion of drip course, bearing of moulding and cornice

Note:-
In calculating area of an opening, any separate lintel or sills shall be included with the size of the opening but end portions of lintel shall be excluded. Extra width of rebated reveals, if any, shall also be excluded.

Walls half brick thick and less shall each be measured separately in square metres stating thickness.

Walls beyond half brick thickness shall be measured in multiples of half brick which shall be deemed to be inclusive of mortar joints. For the sizes of bricks specified in 6.1.1 half brick thickness shall mean 100mm for modular and 115 mm for non-modular bricks.

Where fractions of half brick occur due to architectural or other reasons, measurement shall be as follows:

a) upto ¼ th brick-actual measurements and
b) exceeding ¼ brick – full half bricks

String courses, projecting pilasters, aprons, sills and other projections shall be fully described and measured separately in running metres starting dimensions of each projection.

Square or rectangular pillars shall be measured separately in cubic metres in multiple of half brick.

Circular pillars shall be measured separately in cubic metres as per actual dimensions.

Brick work covered on plan shall be measured like the brickwork in straight walls and shall include all cutting and wastage of bricks, tapered vertical joints and use of extra mortar, if any. Brick work covered on plan to a mean radius not exceeding six metres shall be measured separately and extra shall be payable over the rates for brick work in straight walls. Nothing extra shall be payable if the mean radius of the brick work covered in plan exceeds six metres.

Tapered walls shall be measured net as walls and extra payment shall be allowed for making tapered surface for brick work in walls.

Brick work with brick tiles shall be measured and paid for separately.

7.10 Rate

The rate shall include the cost of materials and labour required for all the operations described above except the vertical reinforcement and its encasement in cement mortar or cement concrete. The rate shall also include the following:-

a) Raking out joints or finishing joints flush as the work proceeds:
b) Preparing tops of existing walls and the like for raising further new brick work
c) Rough cutting and waste for forming gables, splays at eaves and the like
d) Leaving holes for pipes upto 150mm dia and encasing hold fasts etc.
e) Rough cutting and waste for brick work covered in plan and for backing to stone or other types of facing.

f) Embedding in ends of beams, joists, slabs, lintels, sills, trusses etc.

g) Bedding wall plates, lintels, sills, roof tiles, corrugated sheets, etc, in or on walls if not covered in respective items and

h) Leaving chases of section not exceeding 50cm in girth or 350 Sq. Cm. in cross-section.

i) Brick on edge courses, cut brick corners, splays reveals, cavity walls, brick works curved on plan to a mean radius exceeding six metres.

7.11 Half Brick Work:

7.11.1 General

Brick work in half walls shall be done in same manner as described above except that the bricks shall be laid in stretcher bound. The half brick work is to be reinforced 2. Nos. M.S bars of 6mm dia. shall be embedded in every third course as given in the item (the dia of bars shall not exceed 8 mm). These shall be securely anchored at their end where the partitions end. The free ends of the reinforcement shall be keyed into the mortar of the main brick work to which the half brick work is jointed. The mortar used for reinforced brick work shall be rich dense cement mortar of mix 1:4. Lime mortar shall not be used. Over laps in reinforcement, if any shall not be less than 30cm.

The mortar interposed between the reinforcement bars and the brick shall not be less than 5mm. The mortar covering in the direction of joints shall not be less than 15mm.

7.11.2 Measurements

The length and height of the wall shall be measured correct to a cm. The area shall be calculated in sq.m. Where half brick wall is jointed to the main walls of one brick or grater thickness the measurements for half brick wall shall be taken for its clear length from the face of the thicker wall.

7.11.3 Rate

The rate includes the cost of the materials and labours involved in all the operations described above except reinforcement which is to be paid separately.

7.12 Brick tile work

The work shall be done in the same manner as described previously except the brick tile shall be used instead of bricks. The measurement and rate shall be same as specified previously.

7.13 Honey Comb Brick Work

7.13.1 General
The brick honeycomb work shall be done with specified class of brick, laid in specified mortar. All joints and edges shall be struck flush to give an even surface.

The thickness of the brick honeycomb work shall be half only, unless otherwise specified. Opening shall be equal and alternate with half brick laid with a bearing of 2 cm on either side.

7.13.2 Rate

The rate includes the cost of materials and labour involved in all the operations described above.

7.14 Joining Old Brick Work With New Brick Work

7.14.1 General

In case the height of the bricks of old as well as new work is same, the old work shall be toothed to the full width of the new wall and to the depth of a quarter of brick in alternate courses. In case the height of each of the bricks is unequal, then the height of each course of new work shall be made equal to the height of the old work shall by adjusting thickness of horizontal mortar joints in the new wall. Where necessary, adjustment shall be made equal to thickness of old wall by adjusting the thickness of vertical joints.

For joining new cross wall to old main walls, a number of rectangular recesses of width equal to the thickness of cross wall, three courses shall be left between two consecutive recesses. The new cross wall shall be bounded into the recesses to avoid any settlement.

Joining of old brick work with the new brick work shall be done in such a way that there shall not be any hump or projection at the joint.

7.14.2 Measurement:

The height and thickness of vertical face in contact with new work shall be measured to the nearest 0.01m and the area shall be calculated to the nearest 0.01 m and the area shall be calculated to the nearest 0.01 Sqm.

7.14.3 Rate:

The rate includes the cost of labour and material involved in all the operations described above.

7.15 TEST FOR COMPRESSIVE STRENGTH

7.15.1 Specification

Five whole bricks shall be taken from the sample as specimens for this test. Length and width of each specimen shall be measured correct to 1 mm.

7.15.2 Apparatus
The apparatus consists of compression testing machine, the compression plate of which shall have a ball seating in the form of portion of a sphere the centre of which shall coincide with the centre of the plate.

### 7.15.3 Procedure

(a) Pre- Conducting

The specimen shall be immersed in the water for 24 hours at 250 to 290°C. Any surplus moisture shall be allowed to drain at room temperature. The frog of the brick should be filled flush with mortar 1:3 (1 cement : 3 clean coarse sand of grade 3mm and down) and shall be kept under damp jute bags for 24 hours after that these shall be immersed in clean water for three days.

After removal from water, the brick shall be wiped out of any traces of moisture.

(b) Actual Testing

Specimen shall be placed with flat faces horizontal and mortar filled face upward between three 3 plywood sheets each of thickness 3mm and carefully centered between plates of the testing machine. Plaster of Paris can also be used in place of plywood sheets to ensure a uniform surface.

Load shall be applied carefully axially at uniform rate of 14 N/mm² per minute till the failure of the specimen occurs.

### 7.15.4 Reporting the Test results.

The compressive strength of each specimen shall be calculated in N/mm² as under:

Compressive Strength = Maximum load at failure (in N) / Area of Specimen (In Sq mm)

In case the compressive strength of any individual brick tested exceeds the upper limit of the average compressive strength specified for the corresponding class of brick, the same shall be limited to the upper limit of the class specified in 6.1.1 for the purpose of calculating the average compressive strength. Compressive strength of all the individual bricks comprising the sample shall be averaged and reported.

### 7.15.5 Criteria for conformity :

A lot shall be considered having satisfied the requirements of average compressive strength if the average compressive strength if the average in 6.1.2 for the corresponding class of brick tested is not be – low the minimum average compressive strength specified for the corresponding class of bricks by more than 20 percent.

### 7.16 Test For Water Absorption

#### 7.16.1 No. Of Specimen

Five whole bricks shall be taken from samples as specified for the test.

#### 7.16.2 Apparatus
A balance required for this test shall be sensitive to weight 0.1 percent (%) of the weight of the specimen.

**7.16.3 Procedure**

(a) Pre-Conditioning

The specimen shall be allowed to dry in a ventilated oven at a 110°C to 115°C till it attains a substantially constant weight. If the specimen is known to be relatively dry, this would be accomplished in 48 hours. If the specimen is wet, several additional hours may be required to attain a constant weight. It shall be allowed to cool at room temperature. In a ventilated room, properly separated bricks will require for hours for cooling, unless electric fan passes air over them continuously in which case two hours may suffice.

The cooled specimen shall be weight (WI) a warm specimen shall not be used for this purpose.

(b) Actual Testing:

Specimen shall be completely dried before immersion in the water. It shall be kept in clean water at a temperature of 27°C ± 2°C for 24 hours. Specimen shall be wiped out of the traces of water with a damp cloth after removing from the water and then shall be weighted within three minutes after removing from water (W2).

**7.16.4 Reporting the test results:**

The water absorption of each specimen shall be calculated as follows and the average of five tests shall be reported.

Water Absorption = \( \frac{(W_2 - W_1)}{W_1} \times 100 \)

**7.16.5 Criteria for Conformity:**

A lot shall be considered having satisfied the requirements of water absorption if the average water absorption is not more than 20% by weight.
8.0 Marble & Granite Work

8.0 General
Marble shall be hard, sound, dense and homogeneous in texture with crystalline texture as far as possible. It shall generally be uniform in colour and free from stains, cracks, decay and weathering.

8.0.1 Marbles are metamorphic rocks capable of taking polish, formed from the re-crystalization of lime stones or dolomitic lime stones and are distinguished from lime stone by even visibly crystaline nature and nonflaggy stratification.

Note: Marble is a product of nature hence it is difficult to guarantee uniformity of colour, veining or other characteristics that may be represented in any sample submitted. A sample will indicate only an average of colour, veining and other general texture and specified finish.

8.1 Granite Stone: Granite shall be of any colour and size as directed by Engineer-in-Charge. Granite shall be plain machine cut and mirror polished. The stone shall be smooth and of even surface without holes or pits.

8.2 SIZES AND TOLERANCES
The size of marble blocks, slabs and tiles shall be as mentioned in Table 8.1.

TABLE 8.1
Sizes of Marble Blocks, Slabs and Tiles

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Blocks</td>
<td>30 to 250</td>
<td>30 to 100</td>
</tr>
<tr>
<td>2</td>
<td>Slab</td>
<td>70 to 250</td>
<td>30 to 100</td>
</tr>
<tr>
<td>3</td>
<td>Tile</td>
<td>10 to 60</td>
<td>10 to 60</td>
</tr>
</tbody>
</table>

Notes:
1. All dimensions are in centimetre.
2. The length and width, of the blocks shall be in multiple of 30 cm.
3. Length and width of slab shall be in multiple of 10 cm and thickness in multiple of 1 cm.
4. Tiles shall be square cut and linear dimensions in multiple of 10 cm.
5. Only slabs and tiles shall be machine cut and factory made.
6. For 8 mm thick tiles, special precautions will be required for fixing them like using special adhesive as per manufacturer's specifications. Such tiles are not suitable for outside veneering work exposed to rains/sun if used in large areas in continuous stretches. For tiles of thickness 20 mm and above cramps may be provided if approved by Engineer-in-Charge.

Tolerance
The following tolerances shall be allowed in the dimension of blocks, slabs and tiles:

**Tolerance**

**Blocks**

(a) Length + 2 per cent  
(b) Width + 2 per cent  
(c) Thickness + 2 per cent

**Slabs**

(a) Length + 2 per cent  
(b) Width + 2 per cent  
(c) Thickness + 3 per cent

**Tiles**

(a) Linear dimension + 3 per cent  
(b) Thickness + 1 per cent

The sizes other than those mentioned above may be provided as directed by the Engineer-In-Charge and nothing extra shall be payable on this account.

**8.3 PHYSICAL PROPERTIES**

**8.3.1** The physical properties of marble for blocks, slabs and tiles and method of tests are mentioned in Table 8.2.

**TABLE 8.2**  
Physical Properties of Marble & Granite

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Marble Requirements</th>
<th>Method of test</th>
<th>Granite Requirement</th>
<th>Method of test</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Moisture absorption after 24 hrs immersion in cold water</td>
<td>Max. 0.4%</td>
<td>IS 1124</td>
<td>Max. 0.50% by weight</td>
<td>IS 1124</td>
</tr>
<tr>
<td>(2) Hardness</td>
<td>Min. 3</td>
<td>Mohs scale</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>(3) Specific Gravity</td>
<td>Min. 2.5</td>
<td>IS 1122</td>
<td>Min. 2.6</td>
<td>IS 1122</td>
</tr>
</tbody>
</table>

**8.3.2 Approval of Sample**

Before starting the work, the contractor shall get samples of marble approved by the Engineer-In-Charge. Approved samples shall be kept in the custody of the Engineer-In-Charge and the marble supplied and used on the work shall conform to samples with regard to soundness, colour, veining and general texture.

**8.4 SAMPLING**

In any consignment all the blocks/slabs/tiles of the same group, size and finish shall be grouped together to constitute a lot. Sample shall be selected and tested separately for each lot for determining its conformity or otherwise to the requirements of the specification. The number of blocks/slabs/tiles to be selected for the samples shall depend upon the size of the lot and shall be in accordance with the Table 8.3.
TABLE 8.3
Sample Size and Criteria for Conformity

<table>
<thead>
<tr>
<th>Number of Blocks slabs/Tiles in the lot</th>
<th>Number of blocks slabs/ Tiles to be selected in sample</th>
<th>Permissible number of defectives</th>
<th>Sub sample size in no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 25</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>26 to 100</td>
<td>5</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>101 to 200</td>
<td>8</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>201 to 500</td>
<td>13</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>501 to 1000</td>
<td>20</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

**Note:** The blocks/slabs/tiles in the sample shall be taken at random and in order to ensure to randomness of selection, random tables may be used.

**8.5 MARBLE / GRANITE WORK - TABLE RUBBED AND POLISHED (PLAIN WORK)**

Marble work in steps, jambs, columns and other plain work shall be as specified below:

Joints in staircase treads, kitchen platforms shall be permitted only at curvature or when width/length is more than 0.6/2 mtrs. respectively. Number of joints in each direction shall not be more than one number for every 2 mtrs. length beyond the initial 2.00 m length. Additional joints due to curvature or for providing fixture shall be provided judiciously.

**8.5.1 Dressing, Cutting and Rubbing**

Every marble stone shall be gang saw/machine cut to the required size and shape, chisel dressed machine finished on all beds and joints, so as to be free from any waviness and to give truly vertical, horizontal, radial or circular joints as required. The exposed faces and sides of stones forming joints upto 6mm. from the face shall be fine tooled machine cut such that a straight edge laid along the face of the stone is in contact with every point on it. All window sills, tread of steps, counters vanities moulding edges etc. shall be machine cut & polished to give high gloss mirror finish as per direction of Engineerin- Charge. These surfaces shall then be rubbed smooth. All visible angles and edges shall be true, square and free from chipping. Beyond the depth of 6 mm from face, the joints shall be dressed with a slight splay so that the thickness of joint increases, in an inverted V shape. The surfaces of the stones coming in contact with backing need not be chisel dressed.

**8.5.2 Mortar**

The mortar used for jointing shall be as specified.

**8.5.3 Laying**

All marble stones shall be wetted before placing in position. These shall then be floated on mortar and bedded properly in position with wooden mallets without the use of chips or under pinning of any sort.
The walls and pillars shall be carried up truely in plumb or battered. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. In case of work without backing of brick work or coursed rubble masonry, face stone shall be laid in headers and stretchers alternatively unless otherwise directed. The headers shall be arranged to come as nearly as possible in the middle of stretchers above and below. Stone shall be laid in regular courses of not less than 15 cm in height and all courses shall be of the same height unless otherwise specified. For work facing with backing of brick work or coursed rubble masonry, face stone shall be laid in alternate courses of header and stretchers unless otherwise directed. Face stone and bond stone courses shall have break joint on the face of atleast half the height of the standard course and the bond shall be carefully maintained through out. All the connected masonry in a structure shall be carried up nearly at one uniform level throughout but where breaks are unavoidable the joints shall be made in good long steps so as to prevent cracks developing between new and old work. When necessary jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stones and place these in to correct positions, care being taken that the corners of the stone are not damaged. Stone shall be covered with gunny bags, before putting chain or rope is passed over it, and it shall be handled carefully. No piece which has been damaged shall be used in work. The matching of grains shall be carried out as directed by the Engineer-in-Charge.

8.5.4 Bond Stone

Bond or through stones running right through the thickness of walls, shall be provided in walls upto 60 cm thick and in case of wall above 60 cm thickness a set of two or more bond stones overlapping each other by atleast 15 cm shall be provided in a line from face to back.

At least one bond stone or a set of bond stones shall be provided for every 0.5 sqm of the wall surface. All bond stones shall be marked suitably as directed by the Engineer-in-Charge.

8.5.5 Joints

The depth of joints 6 mm from the face shall be uniform and as fine as possible but shall be not more than 1.5 mm thick on the exposed face. Beyond the depth of 6 mm from face, the thickness of joints shall increase in an inverted V shape so as to give good mortar bond between two stones. The inverted portion of the joints shall be filled with bedding mortar and the face 6 mm portion with pointing mortar.

8.5.6 Curing

The work shall be kept constantly moist on all faces for a period of atleast seven days.

8.5.7 Scaffolding

Double scaffolding having two sets of vertical supports shall be provided where necessary. The supports shall be sound and strong, tied together by horizontal pieces over which the scaffolding plank shall be fixed.

8.5.8 Measurements

For plain work: Measurements shall be taken correct to a cm in length and breadth and correct to 0.5 cm in thickness.

8.5.8.1 In the case of radially dressed or circular stone used in the work, the dimensions of the circumscribing rectangle of the dressed stone, shall be measured correct to a centimetre and thickness, correct to 0.5 cm.
8.5.8.2 The marble work in arches and domes shall be measured as for plain work, but extra shall be allowed for such work over the rate for plain work.

8.5.8.3 Sunk or moulded work in marble shall be measured by volume as per plain marble work or work in arches or domes as the case may be on the basis of circumscribed rectangular block of the finished work but extra shall be paid for such work over the rate for plain work for work in arches and domes. For the purpose of extra payment, volume of every stone sunk or moulded shall be considered.

8.5.9 Rate
The rate includes the cost of materials and labour required for all the operations i/c cutting of recesses in wall cutting moulding corners edge rounding finishing & polishing as specified.

8.5.10 Use of Finished Marble Slabs and Tiles
In case such finished tiles are used, these shall be measured and paid for separately.

8.6 WALL LINING/VENEER WORK

8.6.1 Unless and otherwise specified in the nomenclature of the item, the marble slabs used for wall lining/veneer work shall be gang saw cut (polished & machine cut) and conform to dimensions given in Table 8.1 above.

Back shall not be polished/ cut in order to ensure a good grip with the hearting of backing. The cut slabs shall be of the thickness as specified with a tolerance permissible under para 8.2 above. The tolerance in wall lining when straight edge of 3 m length is placed should not be more than 2 mm.

8.6.2 Laying
The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or under pinning of any sort. Care shall be taken to match the grains of veneer work as directed by the Engineer-in-Charge. For purpose of matching the grains, the marble slabs shall be selected judiciously having uniform pattern of veins/streaks. Preferably the slabs shall be those got out of the same block from the quarry. The area to be veneered shall be reproduced on the ground and the marble slabs laid in position and arranged in the manner to give the desired matching of grains. Any adjustment needed for achieving the best results shall be then carried out by replacing or interchanging the particular slabs. Special care shall be taken to achieve the continuity of grains between the two slabs one above the other along the horizontal joints. This shall then be got approved by the Engineer-in-Charge and each marble slabs numbered properly and the same number shall be marked on a separate drawing as well as on the surface to be actually veneered, so as to ensure the fixing of the particular slabs in the correct location.

For the facing of the columns also the same procedure as mentioned above shall be followed.

8.6.2.1 Where so desired, the adjoining stones shall be secured to each other by means of copper pins
75 mm long and 6 mm diameter or as specified.
8.6.2.2 The stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded.

8.6.2.6 The cramps may be of copper alloyed with zinc, tin, nickel, lead or stainless steel.

8.6.2.7 The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 cement : 2 fine sand) and their samples got approved by the Engineer-in-Charge and kept at site.

8.6.3 Joints
All joints shall be full of mortar. Special care shall be taken to see that groundings for veneer work are full of mortar. If any hollow groundings are detected by tapping the face stones, these shall be taken out and relaid. The thickness of the face joints shall be uniform, straight and as fine as possible, not more than 1.5 mm and in the face joint, the top 6 mm depth shall be filled with mortar specified for the pointing.

8.6.4 Mortar
The mortar used for jointing slabs shall be as specified.

8.6.5 Curing, Finishing, Protection and Scaffolding
It shall be as specified before.

8.6.6 Measurements
The length and breadth shall be measured correct to a cm. In case of radially dressed or circular slabs used in the work, the dimensions of the circumscribing rectangles of the dressed stone used in the work, shall be measured & paid for. The area shall be calculated in sqm nearest to two places of decimal.

8.6.7 Rate
The rate includes the cost of materials and labour required for all the operations described above except for the cost of providing and fixing of dowel and cramps which shall be paid for separately, unless otherwise stipulated in the item of work.

IS code followed for stone work:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>IS. No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>IS 1122</td>
<td>Method of test for determination of true specific gravity of natural building stones.</td>
</tr>
<tr>
<td>2.</td>
<td>IS 1124</td>
<td>Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.</td>
</tr>
<tr>
<td>3.</td>
<td>IS 1130</td>
<td>Marble (blocks, slabs and tiles).</td>
</tr>
<tr>
<td>5.</td>
<td>IS 3316</td>
<td>Specifications for structural granite</td>
</tr>
<tr>
<td>6.</td>
<td>IS 14223 (Part 1)</td>
<td>Polished Building Stones (Part-1) Granite</td>
</tr>
</tbody>
</table>
9. WOOD AND P.V.C. WORK

9.0 TERMINOLOGY

Core : The inner layers of a composite wood product.

Block Board : A Board having a core made up of strips of wood, each not exceeding 25 mm in width, laid separately or glued or otherwise joined to form a slab which is glued between two or more outer veneers with the direction of the grain of the core blocks running at right angles to that of the adjacent outer veneers.

Cross Band : A general term indicating a transverse layer of veneer or veneers in composite wood products.

Decorative Veneers : Veneers having attractive appearance due to figure, colour, grain, lusture, etc.

Hard Wood : A conventional term used to denote the wood obtained from broad-leaved trees. It has no relationship to the physical properties of hardness or strength. On account of the confusion this word might cause, its use is discouraged.

Joint : A prepared connection for joining adjacent pieces of wood, veneer, etc.

Particle Board : A board manufactured from particles of wood or other lignocellulose material, for example, flakes, granules, shavings, slivers, splinter agglomerated, formed and pressed together by use of an organic binder together with one or more of the agents, such as heat, pressure, moisture and a catalyst.

Particle : Distinct particle or fraction of wood, or other lignocellulose material produced mechanically for use as the aggregate for making a particle board. This may be in the form of flake, granule, shaving, splinter and sliver.

Plywood : A board formed of three or more layers of veneers cemented or glued together, usually with the grain of adjacent veneers running at right angles to each other.

Seasoning : A process involving the reduction of moisture content in timber under more or less controlled conditions towards or to an amount suitable for the purpose for which it is to be used.

Seasoned Timber : Timber whose moisture content has been reduced to the specified minimum, under more or less controlled processes of drying.

9.1 TIMBER
Timber is classified as under :
(i) Teak wood
(ii) Deodar wood
(iii) Non-coniferous timbers other than teak
(iv) Coniferous timber other than deodar.

The timber shall be free from decay, fungal growth, boxed heart, pitch pockets or streaks on the exposed edges, splits and cracks. The timber shall be graded as first grade and second grade on the basis of the permissible defects in the timber.

**9.1.1 Teak Wood (Tectona Grandis)**

It is of outstanding merit in retention of shape and durability. The heart wood is one of the most naturally durable woods of the world. It usually remains immune to white ant attack and insect attack for very long periods. It is, however, not always immune from fungus attack (rot). Taken as a whole, good quality teak is very durable, it is relatively easy to saw and work. It can be furnished to a fare surface and takes polish well. It is generally used for making furniture and all important timber construction.

**9.1.2 Moisture Content**

Control on moisture content of timber is necessary to ensure its proper utility in various climatic conditions. For specifying the permissible limit of moisture content in the timber the country has been divided into four climatic zones. In each of the zones, maximum permissible limit of moisture content of timber for different uses, when determined in accordance with the procedure shall be as per Table 9.1

<p>| <strong>TABLE 9.1</strong> |
| Maximum Permissible Moisture Content of Timber |</p>
<table>
<thead>
<tr>
<th><strong>Sl.No.</strong></th>
<th><strong>Use</strong></th>
<th>Zone I</th>
<th>Zone II</th>
<th>Zone III</th>
<th>Zone IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Beams, Rafters &amp; Posts</td>
<td>12</td>
<td>14</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>2.</td>
<td>Doors and windows</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a)</td>
<td>50 mm and above thickness</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>(b)</td>
<td>Thinner than 50 mm</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>3.</td>
<td>Flooring strips</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>4.</td>
<td>Furniture &amp; Cabinet making</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
</tr>
</tbody>
</table>

**9.1.2.1 Tolerance on Moisture Content :**

Average Moisture content of all the samples from a lot shall be within + 3 per cent and moisture content of individual samples within + 5 per cent of maximum permissible moisture content specified in Table 9.2. These tolerance are the absolute values over the percentage moisture content for Sl. No. 1 & 2 of Table 9.2. No tolerance on moisture content is permitted for Sl. No. 3 & 4 of Table 9.2.

**9.1.3 Seasoning of Timber**
Technical Specifications for Construction of Township

The process of drying timber under controlled conditions is called seasoning of timber. Timber shall be either air seasoned or kiln seasoned and in both cases moisture content of the seasoned timber shall be as specified in Table 9.2 of Chapter 9 unless otherwise specified, air seasoned timber shall be used. Kiln seasoning of timber, where specified, shall be done as per IS 1141 in a plant approved by Engineer-in-Charge.

9.1.4 Preservation of Timber
Preservative treatment does not improve basic properties of timber but gives varying degree of protection against deterioration due to attacks by fungi, termites, borers and marine organisms. Preservative treatment, where specified, shall be done using Oil type, Organic solvent type or Water-soluble type preservative. Oil type preservatives shall be used if the timber is not required to be polished or painted. Before preservative treatment, the timber shall be sawn and seasoned. All surfaces exposed after treatment, except due to planing, shall be thoroughly brushed with the preservation before jointing. Preservative treatment of timber shall be done as per IS 401 in a plant approved by the Engineer-in-Charge.

9.2 PANELLING MATERIAL

9.2.1 Timber
Timber panels shall be preferably made of timber of larger width. The minimum width and thickness of a panel shall be 150 mm and 15 mm respectively. When made from more than one piece, the pieces shall be joined with a continuous tongue and groove joint, glued together and reinforced with metal dowels. The grains of timber panels shall run along the longer dimensions of the panels. The panels shall be designed such that no single panel exceeds 0.5 square metre in area.

9.2.2 Plywood/Plywood Boards

9.2.2.1 Plywood boards are formed by gluing and pressing three or more layers of veneers with the grains of adjacent veneers running at right angles to each other. The veneers shall be either rotary cut or sliced and shall be sufficiently smooth to permit an even spread of glue. Face veneers may be either decorative on both sides or one side commercial and the other decorative. Plywood shall be of BWP grade or BWR grade as per IS 303.

9.2.2.2 Adhesive: Adhesive used for bonding BWP grade of plywood boards shall be BWP type synthetic resins conforming to IS 848.

9.2.2.3 The thickness of all veneers shall be uniform, within a tolerance of ± 5 per cent. Corresponding veneers on either side of the centre one shall be of the same thickness and species. The requirements of thickness and core veneers shall be as follows:

(a) In 3 ply boards upto 5 mm thick. The combined thickness of the face veneers shall not exceed twice the thickness of centre ply.

(b) In multiply boards, the thickness of any veneer shall not be more than thrice the thickness of any other veneer.
Technical Specifications for Construction of Township

(c) The sum of the thickness of the veneers in one direction shall approximate to the sum of the thickness of the veneers at right angle to them and shall not be greater than 1.5 times this sum except for 3 ply as specified in (a).

9.2.2.4 Thickness: Plywood boards are available in thickness ranging from 3 to 25 mm. Tolerance in thickness shall be ± 10% for boards upto and including 5 mm; ± 7% for boards from 6 to 9 mm and ± 5% for boards above 9 mm thickness. The boards shall be of uniform thickness and the surfaces of the boards shall be sanded to a smooth finish. Number of plys in plywood boards shall be as per Table 9.3.

<table>
<thead>
<tr>
<th>Thickness in mm</th>
<th>No. of ply</th>
<th>Thickness in mm</th>
<th>No. of ply</th>
</tr>
</thead>
<tbody>
<tr>
<td>3, 4, 5, 6</td>
<td>3</td>
<td>12, 15, 16, 19</td>
<td>9</td>
</tr>
<tr>
<td>5, 6, 8, 9</td>
<td>5</td>
<td>19, 22, 25</td>
<td>11</td>
</tr>
<tr>
<td>9, 12, 15, 16</td>
<td>7</td>
<td>(Above 11 Ply as ordered)</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Ply wood of 9mm thk. Of 5 or 7 ply generally used.

9.2.2.5 Moisture content of the plywood boards when tested in accordance with IS 1734 (Part 1) shall not be less than 5 per cent and not more than 15 per cent.

9.2.2.6 Testing: One sample for every 100 sqm or part thereof shall be taken and testing done as per IS 303. However, testing may not be done if the total requirement of plywood boards is less than 30 sqm. All the samples tested shall meet the requirements of physical and mechanical properties of plywood boards.

9.2.3 Particle Boards

9.2.3.1 Particle boards shall be of medium density and manufactured from particles of agro waste, wood or lignocellulose i.e. material blended with adhesive and formed into solid panels under the influence of heat, moisture, pressure etc. The particle boards shall be flat pressed three layered or graded and of Grade-I as per Table 1 of IS 3087. Both surfaces of the boards shall be sanded to obtain a smooth finish and shall conform to IS 3087.

9.2.3.2 Adhesives: Adhesives used for bonding shall be BWP type synthetic resin conforming to IS 848.

9.2.3.3 Thickness and Tolerance: Thickness of particle boards shall be as specified. Tolerance in thickness shall be ± 5% for boards upto and including 25 mm thick and ± 2.5 per cent for boards above 25 mm thickness. Each board shall be of uniform thickness.

9.2.3.4 Testing: One sample for every 100 sqm or part thereof shall be taken and testing done as per IS 3087. However, testing may not be done if the total requirement of particle boards in a
work is less than 30 sqm. All the samples tested shall meet the requirement of physical and mechanical properties of particle boards.

9.2.4 Veneered Particle Boards

9.2.4.1 Veneered Particle Boards with core of FPT-1 or graded board Grade-I particle board (IS 3087) with commercial or general purpose veneer (Type-1) or decorative veneers on both faces or with decorative veneer on one face and commercial /general purpose veneers on the other Type-2. Face veneers are bonded using adhesives under the influence of heat and pressure.

9.2.4.2 Adhesives: The adhesive used for bonding veneers shall be BWP or BWR type conforming to IS 848 for grade I veneered particle board.

9.2.4.3 Thickness & Tolerance: Veneered particle boards are available in various thickness 6, 10, 12, 20, 25, 30, 35, 40, 45 & 50 mm.
Tolerance in thickness shall be ± 5%.

9.2.4.4 Testing: One sample for every 100 sqm or part thereof shall be taken and testing done as per IS 3097. However, testing may not be done if the total requirement of veneered particle boards in a work is less than 30 sqm. All the samples tested shall meet the requirements of physical and mechanical properties of veneered particle boards as under:

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Moisture Content</td>
<td>5-15%</td>
</tr>
<tr>
<td>2</td>
<td>Water Absorption</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) 2 hrs. soaking</td>
<td>Not more than 25%</td>
</tr>
<tr>
<td></td>
<td>(b) 24 hrs. soaking</td>
<td>Not more than 50%</td>
</tr>
<tr>
<td>3</td>
<td>Water Resistance</td>
<td>No sign of disintegration or delamination after 3 hrs. boiling in water.</td>
</tr>
<tr>
<td>4</td>
<td>Swelling in Water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) General absorption for 2 hrs. immersion</td>
<td>Not more than 7%</td>
</tr>
<tr>
<td></td>
<td>(b) Surface absorption for 2 hrs.</td>
<td>Not more than 5%</td>
</tr>
<tr>
<td>5</td>
<td>Adhesion of plies</td>
<td>Knife test</td>
</tr>
</tbody>
</table>

9.2.5 Float Glass, Frosted Glass

Float glass used shall be as specified in sub-head Aluminium work of this specifications. For panel exceeding 0.5 sqm in area, the nominal thickness of the glass to be used shall be as specified.

9.2.6 Wire Cloth (Wire Gauze)

9.2.6.1 Wire Cloth which shall generally conform to IS 1568 shall be regularly woven with equally spaced galvanised mild steel wires in both warp and weft directions. The wire cloth shall be properly selvedged by one or more wires in each edge.

9.2.6.2 Mesh: Average width of aperture and the nominal diameter of the wire shall be as under:
9.2.6.3 Width of aperture and dia of wire cloth shall be as specified. Unless otherwise stated, wire cloth of 1.40 mm average aperture width woven with 0.63 mm nominal dia galvanised mild steel wire shall be used.

9.2.7 Veneered Decorative Plywood

Decorative plywood shall be of two grades namely BWR and MR Decorative Plywood shall be of two types. Type I and type 2 and shall conform to IS 1328.

9.2.7.1 Requirement of Type-I Veneered decorative plywood shall be as under:

(a) Open slits checks or open joints not more than 150 mm in length and 0.5 mm in width shall be permissible provided the same are rectified with a veneer insert bounded with synthetic resin adhesive, as the case may be and further provided that the insert matches with the surrounding veneer in colour as well as figure.

(b) The decorative veneered surface shall be free from torn grain, dead knots decolourisation and sapwood.

(c) The decorative veneered surface shall be selected for figure, texture, colour and grain etc. It shall be free from all manufacturing and wood defects. All veneers shall be matched or mismatched to achieve a decorative effect in colour figure and grain.

9.2.7.2 Adhesive : The adhesive for bonding veneers shall be MR and BWR type synthetic resin adhesive conforming to IS 848 for MR and BWR grade veneered decorative plywood respectively.

9.2.7.3 Dimensions and Tolerances:

9.2.7.3.1 The dimensions of plywood boards shall be as follows:

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>2400 mm x 1200 mm</td>
<td></td>
</tr>
<tr>
<td>2100 mm x 1200 mm</td>
<td></td>
</tr>
<tr>
<td>1800 mm x 1200 mm</td>
<td></td>
</tr>
<tr>
<td>2100 mm x 900 mm</td>
<td></td>
</tr>
<tr>
<td>1800 mm x 900 mm</td>
<td></td>
</tr>
</tbody>
</table>

9.2.7.3.2 Thickness: The thickness of plywood board shall be 3 mm, 4 mm, 6 mm, 9 mm, 12 mm, 19 mm and 25 mm.

Note: Any other dimensions (length, width and thickness) as agreed to between the manufacturer and the purchaser may also be used.
Technical Specifications for Construction of Township

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>+6 mm</td>
</tr>
<tr>
<td></td>
<td>- 0</td>
</tr>
<tr>
<td>Width</td>
<td>+3 mm</td>
</tr>
<tr>
<td></td>
<td>-0 mm</td>
</tr>
</tbody>
</table>

**Thickness:**

(i) Less than 6 mm
(ii) 6 mm and above

Edge straightness

Squareness

2 mm per 1000 mm

Or 0.2 per cent

9.2.7.4 **Finish**: The decorative plywood shall be uniform in thickness within the tolerances limits specified. The ends shall be trimmed straight and square edge straightness and squareness when tested shall be within the tolerance.

9.2.7.5 **Sampling and Criteria for Conformity**: The method for drawing representative samples and criteria for conformity shall be as per IS 7638.

9.2.7.6 **Tests**: Boards shall be subjected to following tests:

(i) **Moisture content**: Decorative veneered plywood of either type when tested in accordance with IS 1734 (Pt. I) shall have a moisture content not less than 5 per cent and not more than 15 per cent.

(ii) **Water Resistance Test**: Three test specimens of size 250 mm x 100 mm shall be prepared for each of the boards selected and submerged in water at 62 ±2°C for a period of 3 hours and dried for 8 hours at a temperature of 65 ± 2°C and then followed by two more cycles of soaking and drying under same conditions described above. Decorative Veneered plywood of either type shall not show delamination or blister formation.

9.2.8 **Prelaminated Particle Boards**

9.2.8.1 Prelaminated particle boards are available in two grades namely Grade I and II as per IS 12823.

Each grade is further classified in four types; namely Type –I, II, III, IV.

9.2.8.2 **Material**

9.2.8.2.1 Particle Board Prelaminated particle board Grade-1 (FPT-I or graded wood particle board FPT-I) bonded with BWP type synthetic resin and prelaminated conforming to IS 12823 Grade-I, type II or I shall be used.

9.2.8.2.2 **Impregnated Base Paper**: Printed or plain coloured absorbent base paper having a weight of 60-140 g/m² impregnated in a suitable synthetic resin and dried to a volatile content of 4-8 per cent shall be used for prelamination on both surfaces of particle board.
9.2.8.2.3 **Impregnant Overlay**: An absorbent tissue paper having a weight of 18-40 g/m² impregnated in a suitable synthetic resin and dried to volatile content of 4-8 per cent.

9.2.8.3 **Dimension and Tolerances**

9.2.8.3.1 Dimensions of prelaminated particle boards shall be as follows:

- **Length**: The length of prelaminated particle boards shall be 4.8, 3.6, 3.0, 2.7, 2.4, 2.1, 1.8, 1.5, 1.2, 1.0 and 0.9 metres.
- **Width**: The width of prelaminated particle boards shall be 1.8, 1.5, 1.2, 1.0, 0.9, 0.6 and 0.45 metres.
- **Thickness**: The thickness of prelaminated particle boards shall be 6, 9, 12, 15, 20, 25, 30, 35, 40 and 45 mm.

9.2.8.3.2 **Tolerances**: Tolerances on the nominal sizes of finished boards shall be as given below:

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>+ 6 mm</td>
</tr>
<tr>
<td></td>
<td>- 0</td>
</tr>
<tr>
<td>Width</td>
<td>+ 3 mm</td>
</tr>
<tr>
<td></td>
<td>- 0</td>
</tr>
<tr>
<td>Thickness</td>
<td>5 per cent</td>
</tr>
<tr>
<td>Edge straightness</td>
<td>2 mm per 1000 mm or 0.2 per cent</td>
</tr>
<tr>
<td>Squareness</td>
<td>2 mm per 1000 mm or 0.2 per cent</td>
</tr>
</tbody>
</table>

**Note**: Edge straightness and squareness shall be tested as per IS 12823.

9.2.8.4 **Sampling and Inspection**: The number of prelaminated particle board to be selected from a lot shall be in accordance with the Table 9.4 given below:

**TABLE 9.4**

<table>
<thead>
<tr>
<th>Lot Size</th>
<th>Number of prelaminated boards to be selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 50</td>
<td>2</td>
</tr>
<tr>
<td>51 to 100</td>
<td>3</td>
</tr>
<tr>
<td>101 to 200</td>
<td>4</td>
</tr>
<tr>
<td>201 to 300</td>
<td>5</td>
</tr>
<tr>
<td>301 to 500</td>
<td>7</td>
</tr>
<tr>
<td>501 and above</td>
<td>10</td>
</tr>
</tbody>
</table>

9.2.8.4.1 The prelaminated particle boards shall be selected at random (ref. IS 4903). In order to ensure randomness of selection, all the prelaminated particle boards in the lot may be arranged in a serial order and every rth prelaminated particle board may be selected till the required number is obtained, 'r' being the integral part of N/n, where N is the lot size and n is the sample size.
9.2.8.4.2 All board selected as given in para 9.2.9.4.1 shall be tested as specified in IS 2380 (part-2) for length, width, thickness, edge straightness and squareness shall comply with the requirements specified under para 9.2.9.3.2.

9.2.8.5 Testing and Number of Tests: For each of particle board selected as per para 9.2.9.4 Test specimens shall be cut out from portion 150 mm away from the edges for tests and tests shall be carried out as per IS 12823.

9.2.8.6 Criteria for Conformity: A lot shall be considered as in conformity to the requirements of the specification if no group of specimens for any of the characteristics fails to meet the conditions as prescribed in para 9.2.9.3 & 9.2.9.5 of this specification.

In case of a failure, double sample shall be taken from the lot for testing. The lot shall be considered as passed, if all these samples conform to the specified requirement.

9.3 DOOR, WINDOW AND VENTILATOR FRAMES

9.3.1 Timber for door, window and ventilators frames shall be as specified. Timber shall be sawn in the direction of the grains. All members of a frame shall be of the same species of timber and shall be straight without any warp or bow. Frames shall have smooth, well-planed (wrought) surfaces except the surfaces touching the walls, lintels, sill etc., which may be left clean sawn. Rebates, rounding or moulding shall be done before the members are jointed into frames. The depth of the rebate for housing the shutters shall be 15 mm, and the width of the rebates shall be equal to the thickness of the shutters. A tolerance of ± 2 mm shall be permitted in the specified finished dimensions of timber sections in frames.

9.3.2 Joints

The Jamb posts shall be through tenoned in to the mortise of the transoms to the full thickness of the transoms and the thickness of the tenon shall be not less than 2.5 cm. The tenons shall closely fit into the mortise without any wedging or filling. The contact surface of tenon and mortise before putting together shall be glued with polyvinyl acetate dispersion based adhesive conforming to IS 4835 or adhesive conforming IS 851 and pinned with 10 mm dia hard wood dowels, or bamboo pins or star shaped metal pins. The joints shall be at right angles when checked from the inside surfaces of the respective members. The joints shall be pressed in position. Each assembled door frame shall be fitted with a temporary stretcher and a temporary diagonal brace on the rebated faces.

9.3.3 Fixing of Frames

The frames shall be got approved by the Engineer-in-Charge before being painted, oiled or otherwise treated and before fixing in position. The surface of the frames abutting masonry or concrete and the portions of the frames embedded in floors shall be given a coating of coal tar. Frames shall be fixed to the abutting masonry or concrete with holdfasts or metallic fasteners as specified. After fixing, the jamb posts of the frames shall be plugged suitably and finished neat. Vertical members of the door frames shall be embedded in the floor for the full thickness of the floor finish and shall be suitably strutted and wedged in order to prevent warping during construction. A minimum of three hold fasts shall be fixed on each side of door and window frames one at centre point and other two at 30 cm from the top and bottom of the frames.
case of window and ventilator frames of less than 1 m in height two hold fasts shall be fixed on each side at quarter point of the frames. Hold fasts and metallic fasteners shall be measured and paid for separately.

9.3.4 Measurements

Wood work wrought, framed and fixed shall be measured for finished dimension without any allowance for the wastage or for dimensions beyond specified dimension. However, in case of members having mouldings, roundings or rebates and members of circular or varying sections, finished dimensions shall be taken as the sides of the smallest square or rectangle from which such a section can be cut. Length of each member shall be measured over all to the nearest cm so as to include projection for tenons. Width and thickness shall be measured to the nearest mm and the quantity shall be worked out in unit of upto three places of decimal.

9.3.5 Rate

The rate shall include the cost of material and labour involved in all the operations described above except the hold fasts or metallic fasteners which will be paid for separately.

9.4 PANELLED GLAZED OR PANELLED AND GLAZED SHUTTERS

9.4.0 Panelled or glazed shutters for doors, windows, ventilators and cupboards shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, fibre board wire gauze or float glass. The shutters may be single or multipanelled, as shown in the drawings or as directed by the Engineer-in-Charge. Timber for frame work, material for panel inserts and thickness of shutters shall be as specified. All members of the shutters shall be straight without any warp or bow and shall have smooth well planed face at right angles to each other.

Any warp or bow shall not exceed 1.5 mm for door shutter and 1 mm for window and ventilator shutters. The right angle for the shutter shall be checked by measuring the diagonals and the difference between the two diagonals should not be more than 3 mm. Generally panelled glazed or panelled and glazed shutter shall conform to IS 1003.

9.4.1 Frame Work

9.4.1.1 Timber for stiles and rails shall be of the same species and shall be sawn in the directions of grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the required dimensions. The stiles and rails shall be joined to each other by plain or haunched mortise and tenon joints and the rails shall be inserted 25 mm short of the width of the stiles. The bottom rails shall have double tenon joints and for other rails single tenon joints shall be provided. The lock rails of door shutter shall have its centre line at a height of 800 mm from the bottom of the shutters unless otherwise specified. The thickness of each tenon shall be approximately one-third the finished thickness of the members and the width of each tenon shall not exceed three times its thickness.

9.4.1.2 Gluing of Joints: The contact surfaces of tenon and mortise shall be treated, before putting
together, with bulk type synthetic resin adhesive conforming to IS 851 suitable for construction in wood or synthetic resin adhesive (Phenolic and aminoplastic) conforming to IS 848 or polyvinyl acetate dispersion based adhesive conforming to IS 4835 and pinned with 10 mm dia hardwood dowels or star shaped metal pins; after the frames are put together and pressed in position by means of press.

9.4.1.3 Stiles and bottom rail shall be made out of one piece of timber only. Intermediate rail exceeding 200 mm in width may be of one or more pieces of timber. The width of each piece shall be not less than 75 mm. Where more than one piece of timber is used for rails, they shall be joined with a continuous tongued and grooved joint glued together and reinforced with metal dowels at regular intervals not exceeding 200 mm.

9.4.1.4 Door Shutters
9.4.1.4.1 Finished dimensions and tolerances of components of door shutters has been given in Table 9.5 below. The finished door shutters should be of 35 mm thick and made up of local Teak wood.

TABLE 9.5
Dimensions and Tolerances of Components of Door Shutters

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Vertical Stile, top and freeze rail</td>
<td>100 ± 3</td>
<td>35 ± 1 or 40 ± 1</td>
</tr>
<tr>
<td>(b)</td>
<td>Lock rail</td>
<td>50 ± 3</td>
<td>35 ± 1 or 40 ± 1</td>
</tr>
<tr>
<td>(c)</td>
<td>Bottom rail</td>
<td>200 ± 3</td>
<td>35 ± 1 or 40 ± 1</td>
</tr>
<tr>
<td>(d)</td>
<td>Muntin</td>
<td>100 ± 3</td>
<td>35 ± 1 or 40 ± 1</td>
</tr>
<tr>
<td>(e)</td>
<td>Glazing bar</td>
<td>40 ± 3</td>
<td>35 ± 1 or 40 ± 1</td>
</tr>
</tbody>
</table>

9.4.1.5 Window and Ventilator Shutters: Window and ventilator shutters shall conform to IS 1003 (Part 2).

9.4.1.5.1 Dimensional Sizes and Tolerances: The finished dimensions and tolerances of different component shall be as given in Table 9.6.
TABLE 9.6
Dimensions and Tolerances of Components of Window and Ventilator Shutters

<table>
<thead>
<tr>
<th>Description of components</th>
<th>Window Shutters</th>
<th>Ventilator Shutters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Width mm</td>
<td>Thickness mm</td>
</tr>
<tr>
<td>Stiles and rails</td>
<td>80 ± 3</td>
<td>25 ± 1</td>
</tr>
<tr>
<td></td>
<td>30 ± 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Munting</td>
<td>60 ± 3</td>
<td>25 ± 1</td>
</tr>
<tr>
<td></td>
<td>30 ± 1</td>
<td></td>
</tr>
<tr>
<td>Glazing bars</td>
<td>40 ± 1</td>
<td>25 ± 1</td>
</tr>
<tr>
<td></td>
<td>30 ± 1</td>
<td></td>
</tr>
</tbody>
</table>

The dimension of window and ventilator should be according to the dimension mentioned in drawing.

9.5 Panelling

The panel inserts shall be either framed into the grooves or housed in the rebate of stiles and rails. Timber, plywood, and particle board panels as given in para 9.2 of this sub head and shall be fixed only with grooves. The depth of the groove shall be 12 mm and its width shall accommodate the panel inserts such that the faces are closely fitted to the sides of the groove. Panel inserts shall be framed into the grooves of stiles and rails to the full depth of the groove leaving space of 1.5 mm. Width and depth of the rebate shall be equal to half the thickness of stiles and rails. Glass panels, asbestos panels wire gauze panels and panel inserts of cupboard shutters shall be housed in the rebates of stiles and rails.

9.5.1 Timber Panels: Timber panels shall be preferably made of timber of large width; the minimum width and thickness of the panel shall be 100 mm, and 15 mm respectively. When made from more than one piece, the pieces shall be jointed with a continuous tongued and grooved joint glued together and reinforced with headless nails at regular intervals not exceeding 100 mm. Depth and thickness of such joint shall be equal to one-third of thickness of panel. The panels shall be designed such that no single panel exceeds 0.5 square metre in area. The grains of timber panels shall run along the longer dimensions of the panels. All panels shall be of the same species of timber unless otherwise specified.

9.5.2 Plywood Panels: Plywood boards used for panelling of shutters shall be BWP type or grade as specified in 9.2.2. Each panel shall be a single piece of thickness, 9 mm for two or more panel construction and 12 mm thickness for single panel construction unless otherwise specified.

9.5.3 Veneered Particle Board Panels: Veneered Particle board used for panelling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive as specified before. Each panel shall be a single piece of thickness 12 mm unless otherwise specified.
9.5.4 **Glass Panels**: Glass panelling (Glazing) shall be done as specified in 9.2.6. Glazing in the shutters of doors, windows and ventilators of bath, WC and Lavatories shall be provided with frosted glass the weight of which shall be not less than 10 kg/sqm. Frosted glass panes shall be fixed with frosted face on the inside. Glass panels shall be fixed by providing a thin layer of putty conforming to IS 419 applied between glass pane and all along the length of the rebate and also between glass panes and wooden beading.

9.5.5 **Putty** can be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 litre of varnish to 18 kg of paste. Fixing of glass panes without beading shall not be permitted. Glazing shall be done after the shutters have been primed and prepared for painting, so that wood may not draw oil out of putty.

9.5.6 **Finish**: Panels of shutters shall be flat and well sanded to a smooth and level surface.

9.5.7 **Beadings**

Beadings in panelled shutter shall be provided where specified in architectural drawings or directed by the Engineer-in-Charge. Each length of beading shall be single piece. Joints at the corners shall be mitred and exposed edges shall be rounded. Beading shall be fixed with headless nails at 75 mm intervals. For external shutters, the beading shall be fixed on the outside face.

9.6. **Fixing of Shutters**

For side hung shutters of height upto 1.2 m, each leaf shall be hung on two hinges at quarter points and for shutter of height more than 1.2 m, each leaf shall be hung on three hinges one at the centre and the other two at 200 mm from the top and bottom of the shutters. Top hung and bottom hung shutters shall be hung on two hinges fixed at quarter points of top rail or bottom rail. Centre hung shutter shall be suspended on a suitable pivot in the centre of the frame. Size and type of hinges and pivots shall be as specified. Flap of hinges shall be neatly counter sunk into the recesses cut to the exact dimensions of flap. Screws for fixing the hinges shall be screwed in with screw driver and not hammered in. Unless otherwise specified, shutters of height more than 1.2 mm shall be hung on butt hinges of size 100 mm and for all other shutters of lesser height butt hinges of size 75 mm shall be used. Continuous (piano) hinges shall be used for fixing cup-board shutters where specified.

9.7 **Fittings**

Fittings shall be provided as per schedule of fittings decided by Engineer-in-Charge. Cost of providing and fixing shutter shall include cost of hinges and necessary screws for fixing the same. All other fittings shall be paid for separately.

9.8 **FLUSH DOOR SHUTTERS**

9.8.0 Flush door shutters shall have a solid core and may be of the decorative or non-decorative (Paintable type as per IS 2202 (Part I). Nominal thickness of shutters should be 35 mm.
9.8.1 Width and height of the shutters shall be as shown in the drawings or as indicated by the Engineer-in-Charge. All four edges of the shutters shall be square. The shutter shall be free from twist or warp in its plane. The moisture content in timbers used in the manufacture of flush door shutters shall be not more than 12 per cent when tested according to IS 1708.

9.8.2 Core
The core of the flush door shutters shall be a block board having wooden strips held in a frame constructed of stiles and rails. Each stile and rail shall be a single piece without any joint. The width of the stiles and rails including lipping, where provided shall not be less than 45 mm and not more than 75 mm. The width of each wooden strip shall not exceed 30 mm. Stiles, rails and wooden strips forming the core of a shutter shall be of equal and uniform thickness. Wooden strips! shall be parallel to the stiles. End joints of the pieces of wooden strips of small lengths shall be staggered. In a shutter, stiles and rails shall be of one species of timber. Wooden strips shall also be of one species only but it may or may not be of the same species as that of the stiles and rails. Any species of timber may be used for core of flush door. However, any non-coniferous (Hard wood) timber shall be used for stiles, rails and lipping.

9.8.3 Face Panel
The face panel shall be formed by gluing, by the hot-press process on both faces of the core, either plywood or cross-bands and face veneers. The thickness of the cross bands as such or in the plywood shall be 3.0 mm. The thickness of the face veneers as such or in the plywood shall be between 0.5 mm and 1.5 mm for commercial veneers and between 0.4 mm and 1.0 mm for decorative veneers, provided that the combined thickness of both is not less than 2.2 mm. The direction of the veneers adjacent to the core shall be at right angles to the direction of the wooden strips. Finished faces shall be sanded to smooth even texture. Commercial face veneers shall conform to marine grade plywood and decorative face veneers shall conform to type I decorative plywood in IS 1328.

9.8.4 Lipping
Lipping, where specified, shall be provided internally on all edges of the shutters. Lipping shall be done with battens of first class hardwood or as specified of depth not less than 25 mm. For double leaved shutters, depth of the lipping at meeting of stiles shall be not less than 35 mm. Joints shall not be permitted in the lipping.

9.8.5 Rebating
In the case of double leaves shutters the meeting of stiles shall be rebated by 8 mm to 10 mm. The rebating shall be either splayed or square type where lipping is provided. The depth of lipping at the meeting of stiles shall not be less than 30 mm.

9.8.6 Opening for Glazing
Opening for glazing shall be provided where specified or shown in the drawing.

9.8.7 Tolerance
Tolerance on width and height shall be + 3 mm and tolerance on nominal thickness shall be ± 1.2 mm. The thickness of the door shutter shall be uniform throughout with a permissible variation of not more than 0.8 mm when measured at any two points.

**9.8.8 Adhesive**

Adhesive used for bonding various components of flush door shutters namely, core, core frame, lipping, cross-bands, face veneers, plywood etc. and for bonding plywood shall conform to BWP type, phenol formaldehyde synthetic resin adhesive conforming to IS 848.

**9.8.9 Tests**

Samples of flush door shutters shall be subjected to the following tests:
(a) End Immersion Test
(b) Knife Test
(c) Glue Adhesion Test

**9.8.10 Rates**

The rate includes the cost of material and labour involved in all the operations described above. Extra rate shall be payable for providing rebates in double leaved shutters. Glazing when provided shall be measured & paid for separately.

**9.9 FITTINGS**

**9.9.0** Fitting shall be of mild steel, brass or aluminium as specified.

**9.9.1 Butt Hinges**

**9.9.1.1 Mild Steel Butt Hinges:**

These shall be medium type manufactured from M.S. sheet. These shall be well made and shall be free from flaws and defects of all kinds. All hinges shall be cut clean and square and all sharp edges and corners shall be removed. These shall generally conform to IS 1341.

**9.9.1.2 M.S. Piano Hinges :**

These shall be made from 1 mm or 0.80 mm thick M.S. sheets and shall be protected with anti-corrosive treatment, such as bright polished, chromium plated or oxidised finish. Hinge pin shall be of galvanised mild steel. It shall fit in the knuckle firmly so as not to allow any play or shake and shall allow easy movement of hinge, but shall not cause looseness. The sides of the knuckles shall be straight and at right angles to the flap. The movement of the hinge shall be free and easy and working shall not have any play and shake.

**9.9.2 Sliding Door Bolts**

**9.9.2.1 Aluminium Sliding Door Bolts :** These shall be made of aluminium alloy and shall generally conform to IS 2681. Aluminium sliding door bolts shall be anodized. All screw holes shall be counter sunk to suit the counter sunk head of screws of specified sizes. All edges and corners shall be finished smooth. In case of single leaf door, when iron socket plate or a brass or aluminium fixing bolts (or sliding door bolt) cannot be fixed, hole of suitable size shall be drilled in the door frame and an iron or brass plate cut to shape shall be fixed at the face of the hole.
9.9.3 Tower Bolts

**9.9.3.1** These shall generally conform to IS 204 (Part. I) & IS 204 (Part. II). Tower bolts shall be well made and shall be free from defects. The bolts shall be finished to the correct shape and shall have a smooth action. All tower bolts made with sheet of 1.2 mm thickness and above shall have counter sunk screw holes to suit counter sunk head of wood screws. All sharp edges and corners shall be removed and finished smooth. The height of knob of tower bolt when the door, window etc. is in closed position from the floor level shall be not more than 1.9 metre.

**9.9.3.2 Aluminium Tower Bolt:** In Aluminium alloy tower bolts, Bolt and barrel are anodized. The anodic film may be either transparent or dyed as specified. The quality of anodized finish shall not be less than grade AC-10 of IS 1868.

9.9.4 Mortice Lock and Latch

**9.9.4.1.** This should generally conform to IS 2209.

**9.9.4.2** The size of the mortice lock shall be denoted by the length of the body towards the face and it shall be 100 mm. The measured length shall not vary more than 3 mm from the length specified. This should be of Brass bright finish having 6 levers and pair of lever handles with necessary screws.

9.9.5 Keys : Each latch shall be provided with two keys which should work smoothly and without any appreciable friction in the lock.

9.9.6 Cupboard or Wardrobe Lock

This should generally conform to IS 729. The size of the cupboard lock shall be 65 mm. This shall be made of cast brass and shall be of the best make of approved quality. These shall be finished bright or chromium plated or oxidised or as specified. The size of the lock shall be denoted by the length of the face across the body in mm. These locks shall be fitted with four levers. False (dummy) levers shall not be used.

9.9.7 Door Handles (Doors and Windows)

**9.9.7.1** These should generally conform to IS 208. The door handles shall be well made and free from defects. These shall be finished correct to shape and dimensions. All edges and corners shall be removed and finished smooth so as to facilitate easy handling. Cast handle shall be free from casting defects. Where the grip portion of the handle is joined with the base piece by mechanical means, the arrangement shall be such that the assembled handle shall have adequate strength comparable to that of integrally cast type handles.

**Aluminium Alloy Handles :** These shall be of aluminium of specified size, and of
shape and pattern as approved by the Engineer-in-Charge. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 125 mm size. These shall be fixed with 25 mm long wood screws of designation No. 6. Aluminium handles, shall be anodized and the anodic coating shall not be less than grade AC 15 – IS 1868 as specified. The finish can be bright natural, matt or satin or dyed as specified.

**Brass Handles:** These shall be of cast brass of specified size and of the shape and pattern as approved by the Engineer-in-Charge. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size. These shall be fixed with 25 mm long wood screws of designation No 6. Brass handles shall be finished bright satin or nickel chromium plated or copper oxidised or as specified.

9.9.8 Floor Door Stopper

9.9.8.1 The floor door stopper shall conform to IS 1823. This shall be made of Aluminium metal. The size of floor stopper shall be determined by the length of its plate. It shall be well made and shall have four counter sunk holes for fixing the door stoppers to the floor by means of wood screws. The body for 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 mild steel screws and cover plate shall be of casting or of sheet metal. The spring shall be fixed firmly to the pin. 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 shock. All parts of the door stopper shall be of good workmanship and finish, burrs and sharp edges removed. It shall be free from surface and casting defects. Aluminium stopper shall be anodised and anodic film shall not be less than grade AC-10 of IS 1868.

9.9.8.2 Hanging Rubber Door Stopper: Aluminium stopper shall be anodised and the anodic coating shall not be less than grade AC-10 of IS 1868. The size and pattern of the door stopper shall be approved by the Engineer-in-Charge. The size shall be determined by its length.

9.10 UPVC- DOOR FRAMES

9.10.1 UPVC Door Frame

UPVC door frame shall be made of PVC material conforming to IS 10151. The door frame shall be made from extruded UPVC section having overall dimensions of 48 x 40 mm having wall thickness of 2.0 mm + 0.2 mm. Corners of the door frame to be jointed by M.S. galvanized brackets. Joints mitred and plastic welded. The hinge side vertical outer frames shall be reinforced by galvanized M.S. Tube of size 19 x 19 mm of wall thickness 1 mm + 0.1 mm and a tie rod shall be provided at the bottom of the frame. The frame shall be fabricated in factory as per nomenclature of the item and directions of Engineer-in-Charge.

9.10.2 Fixing of Frames

The frames are to be fixed in prepared openings in the walls. All civil work and tiling should be completed before the fixing of the frames. The frames are to be fixed directly on the plastered wall. In case tiling is to be done in the place the frames are to be fitted, a 50 mm strip should be left untiled at the location where the frames are to be fitted. The frames are erected in the prepared opening such that the vertical members of the door frame are embedded 50 mm in the floor. The frame shall be fitted truly in plumb. A minimum of three anchor bolts or screws of size 65/100 shall be used to fix each vertical member. One bolt shall be fixed at 200 mm from the top member and one bolt shall be fixed at 200 mm from the floor. The third anchor bolt shall be fixed
in the center. The top horizontal member shall be fixed using two 65/100 size anchor bolts or screws at a distance of 200 mm from both the corners.

9.10.3 Measurements

The outer length of the vertical and horizontal members of UPVC door frame shall be measured in running metres including embedded length in floor corrected upto a cm.

9.10.4 Rate

The rate includes the cost of the materials and labour involved in all the operations described above. The cost of anchor bolts or screws for joining the frame is included in the rate. Any other hardware, which may be required, shall be paid for separately.

9.11 PVC DOOR SHUTTERS

The shutters shall be fabricated at factory as per nomenclature of the item and directions of Engineer-in-Charge. Shutter shall be made of PVC material conforming to IS 10151.

9.11.1 30 mm Thick PVC Door Shutters

9.11.1.1 General Precautions

The test specimens shall not have been exposed to a temperature below 40°C for 24 hours immediately preceding the test and shall be free from all visible moisture. The specimen shall be inspected and any specimen with visible flaws shall be discarded.

9.11.2. Sampling

9.11.2.1 Sampling criteria for conformity shall be in accordance with IS 4020 (Part –I).

9.11.3 Fixing of Shutters

PVC door shutter shall be side hung on three bolt hinges of size 100 mm, one at the centre and the other two at 200 mm from the top and bottom of the shutter. The flat of the hinges shall be neatly counter sunk in to the recesses cut out to the exact dimensions of the hinge flap. The door shall be drilled on the thickness to fit hinges. Screws for fixing the hinges shall be screwed in with screwdrivers and not hammered. The length of the screws should be 8 mm/30 mm. The hinges used should be of stainless steel.

9.11.4 Tolerance

The tolerance on the width and the height of the door shall be + 5 mm and the tolerance on the nominal thickness of the door shall be + 2 mm.

9.11.5 Measurements

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Area is calculated to the nearest 0.01 sqm.

9.11.6 Rate

The specified rate include the cost of the door shutter and labour involved in fixing of the shutter. Fittings & fixtures on the door shutter except hinges & screws shall be paid extra as provided.
9.12 UPVC DOOR/WINDOW SHUTTER

9.12.1 UPVC Doors and windows (Of approved colour and type) as per the approved drawings, fully fabricated in factory, with extruded UPVC sections frames, transoms, shutter frames, rough ground, beadings, etc as mentioned below for all panel complete with 6mm thick toughened glass including all hardware of approved make (Dorma, Geze, Ozone or Equivalent as approved), all as per elevation / detailed drawings. All the frames shall be anchored to the structure (masonry work brick / RCC) with (10x100) anchor fasteners. All UPVC door window glazing shall be fitted with fix hinges, Multipoint locking system, handle, tower bolt etc. Allow for EPDM weather strips, gaskets, all fixing accessories and for sealing gaps between frame and support with white silicon of Neutral Cure Silicon sealant on the Outside & Acrylic sealant in the Inside, sealant all around and all incidental work. Approved make for UPVC Door/Window (FENESTA )or equivalent as approved by the Engineer-In-Charge.

9.12.2 Measurements

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Area is calculated to the nearest 0.01 sqm.

9.12.3 Rate

The specified rate include the cost of the door shutter and labour involved in fixing of the shutter. Fittings & fixtures on the door shutter except hinges & screws shall be paid extra as provided.

9.13 FIRE DOOR

9.13.1 Factory made shutter of approved manufacturer 50 mm thick fire resistant door shutters of 60 or 120 minutes fire rating conforming to IS:3614 (Part-II), tested and certified as per laboratory approved by Engineer-in-charge, with suitable mounting on door frame, consisting of internal structure of shutter will be vertical styles, lock rail, top rail 100 wide x 47.5 mm thick, bottom rail 200 wide x 47.5 mm thick, made out of 16 SWG Galvanised sheet IS:277(zinc coating not less than 120 gm/m2) duly filled FR insulation material and fully flushed double skin panel shall with lock seam joints at style edges of the 1.2 mm Galvanised sheet meeting rebate will be made in cover sheet of shutter which will cover meeting point. Fixing with necessary stainless steel ball bearing hinges of CE marked size of 101 x 75 x 3 mm approved make, including provision of vision panel with both side "U" taper beading made with Galvanised sheet to hold the 6 mm thick fire rated glass. Pre-punching in shutter to fix panic bar, lock & external trim. Applying a coat of approved fire resistant primer etc. all complete as per direction of Engineer-in-Charge. Approved make for Fire Door NAVAIR,GMP,SUKHRI or equivalent as approved by the Engineer-In-Charge.

9.13.2 Measurements

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Area is calculated to the nearest 0.01 sqm.
9.13.3 Rate

The specified rate include the cost of the door shutter and labour involved in fixing of the shutter. Fittings & fixtures on the door shutter.

10.0 STEEL WORK

10.1 STEEL WORK IN BUILT UP SECTION (WELDED)

10.1.0 The steel work in built up sections (welded) such as in trusses, form work, frames etc.

10.1.1 Welding: Welding shall generally be done by electric arc process as per IS 816 and IS 823.

The electric arc method is usually adopted and is economical. Where electricity for public is not available generators shall be arranged by the contractor at his own cost unless otherwise specified. Gas welding shall only by resorted to using oxyacetylene flame with specific approval of the Engineer-in-charge. Gas welding shall not be permitted for structural steel work. Gas welding required heating of the members to be welded along with the welding rod and is likely to create temperature stresses in the welded members. Precautions shall therefore be taken to avoid distortion of the members due to these temperature stresses.

The work shall be done as shown in the shop drawings which should clearly indicate various details of the joint to be welded, type of welds, shop and site welds as well as the types of electrodes to be used. Symbol for welding on plans and shops drawings shall be according to IS 813.

As far as possible every efforts shall be made to limit the welding that must be done after the structure is erected so as to avoid the improper welding that is likely to be done due to heights and difficult positions on scaffolding etc. apart from the aspect of economy. The maximum dia of electrodes for welding work shall be as per IS 814. Joint surfaces which are to be welded together shall be free from loose mill scale, rust, paint, grease or other foreign matter, which adversely affect the quality of weld and workmanship.

10.1.2 Precautions: All operation connected with welding and cutting equipment shall conform to the safety requirements given in IS 818 for safety requirements and Health provision in Electric and gas welding and cutting operations.

10.1.3 Inspection and testing of welds shall be as per IS 822.

10.1.4 Assembly: Before welding is commenced, the members to be welded shall first be brought
together and firmly clamped or tack welded to be held in position. This temporary connection has to be strong enough to hold the parts accurately in place without any disturbance. Tack welds located in places where final welds will be made later shall conform to the final weld in quality and shall be cleaned off slag before final weld is made.

10.1.5 Erection: Erecting a welded structure means it shall be employed for temporary fastening the members together and bracing the frame work until the joints are welded. Such means shall consists of applying of erection bolts, tack welding or other positive devices imparting sufficient strength and stiffness to resist all temporary loads and lateral forces including wind. Owing to the small number of bolts ordinarily employed for joints which are to be welded, the temporary support of heavy girders carrying columns shall be specially attended. Different members which shall be fillet welded, shall be brought into as close contact as possible. The gap due to faulty workmanship or incorrect fit if any shall not exceed 1.5 mm if gap exceeds 1.5 mm or more occurs locally the size of fillet weld shall be increased at such position by an amount equal to the width of the gap.

10.1.5 Painting: Before the member of the steel structures are placed in position or taken out of the workshop these shall be painted.

10.1.6 Measurements
The mode of measurements shall be in in running metres correct to a millimetre and weights calculated on the basis of standard tables correct to the nearest kilogram except that weight of welding material shall not be added in the weight of members for payment and nothing extra shall be paid for making and filling holes for temporary fastening of members during erection before welding. The standard weight of steel sections shall conform to IS 808 with tolerance in sizes as per IS 1852.

10.1.7 Rate
The rate shall include the cost of all labour and materials involved in all the operations described above.

10.2 STEEL WORK WELDED IN BUILT-UP SECTIONS USING STRUCTURAL STEEL
(A) In Stringers, Treads, Landing etc. of Stair cases including use of Chequred Plate wherever required
(B) In Grating, Frames, Guard Bar, Ladder, Railings, Brackete, Gates and similar work.

10.2.1 Steel members used for fabricating these items to be designed structurally to withstanding the all loads to be carried out by the members during erection, fixing and functional use in designed life. Work to be executed as per structural drawings.

10.3 STEEL WORK WELDED IN BUILT-UP SECTIONS FOR HAND RAIL USING M.S. TUBULAR PIPES
10.3.1 General specifications to be same as for steel work welded in built-up section as mentioned in Previous section.

10.3.2 Measurement of Hand Rail of M.S. Tubular
The work as fixed in place shall be measured in running metres correct to a centimetre and their
weights calculated on the basis of standard tables correct to the nearest kilogram or actual weight whichever is less unless otherwise specified.

**10.4.0 SS Railing:**
All stainless steel tube to be of grade 304 welded stainless steel, ornamental tubing - (1.9 inches O.D. for guardrail and 1.5 inches O.D. for handrail) finished and polished. All fittings to be of 304 grade stainless steel.
Handrail assemblies and guards shall be designed to resist desired load applied in any direction at the top and to transfer this load through the supports to the structure.

Upon delivery railing may have protective wrapping. At completion of railing installation, immediately remove any protective wrapping and clean all work for inspection and approval. After installation, General Contractor or Owner shall be responsible for protection of railings during the balance of construction.

**10.4.1 Measurement:**
The work as fixed in place shall be measured in running metres correct to a centimetre and their weights calculated on the basis of standard tables correct to the nearest kilogram or actual weight whichever is less unless otherwise specified. During Weight calculation only weight of SS members has to be considered excluding the fitting accessory such as nuts, bolts, fasteners etc.

**11.00 FLOORING & CLADDING WORK**

**11.1 Inter Locking Floor Tiles:**
Fibre Reinforced Heavy Duty Designer Tiles should confirm to IS 1237 of 1980. The thickness of tiles should be 22-25 mm. The design of tiles should be approved by Engineer- In-Charge before lying.

**11.1.1 Laying:** Base concrete or RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tiles shall be with cement mortar of specified proportion.

Cement mortar 1:4 (1 Cement : 4 coarse sand) bedding shall be used. Average thickness of the bedding mortar shall be 20 mm and the thickness at any place shall not be less than 10 mm. Cement mortar bedding shall be spread, tamped and corrected to proper levels and proper slope has to be maintained according to drawing. Cement slurry i.e. mixture of cement and water to form a thick paste has to be spread on the levelled base mortar. The tiles have to be placed on top of it and tapped gently only with a rubber or wooden mallet to obtain perfect levels.

The surface of Tile has to be cleaned with clean water immediately after laying with wet sponge. The base mortar cement which squeezes through the joints should not settle on the tile. The water used, should not be hard to brackish. The area of laid should be remain unused for at least 24 hours.

**11.1.2 Pointing:** The joints has to be filled with pointing material which is a mixture of white cement and desired color pigment preferably with the use of rubber squeeze or rubber sheet.
Allow pointing material to set for 15 minutes and then clean the surface of the tile with a clean wet sponge, removing the excess pigment on the tile surface.

**11.1.3 Measurement:** Inter locking tile flooring shall be measured as laid in square metre correct to two places of decimal.

**11.2 KOTA STONE FLOORING**

**11.2.1 Kota Stone Slabs**

The slabs 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. They shall be of the colour indicated in the drawings or as instructed by the Engineer-in-Charge. The slabs shall have the top (exposed) face polished before being brought to site, unless otherwise specified. Before starting the work the contractor shall get the samples of slabs approved by the Engineer-in-Charge.

**11.2.2 Dressing**

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.

The thickness of the slab after it is dressed shall be 25mm as specified in the description of the item. Tolerance of ±2 mm shall be allowed for the thickness. In respect of length and breadth of slabs Tolerance of ± 5 mm for hand cut slabs and ± 2 mm for machine cut slabs shall be allowed.

**11.2.3 Preparation of Surface and Laying**

Base 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 1:4 (1 cement : 4 coarse sand). **11.2.3.1** The average thickness of the bedding mortar under the slab shall be 20 mm. Mortar of the specified mix shall be spread under the area of each slab, to the average thickness specified in the item. The slab shall be washed clean before laying. It shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. The slab to be paved shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine a joint as possible.

Subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface of the slabs shall be cleaned off. The flooring shall be cured for a minimum period of seven days. The surface of the flooring as laid shall be true to levels, and, slopes as instructed by the Engineer in-Charge. The edges of the slabs to be jointed shall be buttered with grey cement, with admixture of pigment to match the shade of the slab. The thickness of the joints should be minimum as possible. In any location, it shall not exceed 1 mm.
11.2.4 Measurements and Rates

Kota stone flooring shall be measured separately and in square metre correct to two places of decimal. Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster. No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for laying the floor at different levels in the same room. Steps and treads of stairs paved with marble stone slabs shall also be measured under the item of Marble Stone flooring. Extra shall, however, be paid for such areas where the width of treads does not exceed 30 cm. Nosing for treads shall be measured in running metre and paid for extra. The width of treads shall be measured from the outer edge of the nosing, as laid, before providing the riser.

The rate shall include the cost of all materials and labour involved in all the operations described above.

11.3 KOTA STONE IN RISERS OF STEPS, SKIRTING AND DADO
11.3.1 Kota Stone Slabs and Dressing shall be as specified above. The slabs may be of uniform size if required.

11.3.2 Preparation of surface shall be as specified in above article except that instead of 1:4 (1 Cement: 4 Sand).

11.3.3 Laying shall be as specified above.

11.3.4 Measurements
Length shall be measured along the finished face of riser, skirting or dado correct to a cm. Height shall be measured from the finished level of tread of floor to the top (the underside of tread in the case of steps). This shall be measured correct to a mm in the case of risers of steps and skirting and correct to a cm in the case of dado. The area shall be calculated in square metre correct to two places of decimal.

Lining of pillars etc. shall also be measured under this item.

11.3.5 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above.

11.4 CERAMIC TILE:
The tiles shall be of approved make and shall generally conform to IS 15622. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be tested as per IS 13630. The size and thickness of tile should be according to drawing. The tiles shall conform to table10 of IS 15622 with water absorption 3 to 6%.

The top surface of the tiles shall be glazed. Glaze shall be either glossy or matt as specified. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable, shall be permissible on only upto 50 per cent of the surface area of the edges.
11.4.1 Ceramic Tile in Skirting, Dado, Risers and steps:
11.4.1.1 Preparation of Surfaces
The joints shall be raked out to a depth of at least 15 mm in masonry walls. In case of concrete walls, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

11.4.2 Laying

12 mm thick plaster of cement mortar 1:3 (1 cement : 3 coarse sand) mix of as specified shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal at closed intervals.

The tiles should be soaked in water, washed clean, and a coat of cement slurry applied liberally at the back of tiles and set in the bedding mortar. The tiles shall be tamped and corrected to proper plane and lines. The tiles shall be set in the required pattern and jointed. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Odd size/cut size of tile shall be adjusted at bottom to take care of slope of the flooring. Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size and their edges rubbed smooth. Skirting /dado shall not project from the finished “surface of wall” by more than the tile thickness, undulations if any shall be adjusted in wall.

11.4.3 Curing and Finishing
The joints shall be cleaned off the grey cement grout with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigments if required to match the colour of tiles. The work shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished work shall not sound hollow when tapped with a wooden mallet.

11.4.4 Measurements
Length shall be measured correct to a cm. Height shall be measured correct to a cm in the case of dado and 5 mm in the case of riser and skirting. The area shall be calculated in square metre, correct to two places of decimal. Length and height shall be measured along the finished face of the skirting or dado including curves where specials such as coves, internal and external angles and beads are used. Where cornices are used the area of dado shall be measured excluding the cornices. Nothing extra will be paid for cutting (sawn) the tiles to sizes.

11.4.5 Rates
The rate shall include the cost of all material and labour involved in all the operations described above.

11.5 ANTI SKID TILES:
The tiles shall be of approved make and shall generally conform to IS 15622. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The size must be 600X600 for flooring and for skirting the tile must be 100mm high. The sample should be approved by Engineer-In-Charge before bringing to site.

11.5.1 Preparation of Surface:
The surface on which the tiles are to be fixed shall be rough, clean, free of dust and thoroughly wetted. The tiles shall be soaked in water for a minimum period of six hour before fixing. A layer
of 1:4 cement mortar bed of thickness 20 mm thick. shall be evenly spread according to the slope required. The tiles shall then be laid in a neat thin cement paste, gently tapped with a wooden mallet and pressed in position.

11.5.2 Laying:
The pattern of fixing the tiles shall be as per the drawings. The floor tiles shall always go under the dado tiles. All joints shall be uniform and as thin as possible. Where full tiles are not possible, the same shall be cut or sawed to the required size and their edges rubbed smooth to ensure straight and true joints. After the tiles are laid, the extra cement grout shall be removed. The joints shall then be cleaned with a wire brush and the joints shall then be pointed with cement of a matching color, and cured. The entire surface shall be cleaned and polished alter the work has been completed. The contractor shall protect all work until it is handed over to the Owner.

11.5.3 Measurements
Length shall be measured correct to a cm. Height shall be measured correct to a cm in the case of dado and 5 mm in the case of riser and skirting. The area shall be calculated in square metre, correct to two places of decimal. Length and height shall be measured along the finished face of the skirting or dado including curves where specials such as coves, internal and external angles and beads are used. Where cornices are used the area of dado shall be measured excluding the cornices. Nothing extra will be paid for cutting (sawn) the tiles to sizes.

11.5.4 Rates
The rate shall include the cost of all material and labour involved in all the operations described above.

11.6 VITRIFIED TILE FLOORING
The tiles shall be of approved make and shall generally conform to Table 12 of IS 15622 (Tiles with water absorption E ≤ 0.08 per cent Group B1a). They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be tested as per IS 13630. The size of tile should be of 600X600 mm.

11.6.1 Preparation of Surface and Laying
11.6.1.1 Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:4 (1 cement : 4 coarse sand) or as specified. The average thickness of the bedding shall be 20 mm.

11.6.1.2 Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

11.6.1.3 Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square metre over an area upto one square metre. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.
11.6.1.4 The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. In bath, toilet W.C. kitchen and balcony/veranda flooring, suitable tile drop or as shown in drawing will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap.

11.6.1.5 Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints. Tiles which are fixed in the floor adjoining the wall shall enter not less than 10 mm under the plaster, skirting or dado.

11.6.1.6 After tiles have been laid surplus cement slurry shall be cleaned off.

11.6.2 Pointing and Finishing
The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

11.6.3 Measurements
Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster and the area calculated in square metre correct to two places of decimal. Where coves are used at the junctions, the length and breadth shall be measured between the lower edges of the coves. No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

11.6.3 Rate
The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. Nothing extra shall be paid for the use of cut (sawn) tiles in the work.

11.7 GLASS MOSAIC TILES
Providing & fixing Ist quality glass mosaic tiles of minimum thickness 3.8 mm of approved make of approved make in all colours of group D & shades of any size as approved by Engineer-in-charge in flooring, skirting, risers of steps, slopping window cill, dados, & bends over 12 mm thick bed of cement mortar 1:3 (1cement : 3 coarse sand) and jointing with gray cement slurry & 3.3 kg per sqm including pointing in white cement mixed with pigment of matching shade complete, as per pattern shown in drawing including washing with diluted solution of hydrochloride acid and water (1 acid : 10 water). The surface shall be than thoroughly washed down with fresh water.

Glass Mosaic tiles shall be of approved Indian manufacture unless foreign make is specified in the description of item. They shall be flat, and true to shape. They shall be free from cracks, crazing spots, chipped edges and corners. The glazing shall be of uniform shade.

The tiles shall be of nominal sizes such as 20 x 20 mm or other standard sizes with equal sides as specified in the schedule. The maximum variation from the stated sizes, other than the thickness
of tiles shall be as per manufacturer specification. Tiles shall conform to IS 13753-1993 in all other respects.

11.7.1 PREPARATION OF SURFACE AND LAYING

Sub grade concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:3 (1 cement :3 coarse sand) or as specified. The thickness of the bedding shall be 12mm. Unless otherwise specified. Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to set and enable the mason to place wooden plank across and squat on it.

Over this mortar bedding, neat grey cement slurry of honey consistency shall be spread at the rate of 3.3 kgs of cement per sqm over such an area as could accommodate about 50 tiles. Tiles shall be washed clean and shall be fixed in the grout one after another. Each tile being gently tapped with a wooden mallet till, it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible unless spaces are specified and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. After tiles have laid, surplus cement grout shall be cleaned off.

11.7.2 POINTING AND FINISHING

The joints shall be cleaned off the grey cement grout with wire brush or trowal to a depth of 5 mm and all dust and loose mortar removed. Joints shall be kept wet for 7 days. After curing, the surface, shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

11.7.3 Measurement

Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster and the area calculated in square metre correct to two places of decimal. Where coves are used at the junctions, the length and breadth shall be measured between the lower edges of the coves. No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

11.7.4 Rate

The rate for tiling shall include the cost of all materials and labour involved in all the operations described above.

11.8 WOOD BLOCK FLOORING

11.8.1 Wood Blocks

The wood blocks shall be of 1st class teak wood and shall be in accordance with the general specifications for ‘Wood Work’. The size of blocks shall be as shown in the drawings. The longitudinal edges of the blocks shall be dovetailed grooved near the bottom. The blocks shall be truly rectangular in shape with clean sharp edges and true faces. The top and sides shall be planed true. The thickness of the blocks shall be 38 mm. The timber used for making the blocks shall be thoroughly seasoned in accordance with IS 1141. After seasoning, the timber shall be treated with preservatives in accordance with IS 401.
11.8.2 Base Concrete
The base concrete should be of 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 10 mm nominal size) and 25 mm thick. The concrete layer should be properly uniform and levelled.

11.8.3 Levelling Concrete
The levelling layer of concrete shall be of cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 10 mm nominal size) by volume unless otherwise described in the item. Its thickness shall be 25 mm. Cement concrete shall be placed in position and levelled up with the help of a straight edge and trowel. It shall then be beaten with wooden 'Thappy' or a mason's trowel till the cream comes up. The surface shall be finished with a wooden float to give a sand paper finish, plane and true to level. The finished level of the concrete shall be lower than the proposed finished level of the flooring by the specified thickness of the wooden blocks plus a minimum of 1.5 mm. The levelling layer shall be cured for a weak and then allowed to dry thoroughly, before paving with wood blocks.

11.8.4 Laying
The wood blocks shall be first laid 'dry' to the margin and pattern as directed by the Engineer-in-Charge. The blocks shall fit closely and sides and end shall be corrected by further planing if necessary to get closed and even joints. After the blocks have been fitted and matched they shall be removed and stacked in such a way as to facilitate their repaving in the same order.

The surface of the levelling course shall be thoroughly cleaned and a small area of the surface shall be coated with a thin layer of a hot bitumen such as blown type petroleum bitumen grade 85/25 of IS 702 or other equivalents, applied at a temperature of not less than 180° C and at the rate of 2.45 kg per square metre. The wood blocks shall then be taken in turn serially and be dipped in the same hot bitumen for about half their depth so as to coat thoroughly the bottom and part of the sides and quickly set and pressed into place to required patterns, on the previously coated concrete surface so that the dovetailed grooves at the edges of the blocks get filled up with bitumen. The joints of the work shall be very thin and fine.

When all the blocks shall have been set in position, the surface shall be cleaned of any bitumen droppings and planed or machined level and smooth. The floor shall then be given a final smooth finish by rubbing down with sand paper.

**Note:** No wood of any kind shall be placed within 60 cm of any fire place or flue.

11.8.5 Finishing
The floor shall be Bees waxed or polished with readymade wax polish or given any other finish as required.

11.8.6 Measurements
Length and breadth of superficial areas of the finished work shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. No deduction shall be made not extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. In case of skirting the length should be measured corrected to 5mm.
11.8.7 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above but shall not include the cost of base concrete bees waxing or other finishing unless otherwise specifically described in the item.

11.9 Unistone Wall Cladding

‘Unistone’ or equivalent Glass Reinforced Concrete (G.R.C) Wall Cladding Tiles should be of approved design, size, texture, thickness, pattern and colour. The sample should be approved by Engineer-In-Charge before bringing to site. The thickness of the tiles should be 15mm allowing variance of ±2 mm in accordance with IS: 1237-1980. The composition of tiles should be ‘43’ Grade White Portland cement, reinforced with Alkali Resistant Glass Fiber and the pigmentation should be done with exterior grade synthetic inorganic iron oxide pigments manufactured by ‘BAYFERROX (Germany)’ or equivalent. The pigmentation should be homogeneous and in accordance with British Standards BS EN 12878:1999. The other additives should be fine washed graded quartz, super plasticizers and integrated water proofing agents and others. The tiles should be produced with high vibration technology and should have compressive strength equivalent to M40 Grade@28 days. The top surface of the tiles should be sealed with acrylic lacquer resulting in surface water absorption of tiles, less than 1% and water absorption by 24 hrs immersion method, less than 8%.

11.9.1 Base Concrete:

Concrete should be 1:3 (1 cement: 3 coarse sand) and thickness of mortar should be atleast 12mm or as specified by supplier.

11.9.2 Fixing:

The tiles should be applied on a rough plaster of cement mortar 1:3 (1 cement: 3 coarse sand) and the fixing of tiles should be done by ‘Unistone’ tile adhesive or equivalent as per manufacturer’s laying instruction.

11.9.3 Measurement & Rate:

Unistone wall cladding shall be measured separately and in square metre correct to two places of decimal. The length and height should be measured correctly to a cm. The rate for cladding shall include the cost of all materials and labour involved in all the operations described above.
12.00 ROOFING

12.0 KHURRAS
The khurras shall be constructed before the brick masonry work in parapet wall is taken up and it shall be of size 45 cm x 45 cm and shall be made of cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size).

12.1.1 Laying
12.1.1.1 A PVC sheet of size 1 m x 1 m x 400 micron (alternatively, aluminium foil of 32 SWG) shall be laid under the khurra and then cement concrete shall be laid over it to average thickness of 50 mm with its top surface lower than the level of adjoining roof surface by not less than 50 mm.

12.1.1.2 The concrete shall be laid to a size greater than the stipulated size of the khurra in such a way that the adjoining terracing shall overlap the concrete on its three edges by not less than 7.5 cm. The concrete will slope uniformly from the edges to the outlet, the slope being as much as possible and in no case less than 20 mm cement concrete at the outlet. The concrete shall be continued at the same slope through the width of the wall into the outlet opening to ensure a water tight joint.

12.1.1.3 The khurras and the sides of the outlet shall then be rendered with 12 mm coat of cement plaster 1:3 mix (1 cement : 3 coarse sand) or other mix as stipulated in the description of the item. This shall be done when the concrete is still green and shall be finished. The sides of the khurras and sides of the outlet opening shall be well rounded. The size of the finished outlet opening shall be 10 cm wide and by 20 cm high or as directed by the Engineer-in-Charge.

12.1.1.4 In cases where rain water is to be disposed off through rain water pipes, iron grating shall be provided at the outlet as a safeguard against choking, if so directed by the Engineer-in-Charge. Iron gratings, shall be of overall size 20 × 25 cm. with an outer frame of 15 × 3 mm M.S. flat to which 4 Nos M.S. bars of 10 mm dia shall be welded in a vertical direction keeping equal clear spacing of 2.5 cm or as directed by the Engineer in Charge.

12.1.2 Measurements
Khurras shall be counted in numbers.

12.1.3 Rate
The rate is for each completed khurra of the specified size and is inclusive of the cost of all materials and labour in forming the khurras and outlet opening as described above, except for iron gratings which shall be paid for separately.
12.2 FALSE CEILING

12.2.1 Ceiling Tiles

Ceiling tile should be of 12.5 mm thick tapered edge gypsum board conforming to IS: 2095- Part I.

12.2.2 Frame & Fixing

The frame shall be of special sections power pressed from M.S. sheet and galvanised in accordance with zinc coating of grade 350 as per IS : 277 and consisting of angle cleats of size 25mm wide x 1.6mm thick with flanges of 22mm and 37mm at 1200mm centre to centre one flange fixed to the ceiling with dash fastener 12.5mm diax40mm long with 6mm dia bolts to the angle hangers of 25x25x0.55mm of required length, and other end of angle hanger being fixed with nut and bolts to G.I. channels 45x15x0.9mm running at the rate of 1200mm centre to centre to which the ceiling section 0.5mm thick button wedge of 80mm with tapered flanges of 26mm each having clips of 10.5mm at 450mm centre to centre shall be fixed in a direction perpendicular to G.I. channel with connecting clips made out of 2.64mm diax230mm long G.I. wire at every junction including fixing the gypsum board with ceiling section and perimeter channels 0.5mm thick 27mm high having flanges of 20mm and 30mm long, the perimeter of ceiling fixed to wall/partition with the help of rawl plugs at 450mm centre to centre with 25mm long drive-all screws @ 230mm interval including jointing and fixing to a flush finish of tapered and square edges of the board with recommended filler, jointing tapes, finisher and two coats of primer suitable for board as per manufactures specification and also including the cost of making openings for light fittings, grills, diffusers, cut-outs made with frame of perimeter channels suitably fixed all complete as per drawing and specification and direction of the Engineer in Charge.

12.2.3 Measurement

Length & breadth of the finished ceiling shall be measured correct to a centimetre. The area shall be calculated in square metre correct to two decimal places. No deduction shall be made for making openings for electrical, air conditioning, fire fighting fixtures nor shall extra payment be made either for extra materials or labour involved in making such openings.

12.2.4 Rate

The rate shall include the cost of all the materials and labour involved in all the operation described above including scaffolding etc.

12.3 UNPLASTICISED POLYVINYL CHLORIDE PIPES AND FITTINGS

12.3.1 UPVC Pipes

Pipes shall conform to Type A pipes of IS 13592. The internal and external surfaces of the pipes shall be smooth and clean and free from groovings and other defects. The end shall be clearly cut and shall be square with the axis of the pipe. The end may be chamfered on the plain sides. Slight shallow longitudinal grooves or irregularities in the wall thickness shall be permissible provided the wall thickness remains within the permissible limit.

12.3.2 Colour of Pipe

Surface colour of the pipes shall be dark shade of grey or as specified.

12.3.3 Marking
Each pipe shall be clearly and indelibly marked with the following information at intervals not more than 3 meter.
(a) Manufacturer’s name or trade mark.
(b) Nominal outside dia of pipe.
(c) Type ‘A’
(d) Batch number.

12.3.4 Dimensions

12.3.4.1 Diameter and Wall Thickness: Mean outside diameter, outside diameter at any point and wall thickness for type –A manufactured plain or with socket shall be as given in Table- 1 of IS 13592.

UPVC rain water pipes shall be of the dia, 110 mm and shall be in nominal lengths of 2,3,4 or 6 metres either plain or with sliding/grooved socket unless shorter lengths are required at junctions with fittings. Tolerances on specified length shall be + 10 mm and – 0 mm.

12.3.5 Fixing and Jointing
Pipes shall be either fixed on face of wall or embedded in masonry as required in the description of the item.
Plain pipes shall be secured to the walls at all joints with PVC Pipes clips by means of 50 x 50 x 50 mm hard wood plugs, screwed with M.S. screws of required length i/c cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand ). The clips shall be kept about 25 mm clear off finished face of wall, so as to facilitate cleaning of pipes. Pipes shall be fixed perfectly vertical or to the lines as directed. The pipes shall be fitted to fittings with seal ring conforming to IS 5382 allowing 10 mm gap for thermal expansion.

12.3.6 Installation in Wall/Concrete
The walls/concrete slots should allow for a stress free installation. Pipes and fittings to be inserted into the slots without a cement base have to be applied first with a thin coat of PVC solvent cement followed by sprinkling of dry sand (medium size). Allow it to dry. The process gives a sound base for cement fixation. This process is repeated while joining PVC material to CI/AC materials.

12.3.7 Fittings
Fittings used shall be of the same make as that of the PVC pipes Injecton moulded or fabricated by the manufacturer and shall have a minimum wall thickness of 3.2 mm. The fittings shall be supplied with grooved socketted ends with square grooves and provided with Rubber Gasket conforming to IS 5382.
The plain ends of the fittings should be chamfered. The fittings shall be joined with the help of Rubber lubricant. The details of fittings refer IS 13592.
12.3.8 Measurements

The fittings shall be measured by numbers. The pipes shall be measured net when fixed correct to a cm. excluding all fittings along its length.

12.3.9 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including jointing but excluding the supply and fixing of wall plugs and PVC clips which shall be paid for separately.

13.0 FINISHING

13.1 CEMENT PLASTER

The cement plaster shall be 12 mm, 15 mm or 20 mm thick as specified in the item.

13.1.1 Scaffolding

For all exposed brick work or tile work double scaffolding independent of the work having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

For all other work in buildings, single scaffolding shall be permitted. In such cases the inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not be allowed in pillars/columns less than one metre in width or immediately near the skew backs of arches. The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering.

13.1.2 Preparation of Surface

The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scrapping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

In case of concrete surface if a chemical retarder has been applied to the form work, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface.

13.1.3 Mortar

The mortar of the specified mix using the type of sand described in the item shall be used. It shall be as specified in Subhead 3.0. For external work and under coat work, the fine aggregate shall conform to grading IV. For finishing coat work the fine aggregate conforming to grading zone V shall be used.

13.1.4 Application of Plaster

13.1.4.1 Ceiling plaster shall be completed before commencement of wall plaster.
13.1.4.2 Plastering shall be started from the top and worked down towards the floor. All putlog holes shall be properly filled in advance of the plastering as the scaffolding is being taken down. To ensure even thickness and a true surface, plaster about 15 × 15 cm shall be first applied, horizontally and vertically, at not more than 2 metres intervals over the entire surface to serve as gauges. The surfaces of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall then be laid on the wall, between the gauges with trowel. The mortar shall be applied in a uniform surface slightly more than the specified thickness. This shall be brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upward and sideways movements at a time. Finally the surface shall be finished off true with trowel or wooden float according as a smooth or a sandy granular texture is required. Excessive towelling or over working the float shall be avoided.

13.1.4.3 All corners, arrises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, arrises, provision of grooves at junctions etc. where required shall be done without any extra payment. Such rounding, chamfering or grooving shall be carried out with proper templates or battens to the sizes required.

13.1.4.4 When suspending work at the end of the day, the plaster shall be left, cut clean to line both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scrapped cleaned and wetted with cement slurry before plaster is applied to the adjacent areas, to enable the two to properly join together. Plastering work shall be closed at the end of the day on the body of wall and not nearer than 15 cm to any corners or arrises. It shall not be closed on the body of the features such as plasters, bands and cornices, nor at the corners of arrises. Horizontal joints in plaster work shall not also occur on parapet tops and copings as these invariably lead to leakages. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar. No portion of the surface shall be left out initially to be patched up later on. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

13.1.5 Thickness
Where the thickness required as per description of the item is 20 mm the average thickness of the plaster shall not be less than 20 mm whether the wall treated is of brick or stone. In the case of brick work, the minimum thickness over any portion of the surface shall be not less than 15 mm while in case of stone work the minimum thickness over the bushings shall be not less than 12 mm.

13.1.6 Curing
Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered. The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the contractor’s expense by such means as the Engineer-in-Charge may approve. The dates on which the plastering is done shall be legibly marked on the various sections plastered so that curing for the specified period thereafter can be watched.

13.1.7 Finish
The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.
13.1.8 Precaution
Any cracks which appear in the surface and all portions which sound hollow when tapped, or are found to be soft or otherwise defective, shall be cut out in rectangular shape and redone as directed by the Engineer-in-Charge.

(i) When ceiling plaster is done, it shall be finished to chamfered edge at an angle at its junction with a suitable tool when plaster is being done. Similarly when the wall plaster is being done, it shall be kept separate from the ceiling plaster by a thin straight groove not deeper than 6 mm drawn with any suitable method with the wall while the plaster is green.

(ii) To prevent surface cracks appearing between junctions of column/beam and walls, 150 mm wide chicken wire mesh should be fixed with U nails 150 mm centre to centre before plastering the junction. The plastering of walls and beam/column in one vertical plane should be carried out in one go. For providing and fixing chicken wire mesh with U nails payment shall be made separately.

13.1.9 Measurements

13.1.9.1 Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres correct to two places of decimal.

13.1.9.2 Thickness of the plaster shall be exclusive of the thickness of the key i.e. grooves, or open joints in brick work.

13.1.9.3 The measurement of wall plaster shall be taken between the walls or partitions (the dimensions before the plaster shall be taken) for the length and from the top of the floor or skirting to the ceiling for the height. Depth of coves or cornices if any shall be deducted.

In measuring jambs, sills and soffits, deduction shall not be made for the area in contact with the frame of doors, windows etc.

13.1.10 Rate
The rate shall include the cost of all labour and materials involved in all the operations described above.

13.2 6 MM CEMENT PLASTER ON CEMENT CONCRETE AND REINFORCED CEMENT CONCRETE WORK

13.2.1 Scaffolding
Stage scaffolding shall be provided for the work. This shall be independent of the walls.

13.2.2 Preparation of Surface
Projecting burrs of mortar formed due to the gaps at joints in shuttering shall be removed. The surface shall be scrubbed clean with wire brushes. In addition concrete surfaces to be plastered shall be pock marked with a pointed tool, at spacings of not more than 5 cm. Centres, the pock being made not less than 3 mm deep. This is to ensure a proper key for the plaster. The mortar shall be washed off and surface, cleaned off all oil, grease etc. and well wetted before the plaster is applied.

13.2.3 Mortars
Mortar of the 1:3 (1 Cement:3 sand) mix using the types of sand described in the item shall be used.

13.2.4 Application
To ensure even thickness and a true surface, gauges of plaster 15 x 15 cm. shall be first applied at not more than 1.5 m intervals in both directions to serve as guides for the plastering. Surface
of these gauged areas shall be truly in the plane of the finished plaster surface. The plaster shall be then applied in a uniform surface to a thickness slightly more than the specified thickness and shall then be brought to true and even surface by working a wooden straight edge reaching across the gauges. Finally the surface shall be finished true with a trowel or with wooden float to give a smooth or sandy granular texture as required. Excess troweling or over working of the floats shall be avoided. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar. Plastering of ceiling shall not be commenced until the slab above has been finished and centring has been removed. In the case of ceiling of roof slabs, plaster shall not be commenced until the terrace work has been completed. These precautions are necessary in order that the ceiling plaster is not disturbed by the vibrations set up in the above operations.

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

13.2.6 Thickness
The average thickness of plaster shall not be less than 6 mm. The minimum thickness over any portion of the surface shall not be less than 5 mm.

13.2.7 Measurements
13.2.7.1 Length and breadth shall be measured correct a cm. and its area shall be calculated in sqm.
correct to two places of decimal. Dimensions before plastering shall be taken.

13.2.8 Rate
The rate shall include the cost of all labour and materials involved in all the operations described above.

13.3 OIL EMULSION (OIL BOUND) WASHABLE DISTEMPERING

13.3.1 Materials
Oil emulsion (Oil Bound) washable distemper (IS 428) of approved brand and manufacture shall be used. The primer where used as on new work shall be cement primer or distemper primer as described in the item. These shall be of the same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day’s work shall be prepared.
The distemper and primer shall be brought by the contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight’s work, and the same shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty tins shall not be removed from the site of work, till this item of work has been completed and passed by the Engineer-in-Charge.

13.3.2 Preparation of the Surface
13.3.2.1 For new work the surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.
13.3.2.2 In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc.

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

13.3.3 Application
13.3.3.1 Priming Coat: The priming coat shall be with distemper primer or cement primer, as required in the description of the item. Oil bound distemper is not recommended to be applied, within six months of the completion of wall plaster. However, newly plastered surfaces if required to be distempered before a period of six months shall be given a coat of alkali resistant priming Paint conforming to IS 109 and allowed to dry for at least 48 hours before distempering is commenced.

13.3.3.2 Distemper Coat: For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitutes one coat. The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade. A time interval of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat.

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

13.3.4 Measurement: Length and breadth shall be measured correct to a cm. and area shall be calculated in sqm correct to two places of decimals.

13.3.5 Rate
The rate shall include the cost of all labour and materials involved in all the above operations (including priming coat) described above.

13.4 EXTERIOR PAINTING ON WALL

13.4.1 Material
The paint shall be (Texured exterior paint/Acrylic smooth exterior paint/premium acrylic smooth exterior paint) of approved brand and manufacture.

This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight’s work. The materials shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty containers shall not be removed from the site.
of work till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

13.4.2 Preparation of Surface

For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer in charge after inspection before painting is commenced.

13.4.3 Application

Base coat of water proofing cement paint

13.4.3.1 Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer’s instructions & directions of the Engineer-in-charge shall be followed meticulously.

The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust.

13.4.3.2 Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.

13.4.4 Measurement: Length and breadth shall be measured correct to a cm. and area shall be calculated in sqm correct to two places of decimals.

13.4.5 Rate
The rate shall include the cost of all labour and materials involved in all the above operations (including priming coat) described above.

13.5 PAINTING SYNTHETIC ENAMEL PAINT OVER STEEL WORK

13.5.0 Synthetic enamel

Paint, suitable for painting over Steel work, of approved brand and manufacture and of the required shade shall be used. New or weathered steel work shall be painted with a priming coat of one coat of redoxide zinc chromate Paint. Primer shall be applied before fixing sheets in place. Two or more coat of paint has to be applied as per requirement.
### 13.5.1 Preparation of Surface

**13.5.1.1 Painting New Surface**: The painting of new steel work shall not usually be done till they have weathered for about a year. When new surface are to be painted before they have weathered they shall be treated with a mordant solution prepared by mixing 38 gm of copper acetate in a litre of soft water or 13 gm hydrochloric acid in a solution of 13 gm each of copper chloride, copper nitrate and ammonium chloride dissolved in a litre of soft water. This quantity of solution is sufficient for about 235 sqm. to 280 sqm of area and is applied for ensuring proper adhesion of Paint.

Before painting on new or weathered steel surface, rust patches shall be completely cleaned with coarse emery paper and brush. All grease marks shall also be removed and the surface washed and dried and rusted surface shall be touched with synthetic enamel paint of approved brand, manufacturer and shade.

**13.5.2 Measurement**:  
Measurement of surface shall be taken in sqm.

**13.5.3 Rate**  
Rates shall include cost of all labour and materials involved in all the operations described above.

### 13.6 Plaster of Paris

The plaster of Paris shall be of the calcium-sulphate semi-hydrate variety. Its fineness shall be such that when sieved through a sieve of IS sieve designation 3.35 mm for 5 minutes the residue left on it after drying shall be not more than 1% by weight. It shall not be too quick setting. Initial setting time shall not be less than 13 minutes. The average compressive strength of material determined by testing 5 cm cubes after removal from moulds, after 24 hours and drying in an oven at 40 degree C till weight of the cubes is constant, shall not be less than 84 kg per square metre.

#### 13.6.1 Applications

The material will be mixed with water to a workable consistency. Plaster of Paris shall be applied to the underside of the laths over the rabbit wire mesh in suitable sized panels and finished to a smooth surface by steel trowels. The plaster shall be applied in such a manner that it fully fills the gaps between the laths and the thickness over the laths is as specified in the description of the item. The joints shall be finished flush to make the ceiling in one piece. The finished surface shall be smooth and true to plane, slopes or curves as required. The thickness of POP layer should be maintained 10mm. The design should be according to drawing and should be done by expertise agency.

#### 13.6.2 Measurements

**13.6.2.1** Length and breadth of superficial area of the finished work shall be measured correct to a cm.  
Area shall be calculated in square metre correct to two places of decimal. No deduction will be made to openings of areas upto 40 square decimetre nor shall extra payment be made either for any extra material or labour involved in forming such openings.
13.6.3 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above including all scaffolding, staging etc.

14.00 PILE WORK

14.1 DRIVEN CAST-IN-SITU REINFORCED CEMENT CONCRETE PILES
14.1.1 General
Cast-in-situ piles shall be installed by driving a metal casing with a shoe at the tip and displacing the material laterally. Driven cast-in-situ pile is formed by driving a casing, permanent or temporary and subsequently filling the hole with plain or reinforced concrete.

14.1.2 Equipment
The equipment and accessories used for driven cast-in-situ piles shall depend on type of sub-soil strata, ground water conditions, type of founding material and penetration etc.

**Dolly:** A cushion of hardwood or some suitable material placed on the top of the casing to receive the blows of the hammer.

**Kent Ledge:** Dead weight used for applying a test load to a pile.

**Shoe:** Pile Shoe should be of material as specified in the item. The pile shoes may be either cast iron or mild steel. Cast iron pile shoes shall be made from chill hardened iron as used for making grey iron casting confirming to IS 210. The chilled iron point shall be free from blow holes and other surface defects. Cast steel piles shoe shall be of steel conforming to IS 2644. Straps or other fastenings to cast pile shoes shall be of steel conforming to IS 1079 and shall be cast into the point to form an integral part of shoe.

**Drop Hammer (or Monkey):** Hammer, ram or monkey raised by a winch and allowed to fall under gravity.

**Single or Double Acting Hammer:** A hammer operated by steam compressed air or internal combustion, the energy of its blows being derived mainly from source of motive power and not from gravity along.

**Pile Frame (or Pile Rig):** A movable steel structure for driving piles in the correct position and alignment by means of a hammer operating in the guides or (leaders) of the frame.

14.1.3 Pile Driving

14.1.3.1 Installation of Piles: Installation of piles shall be as accurate as possible and as per design and drawings. The vertically or the required batter should be correctly maintained. Particular care shall be taken in respect of installing either single pile or piles in two pile groups.
14.1.3.2 Deviation /Tolerance
(i) The deviation/tolerance should be as per IS 2911 (Part 1/Sec.1). The piles should not deviate more than 75 mm or D/4 whichever is less (75 mm or D/10 whichever is more in case of piles having diameter more than 600 mm) from their designed position at the working level.
(ii) In case of a single pile under a column, the positional deviation should not be more than 50 mm or D/4 whichever is less (100 mm in case of piles having diameter more than 600 mm. Greater tolerance may be prescribed for piles driven over water and for raking piles.

14.1.3.3 Sequence of Installation: Normal sequence of installation of pile group is from the centre to the periphery of the group or from one side to the other. Particular care shall be taken to avoid damaging the already cast pile while driving a fresh tube nearby before the concrete has sufficiently set. The possibility of the pile getting damaged is more in compact soils than in loose soils.

14.1.3.4 Driving a Group of Friction Piles
(i) The skin friction increases considerably when the pile bore is driven in the loose sand as the pile tends to compact the sand. Therefore in such cases the order of installation shall be altered so that a compact block is not created where driving further pile bore will not be possible. Similar precaution will have to be taken where stiff clay or compact sand layers will have to be penetrated.

(ii) However driving the pile bore from centre outwards or commencing at a particular selected edge or even working across the group the problem pointed out in Para (I) above can be avoided.

(iii) In case of very soft soil it is advisable to start driving the bore hole from outside to inside so that the soil gets restrained from flowing out during operation.

14.1.3.5 Procedure of Pile Driving
(i) Driven cast-in-situ concrete piles are installed by driving a metal casing with a shoe at the tip/toe and displacing the material laterally.
(ii) These piles may be cast in metal shells which may remain permanently in place or the casing may be withdrawn which may be termed as uncased driven cast-in-situ cement concrete piles.
(iii) The metal casing shall be of sufficient thickness and strength to hold in original form and show no harmful distortion when the adjacent casing is driven and the driving core if any is withdrawn.
(iv) Driven cast-in-situ concrete piles shall be installed using a properly designed detachable shoe at the bottom of the casing.
(v) Any liner or bore hole; which is temporarily located and shows partial collapse that would affect the load carrying capacity of the pile, shall be rejected or repaired as directed by the Engineer-in-Charge.

14.1.3.6 A proper record of pile driving and other details such as depth driven, sequence of installation in a group, cut off level/working level shall be mentioned in sequence of occurrence worksheet for the inspection of Engineer-in-charge.

14.1.4 Reinforcement
(i) The design of reinforcing cage varies depending upon the driving and installation conditions, the nature of the sub-soil and the nature of load to be transmitted by the shaft, axial or otherwise. The minimum area of longitudinal reinforcement of any type or grade within the pile
shaft shall be 0.4 per cent of the sectional area calculated on the basis of the outside area of the casings of the shaft.

(ii) The curtailment of reinforcement along the depth of the pile, in general, depends on the type of loading and sub-soil strata. In case of piles subjected to compressive load only, the designed quantity of reinforcement may be curtailed at appropriate level according to design requirements. For piles subjected to uplift load, lateral load & moments, separately or with compressive loads, it may be necessary to provide reinforcement to the full depth of the pile.

(iii) Piles shall always be reinforced with a minimum amount of reinforcement as dowels keeping the minimum bond length into the pile shaft below its cut-off level, and with adequate projection into the pile cap, irrespective of design requirements. **Note:** In some cases the cage may lift at bottom or at the laps during withdrawal of casing. This can be minimized by making the reinforcement “U” shaped at the bottom and up to well secured joints. Also the lifting 5 percent of the length should be considered not to affect the quality of pile.

(iv) Clear cover to all main reinforcement in pile shaft shall be not less than 50 mm and shall be maintained by suitable spacers. The laterals of reinforcing cage may be in the form of links or spirals. The diameter and spacing of the same is chosen to impart adequate rigidity of the reinforcing cage during the handing and installation. The minimum diameter of links or spirals shall be 6 mm and the spacing of the links or spirals shall be not less than 150 mm. The minimum clear distance between two adjacent main reinforcement should normally be 100 mm for full depth of the cage.

(v) The reinforcing cage should be left with adequate protruding length above the cut-off level for proper embedment in the pile cap. Prior to the lowering of reinforcement cage into the pile shaft, the shaft shall be cleaned of all loose materials.

(vi) Reinforcement in the form of cage shall be assembled with additional support, such as spreader forks and lacings; necessary to form a rigid cage hoops, links, or helical reinforcement has to fit closely around the main longitudinal bars and shall be tied by binding wire of approved quality. The ends of the binding wire shall be turned into the interior of the pile. Reinforcement shall be placed and maintained in correct position. The reinforcements shall be joined wherever necessary by welding and the procedure of welding be followed as described in IS 2751.

14.1.5 Concrete

M35 Grade of concrete should be used. This should satisfy all criteria of Reinforced cement concrete.

14.1.5.1. Placing of Concrete

(i) Before commencement of pouring of concrete, it shall be ensured that there is no ingress of water in the casing tubes from bottom. Further, adequate control during withdrawal of the casing tube is essential so as to maintain sufficient head of concrete inside the casing tube at all stages of withdrawal.

(ii) Wherever practicable concrete should be placed in a clean dry hole where concrete is placed in dry hole and when casing is present, the top 3 m pile shall be compacted using internal vibrators. The concrete should invariably be poured through a tremie, with a funnel so that the flow is directed and concrete can be deposited in the hole without segregation. Care shall be taken during concreting to prevent as far as possible the segregation of the ingredients. The
displacement or distortion of reinforcement during concreting and also while extracting the tube shall be avoided.

(iii) Where the casing is withdrawn from cohesive soils for the formation of cast-in-situ pile, the concreting should be done with necessary precautions to minimize the softening of the soil by excess water. Where mud flow conditions exist, the casing of cast-in-situ piles shall not be allowed to be withdrawn.

(iv) The concrete shall be self compacting and shall not get mixed with soil, excess water, or other extraneous matter. Special care shall be taken in silt clays and other soils with tendency to squeeze into newly deposited concrete and cause necking. Sufficient head of green concrete shall be maintained to prevent inflow of soil or wager into concrete. The placing of concrete shall be continuous process from the toe level to the top of pile to prevent segregation, a tube of tremie pipe shall be used to place concrete in all piles. To ensure compaction by hydraulic static heads, rate of placing concrete in the pile shaft shall not be less than 6 m (length of pile) per hour.

(v) The diameter of the finished pile shall not be less than specified and a continuous record shall be kept by the Engineer as to the volume of concrete placed in relation to the length of pile cast. After each pile has been cast and any empty pile hole remaining shall be protected and back filled as soon as possible with approved material.

(vi) The minimum embedment of cast-in-situ concrete piles into pile cap shall be 150 mm. Any defective concrete at the head of the completed pile shall be cut away and made good with new concrete. The clear cover between the bottom reinforcement in pile cap from top of pile shall not be less than 30 mm. The reinforcement in the pile shall be exposed for full anchorage length to permit it to be adequately bonded into the pile cap. Exposing such length shall be done carefully to avoid damaging the rest of the pile. In cases where the pile cap is to be laid on ground a leveling course with cement concrete of Grade M-15 and of 100 mm thickness shall be provided.

(vii) Normally concreting of piles should be uninterrupted. In exceptional case of interruption of concreting, but which can be resumed within 1 or 2 hours, the tremie shall not be taken out of the concrete. Instead it shall be raised and lowered slowly from time to time to prevent the concrete around the pipe from setting. Concreting should be resumed by introducing a little richer concrete with a slump of about 200 mm for each displacement of the partly set concrete. If the concreting cannot be resumed before final set of concrete already laid, the pile so cast may be rejected.

(viii) In case of withdrawal of tremie out of concrete, either accidentally or to removed a choke in the tremie, the tremie may be re-introduced to prevent impregnation of laitance scum lying on the top of the concrete already deposited in the bore. The tremie shall be gently lowered on to the old concrete with very little penetration initially. A vermiculite plug should be introduced in the tremie. Fresh concrete of slump between 150 mm and 175 mm should be filled in the tremie which will push the plug forward and will emerges out of the tremie displacing the laitance/scum. The tremie will be pushed further in steps masking fresh concrete sweep away laitance scum in its way. When the tremie is buried by about 60 to 100 cms, concreting may be resumed.

(ix) The top of concrete in a pile shall be brought above the cut-off level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut-off level for proper embedment into the pile cap.
(x) Where cut-off level is less than 1.5 metres below the working level concrete shall be cast to a minimum of 300 mm above cut-off level. For each additional 0.3 m increase in cut-off level below the working level additional coverage of 50 mm minimum shall be allowed. Higher allowance may be necessary depending on the length of the pile. When concrete is placed by tremie method concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection or to a minimum of one metre above cut off level. In the circumstances where cut-off level is below ground water level the need to maintain pressure on the unset concrete equal to or greater than water pressure should be observed and accordingly length of extra concrete above cut-off level shall be determined.

14.1.6 Measurement
Dimension shall be measured nearest to a cm. Measurement of length on completion shall be along the axis of pile and shall be measured from top of shoe to the bottom of pile cap. No allowance shall be made for bulking, shrinkage, cut off tolerance, wastage and hiring of tools and equipment for excavating driving etc.

14.1.7 Rate
The rate includes the cost of materials and labour involved in all the operations described above including pile embedded in pile cap, except soil investigation, reinforcement, pile cap and grade beam.

15.00 ALUMINIUM WORK
15.1 ALUMINIUM
15.1.1 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. The aluminium extruded sections shall conform to IS 733 and IS 1285 for chemical composition and mechanical properties. The stainless steel screws shall be of grade AISI 304.

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 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 Engineer-in-Charge. If the sections are varied, the contractor shall obtain prior approval of Engineer-in-Charge and nothing extra shall be paid on this account.

15.1.2 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.

15.1.3 Powder Coating

15.1.3.1 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.

15.1.3.2 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.

15.1.3.3 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.

15.1.3.4 Thickness: The thickness of the finished polyester powder coating measured by micron meter shall not be less than 50 micron nor more than 120 micron at any point.

15.1.3.5 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: 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.
15.1.3.6 **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.

15.1.3.7 **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.

15.1.3.8 **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.

15.2 PANELING MATERIAL

15.2.1 Pre-laminated Particle Board

A particles board laminated on both surfaces by synthetic resin impregnated base papers under heat and pressure. Pre-laminated particle boards shall be of two grades, namely, Grade I and II corresponding to IS 3087 & 12823. Each of the grades specified shall be of four types, namely, Types-I, II, III, and IV.

15.2.1.1 **Particle Board**: Synthetic resin bonded flat pressed three layers, multilayer and graded particle board defined in IS 3087 having superfine surface shall be used for production of prelaminated particle board. For ECO Marks the particle board shall also conform to the requirements of ECO Mark specified in IS 3087.

15.2.1.2 **Impregnated Base Paper**: Printed or plain coloured absorbent base paper having a weight of 60-140 g/m² impregnated in a suitable synthetic resin and dried to a volatile content of 4-8 per cent shall be used for pre-lamination on both surfaces of particle board.

15.2.1.3 **Impregnated Overlay**: An absorbent tissue, paper having a weight of 18-40 g/m² impregnated in a suitable synthetic resin and dried to a volatile content of 4-8 per cent shall be used for the manufacture of pre-laminated particle board.

15.2.1.5 **Finish**: The finish of the paper overlaid board depends on the surface of caul plates used. Common surface finishes in use are glossy, matt textured (soft, Swede, wood pore and leather), etc. The surface finish of the foil finished boards depends on the original finish of the foil used.

15.2.1.6 **Dimensions and Tolerances**: Dimensions and tolerances shall conform to IS 12049.

15.2.2 Aluminium Sheet

15.2.2.1 Aluminium Sheets for use as panels shall be 1.25 mm thick aluminium alloy sheet conforming to IS 737. Aluminium alloy sheet for use in general paneling work shall be of types and thickness as specified and conforming to the requirement of IS 737. Aluminium sheets shall be of approved make and manufacturer. Aluminium panel may be prefabricated units manufactured on modular or non-modular dimension.
15.2.2 Fixing: The required size of panel, keeping sufficient margin to be inserted inside the section, shall be cut to correct size and fixed firmly in the frame with CP brass or aluminium or stainless steel screws of star headed, counter sunk and matching size groove. Joints sealed with epoxy resin or silicon sealant to make the unit water proof.

15.2.3 Float Glass
15.2.3.1 The glass shall be clear float glass and should be approved by the Engineer in Charge. It shall be clear, float transparent and free from cracks subject to allowable defects. The float glass shall conform to the IS 14900.

15.2.3.2 Thickness: The thickness of float glass shall be 5.5 mm. The tolerance in thickness shall be as per allowable limits mentioned below.

<table>
<thead>
<tr>
<th>Nominal Thickness (in mm)</th>
<th>Tolerance (in mm)</th>
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<tr>
<td>4.0</td>
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<tr>
<td>5.0</td>
<td>± 0.3</td>
</tr>
<tr>
<td>6.0</td>
<td>± 0.3</td>
</tr>
<tr>
<td>8.0</td>
<td>± 0.6</td>
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</tbody>
</table>

15.2.3.4 Allowable Cluster of Defects: The allowable cluster of defects mentioned under shall be as per IS 14900.

15.2.4.1 Thickness: The thickness of float glass shall be measured with micrometers or a caliper which is graduated to 0.01 mm or with a measuring instrument having an equivalent capacity.

15.3 EPDM- GASKETS
The EPDM Gaskets shall be of size and profile as shown in drawings and as called for, to render the glazing, doors, windows, ventilators etc. air and water tight. Samples of gaskets shall be submitted for approval and the EPDM gasket approved by Engineer-in-Charge shall only be used. The contractor shall submit documentary proof of using the above material in the work to the entire satisfaction of Engineer-in-Charge.

The EPDM gasket shall meet the requirements as given in Table 21.2 below:
TABLE 21.2

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Standard Follow</th>
<th>Specification</th>
</tr>
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<td>1</td>
<td>Tensile strength Kg.f/cm²</td>
<td>ASTM-D 412</td>
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</tr>
<tr>
<td>2</td>
<td>Elongation at break %</td>
<td>ASTM-D 412</td>
<td>250 Min.</td>
</tr>
<tr>
<td>3</td>
<td>Modulus 100% Kg/cm²</td>
<td>ASTM-D 412</td>
<td>22 Min.</td>
</tr>
<tr>
<td>4</td>
<td>Compression set % at 0°C CC 22 Hrs.</td>
<td>ASTM-D 395</td>
<td>50 Max.</td>
</tr>
<tr>
<td>5</td>
<td>Ozone resistance</td>
<td>ASTM-D 1149</td>
<td>No visible cracks</td>
</tr>
</tbody>
</table>

15.4 SEALANT
15.4.1 The sealants of approved grade and colour shall only be used. The silicone for perimeter joints (between Aluminium section and RCC/Stone masonry) shall be of make approved by the Engineer in Charge.

15.4.2 Method of Application

Surface Preparation: Clean all joints and glazing pockets by removing all foreign matter and contaminants such as grease, oil, dust, water, frost, surface dirt, old sealants or glazing compounds and protective coatings.

Masking: Areas adjacent to joints shall be masked to ensure neat sealant lines. Masking tape shall not be allowed to touch clean surfaces to which the silicone sealant is to adhere. Tooling shall be completed in one continuous stroke immediately after sealant application and before a skin forms and masking shall be removed immediately after tooling.

Application: Install backer rod of appropriate size and apply silicone sealant in a continuous operation using a positive pressure adequate to properly fill and seal the joint. The silicone sealant shall be tooled with light pressure to spread the sealant against backing material and the joint surfaces before a skin forms. A tool with convex profile shall be used to keep the sealant within the joint. Soap or water shall not be used as a tooling aid. Remove masking tape as soon as silicone joint is tooled.

Tolerance: A tolerance of + 3 mm shall be allowed in the width of silicone joints. The depth of the joints at throat shall not be less than 6 mm.

15.5 DOOR, WINDOW, VENTILATOR AND PARTITION FRAMES
15.5.1 Frame Work
First of all the shop drawings for each type of doors/windows/ventilators etc. 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 drawings shall also show the details of fittings and joints. Before start of the work, all the shop drawings shall be got approved from the Engineer-in-Charge.

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.

15.5.2 Fixing of Frames
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.

15.5.3 Measurements
All the aluminium sections including snap beadings 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.

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

15.6 DOOR, WINDOWS AND VENTILATOR SHUTTERS

Material, fabrication and dimensions of aluminium doors, windows and ventilators manufactured from extruded aluminium alloy sections of standard sizes and designs complete with fittings, ready for being fixed into the building shall be as per IS 1948.

15.6.1 Tolerances
The sizes for doors, windows and ventilators frames shall not vary by more than ±1.5 mm.
15.6.2 Material

Aluminium alloy extruded sections used in the manufacture of extruded window sections shall conform to IS 733. Hollow aluminium alloy sections used shall conform to IS 1285. Dimension and weight per metre run of the extruded sections shall be as per standard.

15.6.3 Glass Panes

Glass panes shall weigh at least 7.5 kg/m² and shall be free from flaws, specks or bubbles. All panes shall have properly squared corners and straight edges. The sizes of glass panes for use in doors, windows and ventilators shall be as per drawing.

15.6.4 Screws

Screws threads of machine screws used in the fabrication of aluminium doors, windows and ventilators shall conform to IS 1362.

15.6.7 Fabrication

Frames: Frames shall be square and flat, the corners of the frame being fabricated to a true right angle. Both the fixed and opening frames shall be constructed of sections which have been cut to length, mitered and welded at the corners. Where hollow sections are used with welded joints, argon-arc welding or flash butt welding shall be employed (gas welding or brazing not to be done). Subdividing bars of units shall be tenoned and riveted into the frame.

15.6.8 Side-hung Shutters

For fixing aluminium alloy hinges, slots shall be cut in the fixed frame and the hinges inserted inside and may be riveted to the frame. The hinges shall normally be of the projecting type 67 mm wide. The aluminium alloy for cast hinges shall conform to IS Designation A-5-M of IS 617. Specification for Aluminium and Aluminium Alloy Ingots and Castings for General Engineering Purpose and for extruded section of hinges to IS Designation HE10-WP or HE30-WP of IS 733. The pins for hinges shall be of stainless steel of non-magnetic type or aluminium alloy HR30. Irrespective of hinges being anodized or not, the aluminium alloy pins shall be anodized to a minimum film thickness of 0.025 mm shall be sealed with oil, wax or lanolin. Non-projecting types of hinges may also be used where ever required. Frictions hinges may be provided for side-hung shutter windows, in which case peg stay may not be required. The handle for side-hung shutters shall be of cast aluminium conforming to IS Designation A-5-M of IS 617 and mounted on a handle plate welded or riveted to the opening frame in such a way that it could be fixed before the shutter is glazed. The handle should have anodized finish with minimum anodic film thickness of 0.015 mm. The handle shall have a two points nose which shall engage with an aluminium striking plate on the fixed frame in a slightly open position as well as in a fast position. The height of the handles in each type of side-hung shutters shall be fixed in approximate position as indicated in.

The peg stay shall be either of cast aluminium conforming to IS 617 or folded from IS Designation NS4 aluminium alloy sheet conforming to IS:737 specification for wrought aluminium and aluminium alloys, Sheet and strip. It shall be 300 mm long, complete with peg and locking brackets. The stay shall have holes for keeping the shutter open in three different positions. The peg and locking bracket shall be riveted or welded to the fixed frame.
Alternatively, and if specifically required by the purchaser, side-hung shutters may be fitted with an internal removable fly screen of 0.375 mm wire and equivalent to IS Sieve 100 in a 0.900 mm aluminium alloy sheet conforming to IS Designation NS3-1/2H of IS 737 applied to the outer frame of the shutter by case or extruded aluminium alloy turn-buckle at the jambs and by aluminium or plated bronze shoes at the sill to allow of the screen being readily removed, and with a rotor operator at the sill to permit the operation of the shutter through an angle of 90°. On fly-screened shutters the peg stay is omitted and the normal handle shall be replaced by a locking handle to hold the shutter in the fast position.

15.6.9 Top-Hung Ventilators
The aluminium hinges for top-hung ventilators shall be either cast or fabricated out of extruded sections and shall be riveted to the fixed rail after cutting a slot in it. The aluminium alloy for cast hinges shall conform to IS Designation A-5-M of IS 617 and the extruded section of hinge to IS Designation HE10-WP or HE30_WP of IS 733. The pegs stay shall be 300 mm long as in side-hung shutter. The locking bracket shall be fixed to the fixed frame.

15.6.10 Centre-Hung Ventilators
Centre hung ventilators shall be hung on two pairs of cup pivots of aluminium alloy to IS Designation NS-4 of IS 737 and IS Designation A-5-M of IS 617 or on brass or bronze cup pivots which should be either chromium or cadmium plated and riveted to the inner and outer frames of the ventilators to permit the ventilator to swing through an angle of approximately 85°. The opening portion of the ventilator shall be so balanced that it remains open at any desired angle under normal weather condition.

Cast aluminium conforming to IS Designation A-5-M of IS 617 or bronze which shall be either chromium plated or cadmium plated spring catch shall be fitted in the centre of the top bar of the ventilators for the operation of the ventilator. This spring catch shall be secured to the frame and shall close into aluminium catch plate riveted or welded to the outside of the outer ventilator frame bar.

Aluminium or cadmium plated brass cord pulley-wheel in an aluminium bracket shall be fitted at the sill of the ventilator with aluminium or galvanized or cadmium plated steel screw or, alternatively, welded together with an aluminium cord eye riveted or welded to the bottom inner frame bar of the ventilator in a position corresponding to that of pulley.

15.7 Doors

15.7.1 The outer fixed frame shall be of section A1-FX8. The shutter frame shall be of either hollow sections A1-HFX5 and A1-HFX6.

The kick panels shall be of 1.25 mm aluminium alloy sheet conforming to IS Designation NS3-1/2H of IS 737 specification for Wrought Aluminium and Aluminium Alloys, Sheet and strip and shall be screwed to the frame and the glazing bar.

Hinges – Cast of extruded aluminium alloy hinges for doors shall be of the same type as in the windows but of larger size. The hinges shall normally be of the 50 mm projecting type. A suitable lock for the door operable either from inside or outside shall be provided.

In double shutter doors the first closing shutter shall have a concealed aluminium alloy bolt at top and bottom. It shall be so constructed as not to work loose or drop by its own weight. Single
and double shutter doors may be provided with a three-way bolting device. Where this is provided in the case of double shutter door, concealed aluminium bolts may not be provided.

15.7.2 Finish
Aluminium doors, windows and ventilators may be supplied in either matt, scratch-brush or polished finish. They may, additionally, also be anodized, if so required by the Engineer-in-Charge. If colour anodizing is to be done then only approved light-fast shades should be used. A thick layer of clear transparent lacquer based on methacrylates or cellulose butyrate, shall be applied on aluminium doors, windows and ventilators by the supplier to protect the surface from wet cement during installation. This lacquer coating shall be removed after installation is completed.

15.7.3 Glazing
Glazing shall be provided on the outside of the frames. If required, glazing clips may be provided as extra fittings. Four glazing clips may be provided per glass pane. In case of doors, windows and ventilators without horizontal glazing bars the glazing clips shall be spaced according to the slots in the vertical members.

15.8 FITTINGS
15.8.1 Stainless Steel Friction Stay
The stainless steel friction stays of make approved by the Engineer-in-Charge shall be used. The SS friction stays shall be of grade AISI-304 and of sizes specified in nomenclature of item.

15.8.2 Lockable Handles
The lockable handle shall be of make approved by the Engineer-in-Charge and of required colour to match the colour of powder coated (min 50 micron) aluminium sections of outer dia 100mm with SS screws.

15.8.3 Hydraulic Floor Spring
The hydraulic floor spring shall be heavy duty double action floor spring of make approved by the Engineer-in-Charge suitable for door leaf of weight minimum 100 kg. The top cover plate shall be of stainless steel, flushing with floor finish level. The contractor shall cut the floor properly with stone cutting machine to exact size & shape. The spindle of suitable length to accommodate the floor finish shall be used. The contractor shall give the guarantee duly supported by the company for proper functioning of floor spring at least for 10 years.

15.9 BRASS LOCK
This should generally conform to IS-2209. The size of the lock shall be denoted by the length of the body towards the face and it shall be 100 mm. the measured length shall not vary more than 3 mm from the specified length. Ordinary lever mechanism with not less than 2 levers shall be provided. False lever shall not be used. Lever shall be fitted with one spring of phosphor-bronze or steel wire and shall withstand the test as provided in IS-2209. Locking-bolt spring and strike plate shall conform to IS 2209. Two keys shall be provided with each lock.
16.00 WATER PROOFING

16.1 WATER PROOFING TREATMENT WITH APP (ATACTIC POLYPROPYLENE POLYMERIC) MEMBRANE
In selecting the combinations of layers of APP membrane, consideration shall be given to the type and construction of buildings, climate and atmospheric conditions and the degree of permanence required.

16.1.1 FIVE LAYERED WATER PROOFING TREATMENT WITH ATACTIC POLYPROPYLENE POLYMER MODIFIED PREFABRICATED MEMBRANE

16.1.2 Atactic Polypropylene Polymer modified prefabricated five layer water proofing membrane shall be of thickness as specified. In selecting thickness of membrane due consideration shall be given to the type and construction of building, climate and atmospheric condition and permanence required. Five layered 3.00 mm thick with non-woven polyester matt treatment is suitable for heavy condition of rainfall.

16.1.3 Materials
Bitumen primer for bitumen membrane shall have density at 25°C in the range of 0.87 - 0.89 kg./litre and viscosity of 70-160 CPS primer shall be applied @ of 0.40 litre/sqm.

16.1.4 Atactic Polypropylene Polymer Modified Prefabricated Membrane:
It is a polymeric water proofing membrane of 3 mm thick with non-woven polyester matt.

It is prefabricated five layered black finish water proofing membrane comprising of centre core of 50 gsm. Glass fibre matt/170 gsm nonwoven polyester matt sandwiched on both sides by APP polymer modified bitumen which is protected on both sides by 20 micron thermofusible polyethylene sheet. Composite thickness of the membrane including all five layers shall be 2/3 mm with glass fibre matt and 3 mm with non woven polyester matt. It is available in 1 m width and variable lengths.

16.1.5 Preparation of Surface: The surface to be treated shall have a minimum slope of 1 in 120 or as specified. To ensure good adhesion between the surface and water proofing treatment suitable method to dry the surface shall be adopted. All hair line cracks in the surface should be filled with approved sealant.

16.1.6 Laying: Bitumen primer @ 0.40 lts/sqm shall be applied to the prepared roof, drain and all other surfaces where polymer modified membrane is to be laid. The five layered water proofing membrane shall be laid using Butane torch and sealing all joints and preparing the surface complete. Drain outlets shall be given same treatment as specified for the roof in the description of the item in the manner specified for the flat roof surface. Water proofing treatment shall be carried into the drain pipe or outlets by at least 10 cm. The water proofing treatment laid on the roof surface shall overlap the upper edge of the water proofing treatment in the drain outsets by at least 10 cm.
The APP polymer modified prefabricated water proofing membrane shall be cut to the required length. Water proofing membrane shall normally be laid in length in the direction of the slope and laying shall be commenced at the lowest level and worked up to crest. APP water proofing membrane shall be laid in 6 to 8 m lengths. The roof surface shall be cleaned and bitumen primer shall be applied in the correct quantity, over this specified water proofing membrane shall be laid with butane torch after allowing 24 hours for primer to dry. Each strip shall overlap the preceding one by at least 10 cm. at the longitudinal edges and 15 cm. at the ends. All overlaps shall be firmly bonded with bitumen primer and levelled by heating the overlap with butane torch.

If the roof is accessible the treatment is protected by brick tiles laid over 12 mm thick cement mortar of specified grade bedding and joints sealed with cement mortar of which shall be measured and paid for separately.

APP water proofing membrane shall be laid as flashing wherever junction of vertical and horizontal surfaces occurs. Longitudinal laps shall be 10 cm. The upper edge of flashing membrane shall be well tucked into the flashing grooves in the parapets, chimney stack etc. to a depth of not less than 6.5 cm; corresponding applications of primer coat shall also be made. The flashing treatment shall be firmly held in the grooves and it shall be sealed with the approved sealant after terminating the membrane. Where parapet walls are of height 45 cm or less AP water proofing membrane flashing shall be provided in the same manner as for splashing in the core of high parapet walls except that upper edge shall be carried out the full height of the wall and taken right across the top of the parapet and down on the external vertical faces to a minimum distance of 5 cm. Where low dividing walls or inverted beams are met with, the same treatment shall be provided as for the main roof, the lateral bearing carried down both sides of the wall and overlapping the roof treatment. Drain outlets where formed in the low dividing walls, shall be given water proofing treatment same as for the main roof.

Where the expansion joints are provided in the slabs, the joints and their cover slabs shall be suitably treated with water proofing treatment. A typical sketch of an expansion joint with the RCC slabs on either side of the joint turned vertically up and covered with precise RCC cover slab. The cover slabs shall cover the vertical turned up dwarf walls by not less than 7.5 cm and are provided with throatings on their underside along their length. The water proofing treatment shall be taken up the slopping junction fillets and the vertical faces of the walls to the underside of the cover slabs are given the water proofing treatment like the roof slabs, after the cross joints between adjacent cover slabs are first sealed with 15 cm. width of roofing felt struck to them with bitumen. The water proofing treatment shall be carried down the sides of the cover slabs to their full thickness. Care shall be taken to see that overlaps if any in the roofing over the cover slabs stagger with the joints between cover slabs.

The formation of the expansion joints and provision of cover slabs shall be the responsibility of construction agency. The formation of the junctions fillets and the water proofing treatment of the joint and cover slabs shall be carried out by the water proofing agency. No extra shall be paid for the junction fillets or for the sealing of the cross joints in the cover slab with 15 cm. width of bitumen strips.

16.1.7 Measurements: Length and breadth shall be measured correct to a cm. The area shall be calculated in square metres correct to two places of decimal. Measurement shall be taken over the entire exposed area of roofing and flashing treatment including flashing over low parapet.
walls, low dividing walls and expansion joints at pipe projections etc. Overlaps and tucking into flashing grooves shall not be measured.

No deduction in measurements shall be made for either openings or recesses for chimney stacks, roof lights and the like, for areas upto 40 square decimeter (0.4 sqm.) nor any thing shall be paid for forming such openings. For areas exceeding 0.40 sqm. Deductions will be made in measurements for full opening and nothing extra shall be paid for forming such openings.

16.1.8 Rate: The rates shall include the cost of all labour and materials involved in all the operations described above.

16.2 INTEGRAL CEMENT BASED WATER PROOFING TREATMENT WITH BRICK TILES
Before taking up the water proofing work the construction of parapet walls, including finishing should be completed. Similarly, the ancillary items like haunches, khurras, grooves to tack the fibre cloth layer, 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.

16.2.1 Preparing the Surface
The surface of the slab should be roughened by scrapping when the slab concrete is still green, 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 with brooms/cloth.

16.2.2 Providing and Laying of Slurry under Base Coat
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 + water & 2% integral water proofing compound 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 half an hour of preparation i.e. before the initial setting time of cement. The prepared slurry 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, joints of pipes, masonry/concrete etc. The application of the slurry should continue up to a height of 300 mm on the parapet wall and also the groove. The slurry should also be applied up to a height of 150 mm over pipe projections etc.

16.2.3 Laying Base Coat 12 mm thick
Immediately after the application of slurry and when the application is still green, 12 mm thick cement plaster as base coat with cement mortar 1:3 (1 blended cement : 3 coarse sand) shall be evenly applied over the concrete surface taking particular care to see that all the 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.
16.2.4 Laying Brick Tiles

FPS Brick Tiles of class designation 10 shall be laid to required slope/gradient over the base coat of mortar leaving 15-25 mm gap between two tiles. Cement mortar 1:3 (1 blended cement: 3 coarse sand) shall be poured over the brick Tiles and joints filled properly.

16.2.5 Application of Slurry over Brick Tiles

After two days of curing of brick Tiles cement slurry prepared as above shall be applied on the surface of brick Tiles. It should cover the haunches/gola, and the remaining small portion of parapet wall and also inside the groove.

16.2.6 Measurement

The measurement shall be taken along the finished surface of treatment including the rounded and tapered portion at junction of parapet wall. Length and breadth shall be measured correct to a cm and area shall be worked out to nearest 0.01 sqm. No deduction in measurement shall be made for openings or recesses or chimney stacks, roof lights or khurras of area upto 0.40 sqm., nor anything extra shall be paid for making such openings, recesses etc. For areas exceeding 0.40 sqm., deduction will be made in the measurements for the full openings and nothing extra shall be paid for making such openings.

16.2.7 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above.

16.3 CICO Tapecrete Water Proofing:

CICO Tapecrete Water Proofing should be done according to the specification mentioned in BOQ.

16.3.1 SURFACE PREPARATION

1. Prior to application of TAPECRETE - P151 work, all surfaces must be prepared properly to avoid failure. The surface shall be cleaned to remove all dust, foreign matters, loose materials or any deposits of contaminants which could affect the bond between the surface and the TAPECRETE P-151 coating.
2. New surfaces of the structural concrete shall be reasonably smooth to avoid sharp projections so as not to impede the application of TAPECRETE coating.
3. All concrete surface shall be thoroughly pre-wetted for at least one hour prior to the application of TAPECRETE coating by sprinkling of water on flat surface and by vigorously spraying water on vertical/inclined surfaces.
4. Tapecrete Should be applied in two layers. Applying first coat by mixing 1 Kg Tapecrete with 2 Kg cement and Second coat by mixing 1 Kg Tapecrete with admixture of 1.5 Kg cement & 0.5 Kg fine silica sand.

16.3.2 APPLICATION

1. Application of one coat of TAPECRETE -P-151 Polymer Modified Cementitious (PMC) slurry coating over the prepared concrete surface. The slurry shall be spread out over an area which can be covered with fibre glass fabric before the slurry dries out.
2. Unroll the fibre glass fabric on to the wet slurry layer and impregnate with PMC slurry by pressing the fabric down so as to even out all wrinkles.
3. Application of one coat TAPCRETE P-151 slurry coating over the glass fabric so as to fill and over the fabric.
4. Application of one coat TAPECRETE-P151 - PMC brush topping over the TAPECRETE -P151 slurry coating applied surface after the slurry coat has dried on the next day.
5. Providing protective overlay of 25mm minimum thick screed concrete / plaster to slope of (1 in 100) admixed with CICO No. 1 Integral Cement Waterproofing compound after curing of PMC brush top coating.

16.3.3 Curing
1. During the first 12 hours of curing, it must be protected from abrasion, rain and other adverse conditions.
2. No traffic shall be allowed on a standard TAPECRETE-P151 treated surface within 48 hours after installation.
3. After application of final coat of TAPECRETE-P151 composition, initial air drying shall be done for 2-6 hours. During this period no water is to be used for curing.
4. Moist curing shall be done for the next 24 hours by way of spraying water on the TAPECRETE system.
5. Following moist curing, the TAPECRETE-P151 coating shall be allowed to air dry for 3 days before submersion in water.

16.3.4 Measurement
The measurement shall be taken along the finished surface of treatment. Length and breadth shall be measured correct to a cm and area shall be worked out to nearest 0.01 sqm. No deduction in measurement shall be made for openings or recesses or chimney stacks, roof lights or khurras of area upto 0.40 sqm.

16.3.5 Rate
The rate shall include the cost of all labour and materials involved in all the operations described above.
17.00 SWIMMING POOL

The finishing item used in swimming pool should satisfy the relevant IS code. The finishing should be according to the approved drawing. The Equipment & Accessory should be of the same approved make mentioned in BOQ and should be of same rating. They should satisfy the relevant codes. The work should be executed by expertise agency.
SECTION – 2.0

DETAILED TECHNICAL SPECIFICATION – ELECTRICAL WORKS
### TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Clause No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A)</td>
<td>Wiring</td>
</tr>
<tr>
<td>B)</td>
<td>Sub-Main Wiring</td>
</tr>
<tr>
<td>C)</td>
<td>Distribution Boards</td>
</tr>
<tr>
<td>D)</td>
<td>Telephone Wiring System</td>
</tr>
<tr>
<td>E)</td>
<td>Cabling for MATV System</td>
</tr>
<tr>
<td>F)</td>
<td>External Lighting</td>
</tr>
<tr>
<td>G)</td>
<td>Medium Voltage Cables</td>
</tr>
<tr>
<td>H)</td>
<td>Earthing</td>
</tr>
<tr>
<td>I)</td>
<td>Lightning Protection System</td>
</tr>
<tr>
<td>J)</td>
<td>HV Cables</td>
</tr>
<tr>
<td>K)</td>
<td>Bus Duct</td>
</tr>
</tbody>
</table>
A) WIRING

1.0 GENERAL

Technical specifications in this section cover item of wiring installations comprising of:

Point wiring including circuit wiring for light, fan and call bell points as also lighting and power convenience socket outlet points in concealed/surface conduit.

Submain wiring in concealed/surface conduit.

2.0 STANDARDS AND CODES

All equipments, components, materials and entire work shall be carried out in conformity with applicable and relevant Bureau of Indian Standards and Codes of Practice, as amended upto date and as below. In addition, relevant clauses of the Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable.

Equipments certified by Bureau of Indian Standards shall be used in this contract in line with government regulations. Test certificates in support of this certification shall be submitted, as required.

It is to be noted that updated and current standards shall be applicable irrespective of dates mentioned along with ISS’s in the tender documents.

650/1100 V grade PVC insulated wires. IS 694: 1990
Rigid MS Conduits for electrical wiring. IS 9537 Part –III (1983)
Flexible steel conduits for electrical wiring IS 3480: 1966
Switch socket outlets IS 4615: 1968
Switches for domestic and similar purposes IS 3854: 1966
Boxes for the enclosure of electrical accessories IS 5133: 1969
Code of Practice for Personal Hazard Fire Safety of Buildings IS 1644: 1960

Code of Practice for Electrical Installation Fire Safety of Buildings IS 1646: 1982

Code of Practice for Electrical Wiring Installations IS 732: 1989
3.0 CONDUITING:

3.1 MS Conduits

The electrical wiring shall be done in recessed MS Conduits, unless mentioned otherwise.

Conduit work shall be carried out using ISI marked medium grade MS Conduits conforming to IS:9537 Part -III. The interior of the conduit shall be free from obstructions.

No conduit less than 25 mm in diameter shall be used.

3.2 Installation of MS Conduits:

i) The erection of conduits of each circuit shall be completed before the cables are drawn in.

ii) All joints shall be sealed/cemented with approved solvent cement. Damaged conduit pipes/fittings shall not be used in the work. Cut ends of conduit pipes shall have not sharp edges nor any burrs left to avoid damage to the insulation of conductors while pulling them through such pipes.

iii) No bends shall be used which are formed either by bending the pipes by heating. All accessories such as bends, elbows or similar fittings etc. shall be of factory made only. Radius of bends in conduit pipes shall not be less than 7.5 cm. No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet. Care shall be taken while bending the pipes to ensure that the conduit pipe is not injured, and that the internal diameter is not effectively reduced.

3.2 PVC Conduits:

Wiring shall be carried out in recessed /surface PVC conduits. The PVC conduits conform to IS 9537 Part-III and shall be ISI embossed. The conduits shall be heavy gauge (minimum 2 mm wall thickness) and the interiors of the conduits shall be free from all obstructions. All joints in conduits shall be sealed/cemented with approved solvent cement. Damage conduits/fittings shall not be used. Cut ends of conduits shall not have sharp edges.

3.3 Bends:

As far as possible, the conduit system shall be so laid out that it shall obviate use of tees, elbows and sharp bends. No length of conduit shall have more than the equivalent of two quarter bends from inlet to outlet.
3.4 **Conduit Accessories:**

The conduit wiring system shall be complete in all respects, including their accessories.

Bends, couplers etc. shall be solid type in recessed type of works and may be solid or inspection type as required, in surface type of works. The accessories shall conform in all respects to the relevant ISS. Samples shall be got approved by EMPLOYER before use.

3.4.1 **Standard accessories**

Heavy duty black enamel painted standard conduit fittings and accessories like standard/extra-deep circular boxes, looping in boxes, junction boxes, PVC bends, PVC solid elbows, solid/inspection tees, couplers, nipples, saddles, check nuts, earth clips, ball socket joints etc. shall be of superior quality and of approved makes. Heavy duty covers screwed with approved quality screws shall be used. Superior quality screwed PVC bushes shall be used Samples of all conduits fittings and accessories shall be got approved by Project Manager before use.

3.4.2 **Fabricated accessories**

Wherever required, outlet/junction boxes of required sizes shall be fabricated from 1.6 mm thick MS sheets excepting ceiling an outlet boxes which shall be fabricated from minimum 3 mm thick sheets. The outlet boxes shall be of approved quality, finish and manufacture, Suitable means of fixing connectors etc. if required, shall be provided in the boxes. The boxes shall be protected from rust by zinc phosphate primer process. Boxes shall be finished with minimum 2 coats of enamel paint of approved cooler. A screwed brass stud shall be provided in all boxes as ear thing terminal.

3.4.2.1 **Outlet Boxes For Light Fittings**

These shall be minimum 75mmx75mm x50mm deep and provided with required number of threaded collars for conduit entry. For ceiling mounted florescent fittings, the boxes shall be provided 300 mm off centre for a 12mm fitting and 150 mm off centre for a 600 mm fitting so that the wiring is taken directly to the down rod. 3mm thick Perspex/ hylam sheet cover of matching colour shall be provided.

3.3.2.2 **Outlet Boxes For Ceiling**

Outlet boxes for ceiling fans shall be fabricated from minimum 3mm thick MS sheet steel. The boxes shall be hexagonal in shape of minimum 100mm depth and 60mm sides. Each Box shall be provided with a recessed fan hook in the form of one ‘U’ shaped 15mm dia rod welded to the box and securely tied to the top reinforcement of the concrete slab for a length of minimum 150 mm on either side. 3mm thick Perspex/ hylam sheet cover of matching colour shall be provided.

3.4.3 **Boxes For Modular Wiring Accessories**

3.4.3.1 **Switch Boxes Modular Type**

Switch boxes suitable to house modular type switches of required ratings, and fan regulators as required shall be provided in case the number of switches in one box is not tallying with that available in standard manufacture, the box accommodating the next higher umber of switches shall be provided without any extra cost. In case fan regulator/regulators is /are to be provided at a later dated, suitable provision for
Technical Specifications for Construction of Township

accommodating such regulators shall be made in the switch boxes and blank off covers shall be provided without any extra cost.

Switch boxes shall be so designed that accessories are mounted on a grid plate with tapped holes for brass machine screws leaving ample space at the back and on the sides for accommodating conductors, check nuts and screwed bushes at conduit entries etc. The grid plates and M.S. boxes shall be fitted with a brass earth terminal. Boxes shall be attached to conduits by means of inserting the conduits in the outlet boxes. Extra length of conduit shall be cut off inside the box with the help of cutting blade. Moulded front covers made from high impact resistant, flame retardant and ultra violet stabilized engineering plastics shall be fixed by means of counter sunk chromium plated brass machine screws. No timber shall be used for any supports. Switch boxes shall be located with bottom at 1200mm above floor level unless otherwise indicated.

3.4.3.2 Modular Type Boxes For Socket/Telephone/Call Bell Outlets

Outlet boxes shall be suitable for housing modular type switched socket outlets/ telephone outlets/ buzzers and any other outlet as required. These shall be so designed that accessories are mounted on a grid plate with tapped holes for brass machine screws leaving ample space at the back and on the sides for accommodating conductors. The grid plates and M.S. boxes shall be fitted with a brass earth terminal. Boxes shall be cut off inside the box with the help of cutting blade. Moulded front covers made from high impact, resistant, flame retardant and ultra violet stabilized engineering plastics shall be used to mount the outlets and shall be fixed to the outlet M.S. boxes by means of counter sunk chromium plated brass machine screws. No timber supports shall be used. Boxes shall be located at skirting level or bottom at 1200mm from floor or inside raceways on laboratory work tables. As indicated in drawings /or as directed.

3.5 Sheet Metal Outlet/Draw/Inspection/Junction Boxes.

3.5.1 General

Wherever required, outlet boxes of required sizes shall be fabricated from 1.6 mm thick MS sheets excepting ceiling fan outlet boxes which shall be fabricated from minimum 2 mm thick sheets. Outlet boxes shall be provided with minimum 16 mm projected threaded collars. The outlet boxes shall be of approved quality, finish and manufacture. All outlet boxes shall be provided with an earth stud. The boxes shall be protected from rust by zinc phosphate primer process. For concealed conduiting work, boxes with primer only could be embedded. For surface conduiting work, the boxes shall be finished with minimum one coat of enamel paint of approved colour. The outlet boxes shall be so protected at the time of fixing that no mortar find its way inside during concrete filling or plastering. For concealed conduiting work, outlet boxes shall be completely embedded in walls/ceilings leaving edges flush with finished wall/ceiling surface.

3.5.2 Switch/Socket Outlets Boxes - Modular Type

Boxes suitable to house modular type switches/sockets of required ratings, and fan regulators as required shall be provided. In case the number of switches in one box is not tallying with that available in standard manufacture, the box accommodating the next higher number of switches shall be provided without any extra cost. In case fan regulator/regulators is /are to be provided at a later stage, suitable provision for accommodating such regulators shall be made in the switch boxes and blank off covers
shall be provided without any extra cost. The outlet boxes shall be of MS having external and internal surface true to finish. All boxes shall have adequate number of knock out holes of required diameter and earth stud. Unless otherwise stated boxes shall be located with bottom at 1200 mm above finished floor level.

### 3.5.3 Outlet Boxes For Light Fittings.

These shall be minimum 75mm x 75mm x 50mm deep and provided with threaded collars for conduit entry as required. For ceiling mounted florescent fittings, the boxes shall be provided.

300 mm off centre for a 1200 mm fitting and 150 mm off centre for a 600 mm fitting so that the wiring is taken directly to the down rod. 3 mm thick perspex/hylam sheet cover of matching colour shall be provided.

### 3.5.4 Draw Boxes

Draw boxes of minimum 75mm x 75mm x 50mm deep or larger as required shall be provided at convenient locations to facilitate drawing of long runs of conductors. These shall have screwed covers of 3mm thick perspex/hylam sheet.

**Inspection Boxes / Junction Boxes**

Inspection boxes of minimum 75mm x 75mm x 50mm deep shall be provided at suitable location in conduit runs to permit inspection and maintenance. These shall have screwed covers of 3mm thick perspex/hylam sheet.

### 3.6 Cross Section

The conduits shall be of ample sectional area to facilitate simultaneous drawing of wires and permit future provision also. Total cross section of wires measured overall shall not normally be more than half the area of the conduit. Maximum number of PVC insulated 650/1100 Volt grade copper conductor wires conforming to IS : 694 – 1990 shall be as per table given below.

<table>
<thead>
<tr>
<th>Nominal Cross Sectional area of conductor in sq. mm</th>
<th>20 mm</th>
<th>25 mm</th>
<th>32 mm</th>
<th>38 mm</th>
<th>51 mm</th>
<th>64 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>S 5</td>
<td>B 4</td>
<td>S 10</td>
<td>B 18</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2.5</td>
<td>S 5</td>
<td>B 4</td>
<td>S 12</td>
<td>B 18</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>S 3</td>
<td>B 4</td>
<td>S 10</td>
<td>B 10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>S 2</td>
<td>B 4</td>
<td>S 6</td>
<td>B 8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>S 2</td>
<td>B 4</td>
<td>S 5</td>
<td>B 5</td>
<td>S 8</td>
<td>B 6</td>
</tr>
</tbody>
</table>

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Construction of Township at Khilpara, Udaipur, Tripura
Technical Specifications for Construction of Township

<table>
<thead>
<tr>
<th>Size (mm)</th>
<th>S</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>35</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>50</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>70</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Notes:

The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.

The columns headed 'S' apply to runs of conduits which have distance not exceeding 4.25 m between draw boxes and which do not deflect form the straight by an angle of more than 15 degrees. The columns headed 'B' apply to runs of conduit which deflect form the straight by an angle of more than 15 degrees. Conduits sizes are the nominal external diameters.

3.7 Laying of Conduits

Conduits shall be laid either concealed in walls and ceilings or on surface on walls and ceilings or partly concealed and partly on surface, as required. Same rate shall apply for concealed and surface conduiting in this contract.

3.7.1 Concealed Conduiting

Concealed conduits in concrete members shall be laid before casting, in the upper portion of slabs or otherwise as may be instructed, so as to embed the entire run of conduits and ceiling outlet boxes with a cover of minimum 12mm concrete. Conduits shall be adequately tied to the reinforcement to prevent displacement during casting at intervals of maximum 1 meter. No reinforcement bars shall be cut to fix the conduits. Suitable flexible joints shall be provided at all locations where conduits cross expansion joints in the building.

Concealed conduits in brick work shall be laid in chases to be cut by electrical Contractor in brick work before plastering. The chases shall be cut by a chase cutting electric machine. The chases shall be of sufficient width to accommodate the required number of conduits and of sufficient depth to permit full thickness of plaster over conduits. The conduits shall be secured in the chase by means of suitable clamps at intervals of maximum 1 meter. The chases shall then be filled with cement and coarse sand mortar (1:3) and properly cured by watering. Chicken wire mesh shall be used for closing the chases with cement plaster.

Entire concealed conduit work in concrete members and in brick work shall be carried out in close coordination with progress of civil works. Conduits in concrete members shall be laid before casting and conduits in brick work shall be laid before plastering. Should it become necessary to embed conduits in already cast concrete members, suitable chase shall be cut in concrete for the purpose. For minimizing this cutting, conduits of lesser diameter than 25 mm and outlet boxes of lesser depth than 50 mm could be used by the Contractor for such extensions only after obtaining specific approval from EMPLOYER. For embedding conduits in finished and plastered brick work, the chase would have to be made in the finished brick work. After fixing conduit in chases, chases shall be made good in most workmanlike manner to match with the original finish.

Cutting chases in finished concrete or finished plastered brick work for embedding conduits and outlet boxes etc shall be done by the Contractors without any extra cost.
3.7.2 Surface Conduiting

Wherever so desired, conduits shall be laid on surface over finished concrete and/or plastered brickwork. Suitable spacer saddles of approved make and finish shall be fixed to the finished structural surface along the conduit route at intervals not exceeding 600 mm. Holes in concrete or brick work for fixing the saddles shall be made neatly by electric drills using masonry drill bits. Conduits shall be fixed on the saddles by means of good quality heavy duty MS clamps screwed to the saddles by counter sunk screws. Neat appearance and good workmanship of surface conduiting work is of particular importance. The entire conduit work shall be in absolute line and plumb.

3.8 Painting of Conduits and Boxes

All draw/ switch/ junction/ fan-hook boxes shall be painted with red oxide/galvanized/zinc passivated in their manufactured form. All ungalvanized/ unplated boxes shall be again painted with red oxide paint as required before fixing. Boxes fixed on surface shall, in addition, be painted with finishing paint of approved colour and finish.

3.9 Protection of Conduits

To safeguard against filling up with mortar/plaster etc. all the outlet and switch boxes shall be provided with temporary covers and plugs which shall be replaced by sheet/plate covers as required. All screwed and socketed joints shall be made fully water tight with white lead paste.

3.10 Cleaning of Conduit Runs

The entire conduit system including outlets and boxes shall be thoroughly cleaned after completion of erection and before drawing in of cables.

3.11 Earthing

Continuous earth wire shall be provided for all points, outlets and sub-mains. Earthing terminals shall be provided inside all switch boxes, outlet boxes and draw boxes etc.

4.0 WIRES

4.1 Material

Wires shall be PVC insulated with stranded copper conductors, unless otherwise stated, of 650/1100 volt grade, conforming to IS : 694 - 1990. All wires shall bear manufacturer’s label and shall be brought to site in new and original packages. Manufacturer's certificate, certifying that wires brought to site are of their manufacture shall be furnished as required.
coaxial cables

The coaxial cables shall be of wideband type with operation up to 300 MHz capability. Aging resistance shall comply with DIM 472.52 part 2 e.i. maximum 5% increase in attenuation at 200 MHz measured by artificial aging (14 days at 800°C) cables shall meet all exceed following specifications.

- Center core Dia: 0.8mm
- Dielectric Dia: 4.8 mm
- Dielectric: PE
- Outer Conductor Dia: 5.4 mm
- Outer Dia: 7.0 mm
- Bending radius: more than 30 mm
- Impedance: 75 ohms
- D.C. Resistance: 50 ohms/KM
- Screening factor: more than 50
- Attenuation:
  - 50 Mhz: 6.5
  - 100 Mhz: 9
  - 200 Mhz: 13
  - 300 Mhz: 16

4.2 Bunching of Wires

Wires carrying current shall be so bunched in conduits that the outgoing and return wires are drawn into the same conduit. Wires originating from two different phases shall not be run in the same conduit.

4.3 Drawing of Wires

The drawing of wires shall be executed with due regard to the following:

- No wire shall be drawn into any conduit, until all work of any nature that may cause injury to wires is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire. Bushes shall be provided at conduit edges.

Before the wires are drawn conduits, conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction by forcing compressed air through the conduits if necessary.

While drawing insulated wires into the conduits, care shall be taken to avoid scratches and kinks which could cause breakage of conductors.

There shall be no sharp bends.

4.4 Termination /Jointing of Wires

Sub-circuit wiring shall be carried out in looping system. Joints shall be made only at distribution board terminals, switches/buzzers and at ceiling roses/connectors/lamp holders terminals of lights/ fans/ socket outlets. No joints shall be made inside conduits or junction/ draw/ inspection boxes.
For wiring of lighting circuits, looping of neutrals should be done preferably at switch board. Terminating strips should be used for neutral and live conductors. For connecting the switches to the terminating strips short length flexible PVC insulated wires should be used.

If looping of neutral at switch board is not feasible, then terminating strip should be used at junction boxes. Sizing of the junction boxes should be done accordingly.

Wiring conductors shall be continuous from outlet to outlet. Joints where unavoidable, due to any specified reasons shall be made by approved connectors. Specific prior permission from EMPLOYER in writing shall be obtained before making such joint.

Insulation shall be shaved off for a length of 15 mm at the end of wire like sharpening of a pencil and it shall not be removed by cutting it square or wringing.

Strands of wires shall not be cut for connecting terminals. All strands of wires shall be soldered at the end before connection.

Conductors having nominal cross sectional area exceeding 4 sq. mm shall always be provided with crimping sockets.

At all bolted terminals, brass flat washer of large area and approved steel spring washers shall be used.

Brass nuts and bolts shall be used for all connections.

The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less.

Switches controlling lights, fans, socket outlets etc. shall be connected to the phase wire of circuits only.

Only certified wiremen shall be employed to do wiring / jointing work.

4.5 Load Balancing

Balancing of circuits in three phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

4.6 Colour Code of Conductors

Colour code shall be maintained for the entire wiring installation - red, yellow, blue for three phases, black for neutral and green for earth.

5.0 SWITCHES/SOCKET OUTLETS

5.1 Switches

All 6 and 16 amps switches shall be of modular flush mounting type, unless otherwise stated, suitable for 250 volt AC supply, best quality and of approved make. The switch moving and fixed contacts shall be of silver nickel and silver graphite alloy and contact tips coated with silver. Housing of switches shall be made from high impact resisting flame retarding and ultra violet stabilized engineering plastic materials. Switches shall be
fixed inside the box on adjustable MS strips/plates with tapped holes brass machine screws, leaving ample space at the back and side for accommodating wires.

5.2 Combination Outlets:

6A 3 pin / 2 pin combination outlets mounted on switch boards along with other lighting control switches. Each such outlets will have a corresponding controlling switch mounted next to the outlet. Such outlets may be looped into the corresponding lighting circuit.

5.3 Socket Outlets

6/16 amps socket outlets shall be of modular flush mounting type, unless otherwise stated, and shall be switched, three pin type and fitted with automatic linear safety shutters to ensure safety from prying fingers. Socket outlets shall be made from high impact resistant, flame retarding and ultra violet stabilized engineering plastic material.

Switches and sockets shall be located in the same plate. Plates for 6 amp switched/unswitched power and telephone outlets shall be of the same size and shape.

An earth wire shall be provided along the wires feeding socket outlets for electrical appliances. The earth wire shall be connected to the earthing terminal screw inside the box. The earth terminal of the socket shall be connected to the earth terminal provided inside the box.

5.4 Flush Plates

Switches, socket outlets, receptacles, and telephone outlets etc., in walls shall be provided with moulded modular cover plates of approved colour, shape and size made from high impact resistant, flame retarding Polycarbonate and secured to the box with countersunk/round head chromium plated brass screws unless otherwise stated. Where two or more switches are installed together, they shall be provided with one common switch cover plate as described above with notches to accommodate all switches either in one, two or three rows.

One and two gang switch cover plate, telephone outlet cover plate, 6 and 16 amps switched/unswitched outlet plates, shall have the same shape and size. Three and four gang switch cover plates shall have the same shape and size. Six and eight gang switch cover plates shall have the same shape and size. Nine and twelve switch cover plates shall have the same shape and size. Wherever five switches, seven switches, ten switches and eleven switches are to be fixed the next higher size of gang switch cover plate to be used and extra openings shall be provided with blank-offs without extra cost.

5.5 Lighting Fixtures

Light fixtures and fittings shall be assembled and installed complete as required and ready for service, in accordance with details, drawings, manufacturer’s instructions and to the satisfaction of the EMPLOYER.

Wires brought out from junction boxes shall be encased in G.I. flexible pipes for connecting to fixtures concealed in suspended ceilings. Flexible pipes shall be provided with a checknuts at both ends.
Pendant fixtures specified with overall lengths are subject to change and shall be checked with site conditions and installed as required.

All suspended fixtures shall be mounted rigid and fixed in position in accordance with drawings, instructions and as approved by architect/Corporation.

Fixtures shall be suspended true to alignment, plumb, level and capable of resisting all lateral and vertical forces.

All suspended light fixtures, fans etc. shall be provided with concealed suspension arrangement in the concrete slab/roof members. Making provisions for such arrangements at the appropriate stage of construction is deemed to be included in contractors’ scope.

Exhaust fans shall be fixed at locations shown on the drawings. They shall be wired to a plug socket at a convenient location near the fan in flexible conduits.

All switch and outlet boxes, and fan regulators shall be bonded to earth with PVC insulated stranded copper wire as specified.

Wires shall be connected to all fixtures through connector blocks.

Flexible conduits, wherever used, shall be of make and quality approved by EMPLOYER.

### 6.0 POINT WIRING

#### 6.1. Measurement and payment

Wiring for light, ceiling fan, exhaust fan, socket outlet and telephone outlet points, carried out as per tender specification, shall be measured and paid on point basis only. No part of point wiring items shall be paid on linear basis. Rates quoted for point wiring items shall be based on parameters stipulated in para 6.2 below. Average wiring length and average conduiting length forming the basis of point wiring rates, shall take the electrical layouts of the entire project into consideration. Tenderers are advised to seek clarifications, if they so desired, on this aspects before submitting tenders. No claim for extra payment on account of electrical layouts in parts of projects requiring larger average wiring and conduit length per point, whether specifically shown in tender drawings or not, shall be entertained after the award of contract.

#### 6.2 Primary and Secondary light point wiring

In respect of group control of lights (more than one light controlled by one switch or MCB), wiring up to the in respect of group shall be measured and paid for as a primary light point. Wiring for other lights looped in one group for switch controlled as also MCB controlled lights shall be measured and paid for as secondary light points. For switch controlled lights shall include the cost of control switch whereas primary light points controlled by MCBs shall not include the switch cost. The cost of MCB shall be paid for in the item of DB.
The point wiring shall assume average wiring length and average conduiting length per point based on parameters stipulated in para 9.2 below. The average wiring length and average conduiting length forming the basis of point wiring payment shall take the electrical layouts of the entire project into consideration. Tenderers are advised to seek clarifications, if they so desire, on this aspect before submitting their tenders. No claim for extra payment on account of electrical layouts in part or whole of the project requiring larger average wiring and conduiting length per point, whether specifically shown in tender drawings or not, shall be entertained after the award of contract.

6.3 Parameters
Point wiring shall be carried out as per following parameters.

In concealed/surface conduit system unless otherwise stipulated.

Only looping system of wiring shall be adopted through-out.

All accessories shall be flush type unless otherwise stated.

For estimation of load, following loads per point shall be assumed.

<table>
<thead>
<tr>
<th>Light points</th>
<th>60 Watts.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 amps socket outlet points</td>
<td>100 Watts.</td>
</tr>
<tr>
<td>Fan points</td>
<td>60 Watts.</td>
</tr>
<tr>
<td>Exhaust fan points</td>
<td>150 Watts or as specified.</td>
</tr>
<tr>
<td>16 amp socket outlet points</td>
<td>1000 Watts.</td>
</tr>
</tbody>
</table>

Light points, fan points and 6 amp socket outlet points may be wired on a common final such circuit. Such circuit shall not normally have more than a total of 10 light, fan or socket outlets or a load of 800 watts unless otherwise is stipulated. Wiring from DB to the first switch in each sub circuit is defined as circuit wiring which shall be wired with one size higher wire.

Power circuits shall normally have maximum one 16 amps socket outlet unless otherwise stated. Separate circuit shall be run for each geyser, kitchen equipment, window air conditioners and similar appliances.

Point wiring rates shall include painting of conduits and other accessories as required.

Point wiring rates shall include cleaning of dust, splashes of colour wash or paint from all fixtures, fans, fittings etc. at the time of taking over of the installation.

Rates quoted for wiring for groups of more than one light controlled by one switch shall be on the same basis as above excepting that the cost of interconnection looping wiring between the first light and subsequent lights controlled by one switch shall also be included in the point wiring rate.

Wiring for DB controlled groups of lights shall be done through MCB directly from DB. Control switches are not required and cost of MCB is also not included in the point wiring rate since this cost is included in the item of DB. Rates quoted for the DB controlled groups of lights shall be on the same basis as for switch controlled groups excepting that the cost of switches shall not be included.
6.4  Point wiring definitions

6.4.1  Wiring for Light points

Point wiring for light points shall commence at the distribution board terminals and shall terminate at the ceiling rose/connector in ceiling box/fixture terminal via the control switch. Rates quoted shall be deemed to be inclusive of the cost of entire materials and labour required for completion of point wiring thus defined including:

a)  Conduiting system complete with all accessories, junction, draw/inspection boxes, bushes, check nuts etc. complete as required,

b)  Wiring with stranded copper PVC insulated 660/1100 volt grade wires for point wiring including circuit wiring (wiring from distribution board terminals to the first switch in the sub-circuit) and terminations etc. complete as required.

c)  Control switch with switch box and cover plate of specified type including fixing screws, earth terminal etc. complete as required

d)  Loop earthing with PVC insulated stranded copper wires complete as required.

Secondary Light points.

Secondary light points, as defined as above shall cover the cost of interconnection wiring between group controlled light fittings as shall be deemed to be inclusive of the cost of entire materials and labour for completion of the secondary light point thus defined including. Recessed/ surface conduiting system with all accessories, Junction/draw/inspection boxes, bushes, check nuts etc. complete as required, Wiring with stranded copper conductor PVC insulated 660/1000 volt grade wires including terminations etc. complete as required. Loop earthing with insulated copper wires

6.4.2  Wiring for Ceiling Fans

Wiring for ceiling fan points shall be same as for primary light points and shall in addition, include ceiling outlet box with recessed fan hooks.

6.4.3  Wiring for Exhaust Fans

Wiring for exhaust fan points shall be same as for primary light points and shall in addition include the cost of providing a 3/5 pin 6 amp socket outlet near the fan along with plug top and a 6 amp control switch at convenient location near the room entry.

6.4.4  Wiring for Call Bell Points

Wiring for call bell points shall be the same as for primary light points and shall in addition include the cost of a call bell/buzzer of approved type and make in the required location and a call bell in lieu of the control switch at a convenient location as required.

6.4.5  Wiring for Telephone Outlets

Wiring for telephone outlets points shall include the entire wiring and conduiting from the telephone tag block to the telephone outlet including the telephone outlet complete as required and as itemized in the schedule of Quantities.

6.4.6  Wiring for TV Outlets

Wiring for TV outlet points shall include the entire wiring and conduiting from the central point to the TV outlet including the TV outlet complete as required and as itemized in the Schedule of Quantities.
6.4.7 **Wiring for Convenience Socket Outlets**

3/5 pin 6 amps and 3/6 pin 16 amps single phase switched convenience socket outlets shall be provided in the building as indicated in the layout drawings. In addition, combined 3 pin 6/16 amps socket outlets at modular intervals in special PVC raceway over the work tables in laboratories shall be provided wherever required 20/32/50 amps single phase and 32/50 amps 3 phase outlets shall also be provided.

**Wiring for 3/5 pin 6 amps convenience socket outlets**

Point wiring for 3/5 pin 6 amps socket outlets (in locations other than over the laboratory work tables) on point wiring basis shall be the same as primary light point defined in para 8.3.1 and shall in addition include 3/5 pin 6 amp socket outlet with 6 amp control switch in MS box with cover. Including loop earthing or the third pin complete as required as itemized in scheduled of quantities.

**Wiring for 3/6 amps convenience socket outlets**

Point wiring for 3/6 pin 16 amps socket outlets (in locations other than over the laboratory work tables) on point wiring basis shall be the same as primary light point defined in para 8.3.1 and shall in addition include 3/6 pin 16 amp socket outlet with 16 amp control switch in MS box with cover including loop earthing of the third pin complete as required as itemized in scheduled of quantities.

6.4.8 **Exhaust fan point**

Wiring for exhaust fan points shall be same as for 5 pin 6 amp socket outlet point excepting that the socket outlet and the control switch shall not be in the same box. The socket outlet shall be located near the exhaust fan and the control switch shall be located near the light control switches of the room.

6.4.9 **SUB-MAIN WIRING**

Sub-main wiring shall comprise of stranded copper conductor PVC insulated 1100 volt grade wires in MS Conduits including loop earthing, terminations etc. complete as required.

Sizes of conduits, number/ type/size of wires and loop earthing shall be as stipulated in the schedule of quantities and/or drawings.

Wires shall be drawn in the concealed or surface conduits as required, without being damaged. For this purpose, draw boxes shall be located at convenient locations.

Every sub-main shall run in an independent conduit with an independent earth wire of PVC insulated stranded copper wire as specified running along the entire run of conduit. For single phase, one earth wire shall run and for three phase two earth wires shall run.

Necessary provision of wire lengths entering and emerging from the conduit shall be made for connections.

Measurement shall be taken of the actual conduit run containing the wires from one point to the other.
7. ROUTINE AND COMPLETION TESTS

7.1 Installation completion Tests

1. Wiring continuity test
2. Insulation resistance test
3. Earth continuity test
4. Earth resistivity test

Besides the above, any other test specified by the local authority shall also be carried out. All tested and calibrated instruments for testing, labour, materials and incidentals necessary to conduct the above tests shall be provided by the contractor his own cost.

7.2 Wiring Continuity Test

All wiring systems shall be tested for continuity of circuits, and earthing after wiring is completed an before installation is energized.

7.3 Insulation Resistance Test

The insulation resistance shall be measured between earth and the whole system conductors, or any section thereof with all protection in place and all switches closed except in concentric wiring all lamps in position of both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure provided that it does not exceed 1100 volt for medium voltage circuits. Where the supply is derived from AC three phase system the neutral pole of which is connected the earth, either direct or through added resistance, pressure shall be deemed to be that which is maintained between the phase conductor and the neutral. The insulation resistance measured as above shall not be less than 50 mega ohms divided by the number of point provided on the circuit the whole installation shall not have an insulation resistance lower than one mega ohm.

The insulation resistance shall be measured between all conductors connected to one phase conductor of the supply and be carried out after removing all metallic connections between he two poles of the installation and in those circumstances the insulation shall not be less than that specified above.

The insulation resistance between the frame work of housing of power appliances and all live parts of each appliance shall not be less than that specified in the relevant standard specification or where there is no such specification, shall not be less than half a mega ohm or when PVC insulated cables are used for wiring 12.5 mega ohms divided by the number of outlets. Where a whole installation in being tested a lower value than that given by the above formula subject to a minimum of 1 Mega ohms is acceptable.

7.4 Testing of Earth Continuity Path

The earth continuity conductor including metal conduits and metallic envelopes of cable in all cases shall be tested for electric continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance of earth leakage circuit breaker measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one ohm.
7.5 **Testing of Polarity Of Non-Linked Single Pole Switches**

In a two wire installation a test shall be made to verify that all non-linked single pole switches have been connected to the same conductor throughout, and such conductor shall be labeled or marked for connection to an outer or phase conductor or to the non earthed conductor of the supply. In the three of four wire installation, a test shall be made to verify that every non linked single pole switch is fitted to one of the outer or phase conductor of the supply. The entire electrical installation shall be subject to the final acceptance of the Project Manager as well as the local authorities.

7.6 **Earth Resistivity Test**

Earth resistivity test shall be carried out in accordance with IS Code of Practice for earthing IS 3043.

7.7 **Performance**

Should the above tests not comply with the limits and requirements as above the contractor shall rectify the faults until the required results are obtained. The contractor shall be responsible for providing the necessary instruments and subsidiary earths for carrying out the tests. The above tests are to be carried out by the contractor without any extra charge.

7.8 **Tests And Reports**

The Contractor shall furnish test reports and preliminary drawings for the equipment to the project Manager for approval before commencing supply of the equipment. The contractor should intimate with the tender the equipment intended to be supplied with its technical particulars. Any test certificates etc. required by the local inspectors or any other Authorities would be supplied by the Contractor without any extra charge All test reports shall be approved by the Project Manager prior to energizing of installation.
C) DISTRIBUTION BOARDS:

1.0 GENERAL

Distribution board shall be suitable for 415 volts, 3 phase AC supply or 230 volts single phase AC supply as required. Distribution boards shall generally conform to IS 2675 or BS 214. However, the specifications hereinafter described shall take precedence over the above wherever this specifications call for a higher standard or material or workmanship.

2.0 TYPE AND CONSTRUCTION

Distribution boards shall be of totally enclosed dead front type. The enclosure shall be made of CRCA sheet steel of not less than 2mm thickness. The sheet steel shall be folded and braced as necessary to provide a rigid supports for all components. The distribution boards shall comprise of miniature circuit breaker as incoming and required number of miniature circuit breakers as outgoings. The main and outgoings shall have rating as specified on the drawings and schedule.

3.0 BUS BARS

Suitable bus bars made of high conductivity copper strips and mounted on non-hygroscopic insulating supports shall be provided. The current density for bus bars shall not exceed 1.8 Amps/Sq.mm of cross section area. Ends of the bus structures shall also be shrouded.

4.0 CABINET DESIGN

The cabinet shall be stove enameled to gray shade finish. The interior surface shall be finished to an off-white shade. The interior components shall be mounted on a separate sheet steel which is mounted and locked on to the studs provided inside the cabinet. Over this, a cover made of hylam sheet or stove enameled sheet steel shall be provided with slots for operating handles of breakers. The cabinet shall be equipped with a front door having a spring latch and a vault lock. Cabinets shall have detachable gland plates at both top and bottom.

5.0 TERMINALS

Distribution boards shall be provided with a terminal block of adequate size to receive mains 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.

Earth bus for termination of earth wires and earthing studs shall be provided in the Distribution Board.

6.0 INSTALLATION

The distribution boards shall be suitable for surface mounting until and unless Bill of Quantities specifies recessed mounted Distribution Boards.

7.0 TESTING

Distribution boards shall be tested at factory as per IS 2675 or BS 214. The tests shall include insulation test, high voltage tests etc. Distribution boards shall be tested for insulation resistance after the erection. The Distribution boards shall be factory made as per the manufacturer.
8.0 MINIATURE CIRCUIT BREAKERS

The MCB's shall be of the completely moulded design suitable for operation at 240/415 Volts 50 Hz system. MCB's shall be quick make and break type conforming to relevant IS. Housing shall be heat resistant and have a high impact strength. MCB's shall be flush mounting type and shall be provided with trip free manual operating lever with ON/OFF indications.

MCB's shall be provided with magnetic thermal releases for overcurrent and short circuit protection. The overload or short circuit device shall have a common trip bar in case of DP and TPN MCB's. The MCB's shall have inverse time delayed thermal overload and instantaneous magnetic short circuit protection. The MCB time current characteristic shall coordinate with H.R.C. fuse/PVC cable characteristic.

The MCB's shall have a minimum breaking capacity of 10 kA at 230/415 volts in accordance with IEC : 898 - 1995 and IS : 8828 – 1996.

9.0 MOULDED CASE CIRCUIT BREAKERS

9.1 GENERAL

Moulded case circuit breakers shall be incorporated in the switch board wherever specified. MCCB shall conform to IEC:947-II or IS:13947-II in all respects. MCCB shall be suitable for three phase 415 volts AC. Suitable discrimination shall be provided between upstream and down stream breakers in the range of 10-20 milli seconds. All MCCBs will have earth fault module (if specifically asked) and front operated. All four pole MCCB shall be suitable for three phase four wire system, with the neutral clearly identified and capable of first make last break feature.

9.2 CONSTRUCTION

The MCCB cover and case shall be made of high strength heat-resistant and flame retardant thermosetting insulating material, operating handle shall be quick make/quick break. The operating handle shall have suitable 'ON' 'OFF' and 'TRIPPED' mechanical indicators notable from outside. All MCCBs shall have a common operating handle for simultaneous operation and tripping of all the three phases. The MCCB should be suitable for disconnection and isolation with marking on front name plate.

Suitable arc extinguishing device shall be provided for each contact. Tripping unit shall be thermal-magnetic type provided on each pole and connected by a common trip bar such that tripping of any one pole operates all three poles to open simultaneously. Thermal magnetic tripping device shall have IDMT characteristics for sustained overload and short circuits. All MCCBs above 250 Amps will also have short circuit magnetic pickup level adjustment.

All MCCBs shall have variable thermal overload releases which can be adjusted at site.

Contact tips shall be made of suitable arc resistant, sintered alloy for long electrical life. Terminals shall be of liberal design with adequate clearances. All MCCBs of higher ratings above 250 Amps, shall be provided with separate extended arcing contacts.
9.4 INTERLOCKING

Moulded case circuit breakers shall be provided with the following interlocking devices for interlocking the door of a switch board.

a) Handle interlock to prevent unnecessary manipulations of the breaker.

b) Door interlock to prevent the door being opened when the breaker is in ON or OFF position.

c) Defeat-interlocking device to open the door even if the breaker is in ON position.

9.5 BREAKING CAPACITY

The moulded case circuit breaker shall have a rated service. Short circuit breaking capacity of not less than 25 KA rms at 415 volts AC. Wherever required, higher breaking capacity breakers to meet the system short circuit fault shall be used.

9.6 ACCESSORIES

All the accessories like shunt, undervoltage contact blocks shall be of snap fitting possible at site.

9.7 TESTING

a) Original test certificate of the MCCB shall be furnished.

b) Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.
TELEPHONE WIRING SYSTEM:

1.0 SCOPE:

This section relates to specification for the supply, installation, testing & commissioning of works included in electrical section for telephone system.

The scope of work included in this section is as follows:

a) Supply and installation of cables/wires G.I. fabricated perforated cable trays for laying telephone from the telephone exchange room upto each floor. (Cable tray quantity covered in cabling works).

b) Providing & installing cable ladders in the telephone vertical duct from Ground floor upto 2nd floor in each block of the building (Quantity covered in cabling works).

c) Providing & installing MS/PVC conduits run from corridor to each office unit/Guest room to connect between cable tray & the telephone tag block.

d) Providing conduits for telephone wiring in the public areas with G.I. fish wire.

e) Providing & installing GI/PVC moulded boxes including plugin type telephone outlets in public/Guest office areas.

f) Providing & installing pipe sleeves for P&T incoming lines into the EPABX room if required.

The electrical contractor shall co-orderate with P & T and other agencies to finalize the exact requirement.

2.0 CONDUITING:

2.1 All concealed/surface installation including the conduit run above the false ceiling space shall be heavy gauge black enameled MS/PVC Conduit. The specification for materials & installation shall be same as described in electrical section. All relevant clauses are applicable for telephone system as well. The conduit for telephone system shall be installed minimum 20 cm away from the power conduit. Care shall be taken so that no telephone conduit is run in parallel to Electrical conduit in close proximity. Wherever telephone conduits cross power conduits, they shall be at right angle, to each other. All telephone conduits shall be earthed.

<table>
<thead>
<tr>
<th>Size of Cable</th>
<th>Conduit Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 5 pair</td>
<td>20 mm</td>
</tr>
<tr>
<td>Above 5 pair up to 10 pair</td>
<td>25 mm</td>
</tr>
<tr>
<td>Above 10 pair up to 20 pair</td>
<td>32 mm</td>
</tr>
<tr>
<td>2 Nos. 2 pair</td>
<td>20 mm</td>
</tr>
<tr>
<td>3 to 5 Nos. 2 pair</td>
<td>25 mm</td>
</tr>
<tr>
<td>6 to 10 Nos. 2 pair cable</td>
<td>32 mm</td>
</tr>
</tbody>
</table>

The size of conduit shall depend upon no. of wires to be drawn. However minimum size of conduits shall be 19/20 mm.
2.2 All telephone wires shall be 0.61 mm dia annealed tinned copper conductor PVC insulated and PVC sheathed cables. All telephone cables inside the building shall be un-armoured. Each outlet shall be wired with 2 pair cables from final tag unless otherwise specified separately. From main tag block to sub tag block cabling shall be done with suitable size of telephone un-armoured cable laid in conduit/pipe/ cable trays.

3.0 CABLE TRAYS:

The specification & installation method described in the other section of electrical specification shall be applicable.

4.0 BOXES & TELEPHONE OUTLETS:

All concealed boxes shall be of G.I. as described in the electrical wiring section & shall match with electrical wiring accessories. The boxes/main Junction box shall be suitable for wall mounting having opening for cable/ conduit entry. All PVC cable shall enter the telephone junction box from the bottom through brass cable glands and enough cable length shall be available for termination. Each PVC cable serving the telephone socket shall be marked for identification.

Junction boxes shall be fully enclosed, kept tight with lockable hinged doors.

Prior to the system installation the contractor shall consult telephone department for their requirements and notify the Construction manager/Consultants on the same. All equipment like tag blocks, wires shall be MTNL approved makes.

5.0 SUPPLY OF MATERIALS:

Exclusions:

a) Telephone Exchange & Telephone instruments.

b) Main incoming cable.

Rest all material for distribution of telephone system as covered in BOQ shall be in the Contractors scope.

The telephone outlet shall be plug-in (clip on) type socket outlet. The switch plate shall be similar to the electrical wiring devices.
E) **CABLING FOR MATV SYSTEM:**

1.0 The Co-axial shall be of wide band type with operation capability upto 500 MHz.

2.0 The ageing resistance of the co-axial cable shall comply with DIN 47252. Part 2, i.e. max. 5% increase in attenuation at 200 MHz measured by artificial ageing (14 days at 80 deg.C).

3.0 Cables shall meet or exceed the following specifications.

<table>
<thead>
<tr>
<th>Construction</th>
<th><strong>RG-6 MATV Type</strong></th>
<th><strong>RG-11 MATV Type</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Centre Conductor</td>
<td>18 AWG copper coated steel 18% conductivity</td>
<td>12 AWG copper coated steel 18% conductivity.</td>
</tr>
<tr>
<td>b. Dielectric</td>
<td>Foam polyethylene Nom. Dia. 0.180</td>
<td>Foam polyethylene Nom. Dia. 0.280</td>
</tr>
<tr>
<td>c. Shield</td>
<td>Foil – 0.003 Al. Tape Braid – 34 AWG 4 end Al. 60% coverage dia. 0.212</td>
<td>Foil – 0.003 Al. Tape Braid – 34 AWG 6 end Al. 60% coverage dia. 0.314</td>
</tr>
<tr>
<td>d. Jacket</td>
<td>Black PVC flame retardant dia. Over jacket 0.272 ± 0.008 Min. spot 0.023</td>
<td>Black PVC flame retardant dia. Over jacket 0.405 ± 0.010 Min spot 0.032.</td>
</tr>
</tbody>
</table>

**Electrical Properties**

| a. Dielectric Strength | Conductor to shield 2000 VDC | Conductor to shield 1500 VDC |
| c. Impedance | 75.0 ± 3.0 ohms | 75.0 ± 3.0 ohms |
| d. Attenuation | DB/100 ft. | DB/100 ft. |
| 0.65 DB at 5 MHz | 0.35 DB at 5 MHz |
| 0.76 DB at 10 MHz | 0.94 DB at 50MHz |
| 0.96 DB at 20 MHz | 1.28 DB at 100 MHz |
| 1.98 DB at 100 MHz | 1.78 DB at 200 MHz |
| 4.21 DB at 450 MHz | 2.20 DB at 300 MHz |
| 4.80 Db at 550 MHz | 2.75 Db at 450 MHz |
| 6.49 DB at 1000 MHz | 4.30 DB at 1000 MHz |
| e. Velocity of Propagation | 82.0% Nom | 92.0% Nom |
| f. DCR | 35.47 ohms/1000 ft. | 14.29 ohms/1000 ft. |
| g. SRL | 30 DB (10 MHz to 300 MHz) | 20 DB (5 to 450 MHz) |
4.0 **Directional Couplers**

4.1 These shall be of Ultra Wideband type and of hybrid circuit design.

4.2 These shall have a near flat frequency response over the entire operating range.

4.3 These shall have an aluminium cast housing for high frequency radiation resistance.

4.4 These shall have 'F' sockets for all input, output and branch ports.

4.5 The Tap offs shall be available in one way, two way and four way configurations.

4.6 The splitters shall be available in two way, three way and four way configurations.

4.7 The Tap offs shall be available in different tap values ranging from 11 dB, 15 dB, 20 dB, 25 dB and 30 dB.

4.8 These shall meet or exceed the following specifications:

<table>
<thead>
<tr>
<th></th>
<th>Tap offs</th>
<th>Splitters</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Tap Loss</td>
<td>11-30 dB</td>
<td>----</td>
</tr>
<tr>
<td>b) Through Loss</td>
<td>0.5-4 dB</td>
<td>4.0 – 8.0 dB</td>
</tr>
<tr>
<td>c) Isolation</td>
<td>&gt;22 dB</td>
<td>&gt; 22 dB</td>
</tr>
<tr>
<td>d) Screening Factor</td>
<td>&gt; 50 dB</td>
<td>&gt; 50 dB</td>
</tr>
</tbody>
</table>
F) **EXTERNAL LIGHTING:**

The specifications covers the supply, installation, testing and commissioning of the following items:

- Street/Boundary lighting poles complete with all accessories e.g. looping box, clamps and required hardwares etc.
- Street/boundary lighting fixtures complete with all accessories e.g lamps latest etc.
- Wiring of street light fixtures.
- Cable laying, earthing and inter connection
- Foundation of poles and erection.
- All the items should be tested and installed as per the latest Indian standards specifications and all the sundry items such as clamps, bolts, nuts, racks, support miscellaneous wiring etc., required to make the installation complete shall be taken care while quoting the major items.

a) **Steel Tubular pole**

The poles for street lighting purpose shall be complete in all respects and shall confirm to IS: 2713 unless otherwise specified. All poles shall be complete with base plate of 400 mm x 400 mm x 10 mm thick welded to bottom. The poles shall be provided terminal box for looping in and looping out of cables and shall consists fuse / MCB as specified. The looping box shall be suitable for outdoor installation and complete with all hardwares such as clamp, bolts, earthing studs, lockable door etc. and shall be paint also in the same manner as specified for poles. The poles shall be provided with two numbers of GI pipes of suitable dia for cable entry as shown in drawing. The poles shall be painted with two coats of red oxide primer on both outside and the portion of the pole below the ground before erection and two coats of aluminium paint of approved shade after erection over the exposed portion.

b) **Erection of pole**

While loading, transporting, unloading and erecting the poles care shall be taken so that the poles do not get bent. Out of shape and where necessary such defects shall be rectified before the poles are erected in position. The poles shall be erected in plumb line and correct level as indicated in the drawing and to the satisfaction of the Engineer-in-charge. They shall be kept in this position with the help of manila ropes until the foundation are constructed (for a minimum period of 10 days) and the back filling is complete. Foundation shall be made with reinforced cement concrete (1:2:4) and not less than 200 mm thick all round. The pole base plate shall be fixed over 150 mm thick concrete bed. Foundation shall be continued upto 300 mm or more above ground level as per location of the pole to avoid ingress of water logging etc. The foundation shall be tapered suitably into a collar. The excavated portion shall be filled back with earth and consolidated. The cement concrete foundations shall be cured properly by
covering the same with water soaked or moist gunny bags at least two weeks before loading the pole.

c) Erection of light fixtures

Each light fixture shall be connected to the supply through fuse/MCB of a suitable rating mounted in the looping box. The fitting shall be fixed to the pole properly and securely.

d) Wiring of light fixtures

The wiring of lighting fixtures from terminal block by means of 2.5 Sq.mm PVC insulated single core copper conductor through a suitable rated MCB/fuse and neutral. Cost of single core connecting cable from junction box to lighting fixture and earth wire complete with connections are included in the quoted rate.

e) Cabling works

All cable installation work shall be done as per relevant clauses of section cable work.

f) Tests

Before handing over the installation, tests on all fittings and cables shall be carried out as per IS specification.

The tests shall include:

a) Meggar test

b) Continuity test

c) Polarity test and phase sequence test
G) MEDIUM VOLTAGE CABLES

1.0 STANDARDS OF CODES

This chapter covers the specifications for supply and laying of Medium Voltage XLPE cables.

All equipments, components, materials and entire work shall be carried out in conformity with applicable and relevant Bureau of Indian Standards and Codes of Practice, as amended upto date. In addition, relevant clauses of the Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable.

2.0 DELIVERY, STORAGE AND HANDLING

Cables shall be delivered at site in original drums with manufacturer’s name clearly written on the drum.

Manufacturers recommendation particularly in respect of sealing shall be strictly followed.

Cable drum shall be stored on a well drained, hard surface, preferably of concrete, so that the drums do not sink in ground causing rot and damage to the cable drum. The cable drum shall conform to latest IS.

During storage, periodical rolling of drums, in the direction of arrow marked on the drum, shall be done once in 3 month through 90° C.

Both ends of cables shall be properly sealed to prevent moisture ingress.

Drums shall be stored in well ventilated area protected from sun and rain.

Drums shall always be rested on the flanges and not on flat sides.

Damaged battens of drums etc. shall be replaced.

Movement of drums shall always be in direction of the arrow marked on the drum.

For transportation over long distance, the drums shall either be mounted on drum wheels and pulled by ropes or they shall be mounted on trailers etc. drums shall be unloaded preferably by crane otherwise they shall be rolled down carefully on suitable ramps.

While transferring cable form 1 drum to another, the barrel of the new drum shall have diameter not less than the original drum.

Cables with kinks or similar visible defects like defective armouring etc shall be rejected.

Cables shall be supplied at site in cut pieces as per actual requirements.

3.0 CABLES
Medium voltage cables shall be aluminium conductor XLPE insulated, PVC sheathed armoured conforming to latest IS. Cables shall be rated for a 1100 Volts. The conductor of cables from 16 Sq. mm. to 50 Sq. mm. shall be stranded. Sector shaped stranded conductors shall be used for cables of 50 sq. mm and above. Conductors shall be made of electrical purity aluminium ¾ H or H temper.

Conductors shall be insulated with high quality PVC base compound. A common covering (bedding) shall be applied over the laid up cores by extruded sheath of un-vulcanized compound. Armouring shall be applied below outer sheath of PVC sheathing. The outer sheath shall bear the manufacturer’s name and trade mark at every meter length. Cores shall be provided with following colour scheme of XLPE insulation.

<table>
<thead>
<tr>
<th>Core</th>
<th>Colour Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Core</td>
<td>Red/Black/Yellow/Blue</td>
</tr>
<tr>
<td>2 Core</td>
<td>Red and Black</td>
</tr>
<tr>
<td>3 Core</td>
<td>Red, Yellow and Blue</td>
</tr>
<tr>
<td>3 ½ /4 Core</td>
<td>Red, Yellow, Blue and Black</td>
</tr>
</tbody>
</table>

4.0 LAYING OF CABLES

4.1 On Trays/Walls

4.1.1 Cable laying

Wherever so specified, cables shall be laid along walls/ceiling or on cable trays. Cable shall be secured in position and dressed properly by means of suitable clamps, hooks, saddles etc. such that the minimum clear spacing between cables is diameter of the cable. Clamping of cables shall be at minimum intervals as below.

<table>
<thead>
<tr>
<th>Type of cables</th>
<th>Size</th>
<th>Clamping by</th>
<th>Fixing intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>MV</td>
<td>Upto and including 25 sqmm</td>
<td>Saddles 1 mm thick</td>
<td>45 cm</td>
</tr>
<tr>
<td>MV &amp; HV</td>
<td>35 sq mm to 120 sq mm</td>
<td>Clamps 3mm thick 25mm wide</td>
<td>60 cm</td>
</tr>
<tr>
<td>MV &amp; HV</td>
<td>150 sq mm and above</td>
<td>Clamps 3 mm thick 40 mm wide</td>
<td>60 cm</td>
</tr>
</tbody>
</table>

Note: The fixing intervals specified apply to straight runs. In the case of bends, additional clamping shall be provided at 30 cm from the center of the bend on both sides.
4.1.2 Cable trays

Cable trays, of sizes as per schedule of quantities and drawings, shall be of doubled bend channel design unless otherwise stated. Cable trays shall be fabricated from minimum 2 mm thick perforated sheet steel and shall be complete with tees, elbows, risers, and all necessary hardware. Trays shall be galvanized or painted as specified. Cable trays shall be erected in perfect level and plumb and shall comply with the following:

Trays shall not have sharp edges, burrs or projections injurious to cable insulation.

Trays shall include fittings such as bends, risers etc. for changes in direction and elevation.

Trays shall be supported adequately at minimum 1 m distance from the building structure by means of painted/galvanized MS structural members secured to the structure by dash fasteners or by grouting. The entire cable tray system shall be rigid. Cost of support arrangement shall be included in the rates quoted for supply and installation of trays. Complete details of this support arrangement shall be shown in shop drawings to be prepared by the Contractors and submitted for Project Manager approval before execution. Works shall be carried out only as per approve shop drawing.

Each run of cable tray shall be completed before laying of cables.

Cable trays shall be exposed and accessible.

4.2 Buried Directly In Ground

4.2.1 Routing of the Cable Runs

Before cable laying work is undertaken, the route of the cables shall be decided in consulting with the Project Manager.

While shortest practicable route shall be preferred, cable runs shall follow fixed development such as roads, footpaths etc with proper off-sets so that future maintenance and identification are rendered easy.

Whenever cables are laid along well demarcated or established roads, the LV/MV cables shall be laid further from the kerb line than HV cables.
Cables of different voltages and also power and control cables shall be kept in different trenches with adequate separation. Where available space is restricted, LV/MV cables shall be laid above HV cables.

Where cables cross one another, the cables of higher voltage shall be laid at a lower level than the cables of lower voltage.

Power and communication cables shall as far as possible cross at right angles. Where power cables are laid in proximity to communications cables the horizontal and vertical clearances shall not normally be less than 60 cm.

4.2.2 Route Markers

Route markers shall be provided along straight runs of the cables at locations approved and generally at intervals not exceeding 25 meters.

Markers shall also be provided to identify change in the direction of the cable route and also for location of every underground joint.

Route markers shall be made out of 100mm x 100mm x 5mm GI/aluminium plate welded or bolted onto 35 mm x 35 mm x 6 mm angle iron 600 mm long dully painted with anti-corrosive paint. Such plate markers shall be mounted parallel to and 300 mm or so away from the edge of the trench/pipe/duct.

They shall be embedded in cement concrete 1:2:4 (one cement, 2 coarse sand : 4 graded stone aggregate of 30 mm normal size).

The word "Cable" and other details such as voltage grading, size etc as required shall be painted on the marker.

4.3 Laying of Cables in Floors

Laying of cables directly in floors shall be avoided and GI pipes of adequate size shall be used wherever necessary. However if the cables have to be laid direct in the floor specific written approval of Project Manager shall be obtained and the Contractor shall cut chases, lay the cables and make good the chases to original finish.
4.4 **Cable Entry Into Buildings**

Cable entry into buildings shall be made through RCC pipes recessed in the floor. RCC Hume pipes shall be provided well in advance for service cable entries. The pipe shall be filled with sand and sealed at both ends with bitumen mastic to avoid entry of water. Suitable size manholes shall be provided wherever required to facilitate drawing of cables as per requirements.

4.5 **Cable Joints**

Cable joints shall be resorted to and permitted only if length of cable run is more than standard cable drum length. Cable joints shall not be permitted in any other circumstances. Wherever unavoidable these joints shall be made with specific approval of Project Manager, and shall from a part of cable run.

4.6 **Measurement of Cable Runs**

The cable runs shall be measured upto the outer end of the boxes without any allowances for over lap in joints. The actual run of the cables shall be measured and the rate shall include all the above mentioned material, labour etc for laying as required.

4.7 **Cable Loops**

At the time of the installation approximately 3 meters of surplus cable shall be left as below or as directed by Engineer.
- at each end of the cable
- on each side of underground straight through/tee/termination joints.
- at entries to buildings

This cable shall be left in the form of a loop.

Wherever long runs of cable length are installed cable loops shall be left at suitable intervals as specified by the architect/clients.

5.0 **TERMINATION/JOINTING OF CABLES**

Soldered jointing/termination shall be totally avoided. Solderless terminations by using Dowel crimping tools and suitable lugs shall be adopted for all cable terminations. **Double compression brass glands shall be used.** Any termination without use of proper crimping tool shall be liable to be rejected.
In the case of aluminium conductors, it is to be ensured that the conductor oxidation is cleaned by means of emery paper and then a thin coat of tin is applied before pinching into any equipment.

6.0 TESTING

6.1 Tests At Manufacturer’s Works

6.1.1 Type tests
Cables shall be subjected to type tests and acceptance test at manufacturers work as per latest IS code carried out in accordance with appropriate parts of latest amended upto date. Copies of the type test reports shall be furnished.

6.1.2 Routine test
Cables shall be subjected to routine test as per latest IS code.

a) Conductor resistance test
b) High voltage test at room temperature.

Copies of routine tests carried out at manufacturers works shall be furnished alongwith the cables

6.2 Testing at Site

6.2.1 Before laying
All cables before laying shall be pressure tested for one minute with 1000 volts megger. Cable cores shall be tested for continuity, absence of cross phasing, insulation resistance to earth/sheath/armour and insulation resistance between conductors

6.2.2 After laying
After laying and jointing, cables shall be subjected to a 1.5 minutes AC/DC pressure test.
H) EARTHING

1.0 STANDARDS

IS 3043 1987 alongwith Rules Regulations, Directives, and Specifications stipulated in para 6.3 of these specifications shall apply.

2.0 GENERAL

All the non-current carrying metal parts of electrical installation shall be earthed properly. All metal conduits, trunking, cable sheaths, switchgear, distribution fuse boards, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All earthing shall be in conformity with Indian Electricity Rules.

The Earthing System shall in totally comprise the following:-

a) Earth Electrodes
b) Earthing Leads
c) Earth Conductors

All three phase equipment shall have two separate and distinct body earths and single phase equipment shall have a single body earth.

3.0 EARTHING MATERIAL

Materials of which the protective system is composed shall be resistant to corrosion or be adequately protected against corrosion. The material shall be as specified in the schedule of quantities and shall comply to the following requirements:

a) Copper - When solid or stranded copper wire is used it shall be of the grade ordinarily required for commercial electrical work generally designated as being of 98% conductivity when annealed, conforming to Indian standard specifications.

b) Galvanised Steel - Galvanised steel used shall be thoroughly protected against corrosion by hot dipped Zinc coating. The material coating shall withstand the test specified in IS 2309:1969.

c) The strips to be used shall be in maximum lengths available as manufactured normally avoiding unnecessary joints.

4.0 EARTH ELECTRODES

PLATE EARTH ELECTRODE

The plate electrodes shall be of copper/ GI as called for in the schedule of quantities. The minimum dimensions of the electrodes shall be 600 mm x 600 mm. Thickness of copper electrodes shall not be less than 3 mm and of GI electrodes not less than 6 mm.

The electrode shall be buried in ground with its face vertical and top not less than 3 metres below ground level.
**EARTH ELECTRODE PIT**

**METHOD OF INSTALLING WATERING ARRANGEMENT**

In the case of plate earth electrode, a watering pipe of 50 mm dia of medium class G.I. Pipe shall be provided and attached to the electrode. A funnel with mesh shall be provided at the top of this pipe for watering the earth. The watering funnel attachment shall be housed in masonry enclosure of not less than 1000 x 500 x 500 mm. A cast iron/M.S. frame with cover having locking arrangement shall be suitably embedded in the masonry enclosure.

**LOCATION OF EARTH ELECTRODE**

The following guidelines shall be followed for locating the earth electrodes

An earth electrode shall not be situated less than 1.5 metres from any building.

The excavations for electrode shall not affect the column footings or foundations of the buildings. In such cases electrode may be further away from the building.

The location of the earth electrode shall be such where the soil has reasonable chance of remaining moist, as far as possible.

Entrances, pavements and road ways shall not be used for locating the earth electrode.

**NUMBER OF EARTH ELECTRODES**

In all cases the relevant provision of rule 33, 61 & 67 of the Indian Electricity Rules 1956 as amended shall be complied with.

Metallic covers or supports of all medium or H.T. apparatus or conductors shall, in all cases be connected to not less than two separate and distinct earth electrodes.

**5.0 EARTHING LEADS**

The strip earthing leads shall be connected to the Earth Electrode at one end and to the metallic body of the main equipment at the other end. The earthing lead shall connect to the earthing network in the installation.

**EARTHING LEAD SIZES**

Strip earthing leads shall be of copper/GI and as per specifications.

**EARTHING LEAD INSTALLATION**

The length of buried strip earthing lead shall be not less than 15 metres and shall be buried in trench not less than 0.5 m deep.

If conditions necessitates use of more than one earthing lead they shall be laid as widely distributed as possible preferably in a single straight trench or in a number of trenches radiating from one point.
METHOD OF CONNECTING EARTHING LEAD TO EARTH ELECTRODE

In the case of plate earth electrode the earthing lead shall be securely bolted to the plate with two bolts, nuts, checknuts and washers as required by IS 3043 : 1987.

All materials used for connecting the earth lead with electrode shall be GI in case of GI Pipe and GI plate earth electrodes or tinned brass in case of Copper plate electrode.

PROTECTION OF EARTHING LEAD

The earthing lead from electrode onwards shall be suitably protected from mechanical injury and corrosion by a

15 mm dia GI pipe in case of wire and
100/40 mm dia medium class GI Pipe

The portion of the G.I. pipe within ground shall be buried at least 30 cm deep (to be increased to 60 cm in case of road crossing or pavements). The portion within the building shall be recessed in walls and floors to adequate depth.

6.0 EARTHING CONDUCTORS

Earthing conductors shall form the earthing network throughout the installation for earthing of all non-carrying metal parts.

CONNECTION OF EARTHING CONDUCTORS

a) Main earthing conductors shall be taken from the earth connections at the main switch boards to all other switchboards in the network.

b) Sub-mains earthing conductors shall run from the main switch board to the sub distribution boards and to the final distribution boards.

c) Loop earthing conductors shall run from the distribution boards and shall be connected to any point on the main/sub-main earthing conductor, or its distribution board or to an earth leakage circuit breaker.

d) Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to switch boards at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing, Switches, accessories, lighting fitting etc shall be effectively connected to the Loop Earthing Conductors. These though rigidly secured in effective electrical contact with a run of metallic conduit shall not be considered earthed, even though the run of metallic conduit is earthed.

e) No joints shall be allowed in the protective conductors. The same must be directly terminated at metallic switch board / distribution boxes.

f) All terminations shall be made on studs/earth terminal blocks with the use of terminating lugs and double check nuts of appropriate sizes.

EARTHING CONDUCTOR INSTALLATION
The earthing conductors inside the building wherever exposed shall be properly protected from mechanical injury by running the same in GI pipe of adequate size.

Joints shall be revetted and brazed in approved manner.

Sweated lugs of adequate capacity and size shall be used for termination. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substances and properly tinned.

**SIZING OF EARTHING CONDUCTORS**

All fixtures, outlet boxes and junction boxes shall be earthed with 14 SWG copper/12 SWG GI wire.

All 3 phase switches and distribution boards upto 60 amps rating shall be earthed with 2 Nos. distinct and independent 4 mm dia copper/6 mm dia GI wires. All 3 phase switches and distribution boards upto 100 amps rating shall be earthed with 2 Nos. distinct and independent 6 mm dia copper/8 mm dia GI wires. All switches, bus bar, ducts and distribution boards of rating 200 amps and above shall be earthed with a minimum of 2 Nos. separate and independent 25 mm x 3 mm copper/25mm x 6 mm GI tape.

**7.0 PROHIBITED CONNECTIONS**

Neutral conductor, sprinkler pipes, or pipes conveying gas, water, or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lighting protection system conductors shall not be used as a means of earthing an installation or even as a link in an earthing system.

**8.0 RESISTANCE TO EARTH**

No earth electrode shall have a greater ohmic resistance than 1 ohms as measured by an approved earth testing apparatus. In rocky soil the resistance may be upto 5 ohms. The electrical resistance measured between earth connection at the main switchboard and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate fuses or circuit breakers, and shall not exceed 1 ohm.
I) LIGHTNING PROTECTION SYSTEM

1.0 STANDARDS

The following Indian Standard Specifications and Codes of Practice will apply to the equipment and the work covered by the scope of the Contract. In addition the relevant clauses of the Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended upto date shall apply. Wherever appropriate Indian Standards are not available relevant British and/or IEC Standards shall be applicable.

BIS certified equipment shall be used as a part of the Contract in line with Government regulations. Necessary test certificates in support of the certification shall be submitted prior to supply of the equipment.

It is to be noted that updated and current Standards shall be applicable irrespective of those listed below.

Code of Practice for the Protection of buildings and Allied Structures against Lightning IS 2309 : 1989
Code of Practice for Earthing IS 3043 : 1987

2.0 GENERAL

The Lightning Protective System shall comprise of Air Terminations, Down Conductors, Earth Terminations etc as required. The System shall preferably use the same conducting material throughout and will comply to the detailed specifications detailed hereinafter.

The entire lightning system should be mechanically strong to withstand the mechanical forces produced in case of a lightning stroke.

3.0 MATERIALS

The materials of which the protective system is composed shall be resistant to corrosion or be adequately protected against corrosion. The material shall be as specified in the Schedule of Quantities and shall comply to the following requirements:

- Copper - When solid or stranded copper wire is used it shall be of the grade ordinarily required for commercial electrical work generally designated as being of 98% conductivity when annealed, conforming to Indian Standard Specifications.

- Galvanised Steel - Galvanised steel used shall be thoroughly protected against corrosion by hot dipped Zinc coating. The material coating shall withstand the test specified in IS 2309:1968.

- The strips to be used shall be in maximum lengths available as manufactured normally avoiding unnecessary joints.
4.0 AIR TERMINATIONS

4.1 Vertical Air Terminations

Vertical air terminations shall comprise of finials made of 25 mm dia GI tube with single or multiple prongs at the top. Vertical terminations where provided shall project 30 cms above the project salient point or net work on which it is fixed.

4.2 Horizontal Air Terminations

Horizontal air terminations should be so interconnected that no part of the roof is more than 9 m away from the nearest horizontal conductor. For a flat roof horizontal air termination along the outer perimeter of the roof is to be used. For a roof of larger area a net work of parallel horizontal conductors shall be installed. Horizontal air terminations should be coursed along contours such as ridges, parapets and edges of the flat roofs and where necessary over flat surfaces in such a way as to join each air termination to the rest and should themselves form a closed network.

All metallic finials, chimneys, duct, vent pipes, railings, gutters, and the like on or above the main surface of the roof of the structure should be bonded to and form part of the air termination network.

5.0 DOWN CONDUCTORS

The Down Conductors shall be of material as specified in the Schedule of Quantities. These shall be distributed around the outside walls of the structure and shall preferable be run along the corners and other projections. Lift shafts shall not be used for fixing the Down Conductors.

The routing of the Down Conductors shall be such that it is accessible for inspection, testing and maintenance.

6.0 TESTING JOINTS AND BENDS

The lightning protective system should have as few joints in it as possible.

Wherever joints in the down conductor above ground level are necessary they shall be mechanically and electrically effective.

In the down conductor below ground level there shall be no joints.

The joints may be clamped, screwed, bolted, rivetted, sweated braced or welded. Bolted joints should be used on test points or on bonds to existing metal.

Each down conductor should be provided with a testing joint in a position convenient for testing but inaccessible for interference.

7.0 FASTENERS

Conductors shall be securely attached to the building by fasteners which shall be substantial in construction, not subject to breakage.
These shall be of galvanised steel or other suitable materials with suitable precautions to avoid corrosion.

The method and nature of the fixing should be simple, solid and permanent. The lightning conductors shall be secured at not more than 1.20 m apart for horizontal run and 1.00 m for vertical run.

8.0 EARTH TERMINATION

Each down conductor shall have an independent earth termination and all earth terminations should be interconnected.

9.0 EARTH ELECTRODES

Earth electrodes shall be constructed and installed as laid down in the IS 3043.

9.1 Plate Earth Electrode

The plate electrodes shall be of Copper or G.I. as called for in the Bill of Quantities. The minimum dimensions of the electrode shall be G.I. 600 mm x 600 mm x 6 m thick and for Copper 600mm x 600mm x 3mm.

The electrode shall be buried in ground with its face vertical and top not less than 3 m below ground level.

9.2 Earth Electrode Pit

In the case of plate earth electrode, a watering pipe of 20 mm dia of medium class G.I. Pipe shall be provided and attached to the electrode. A funnel with mesh shall be provided at the top of this pipe for watering the earth. The watering funnel attachment shall be housed in masonry enclosure of not less than 300 x 300 x 300 mm. A cast iron/M.S. frame with cover having locking arrangement shall be suitably embedded in the masonry enclosure.

9.3 Location Of Earth Electrode

The following guidelines shall be followed for locating the earth electrodes

- An earth electrode shall not be situated less than 2 metres from any building.

- The excavations for electrode shall not affect the column footings or foundations of the buildings. In such cases electrode may be further away from the building.

- The location of the earth electrode shall be such where the soil has reasonable chance of remaining moist, as far as possible.

- Entrances, pavements and road ways shall not be used for locating the earth electrode.
10.0 EARTH RESISTANCE

The whole of the lightning protective system should have a combined resistance to earth not exceeding 1.0 ohms before any bonding has been effected to metal or on a surface or to surface below ground.

J) H.V. CABLES:

1.0 GENERAL:

The cables shall be supplied, inspected, laid, tested and commissioned in accordance with Drawings, Specifications, Indian Standard Specifications as per latest IS and cable manufacturers instructions. The cables shall be of reputed make.

The recommendations of the cable manufacturer with regard to jointing and sealing shall be strictly followed. The installation of cables shall be done by an approved, qualified and experienced person in this trade.

2.0 MATERIAL:

The H.V. cables shall be 11 KV, aluminium conductor CROSS LINKED POLY-ETHYLENE steel tape armoured cable laid underground and or in masonry trenches as shown on Drawings. The conductor shall be made of Electrical purity aluminium wires and stranded together and compacted. The cable shall be of 3 Core type. The insulation shall be of high quality cross linked polyethylene applied by extrusion process. Both conductor and the insulator are provided with shielding made of Semi Conducting compound. Armouring is applied over inner sheath and shall be of flat steel strips. The outer sheath shall be of heat resisting tropodur (PVC) compound. This shall be of black colour.

3.0 INSPECTION:

All cables shall be inspected upon receipt at site and checked for any damage during transit.

4.0 JOINTS IN CABLES:

The contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilisation and avoidance of jointing cable. This apportioning shall be got approved by the Owner/Consultant before the cables are cut to lengths. Where joints are unavoidable, the location of such joints shall be got approved by the Owner/Consultants.

5.0 JOINTING BOXES FOR CABLES:

Cable joint boxes shall be of appropriate size, suitable for aluminium conductor XLPE insulated cables of 11000 volts ratings, and shall be manufactured by CCI & Indian Cable Corporation or approved equal.

6.0 JOINTING CABLES:

All cable joints shall be made in suitable, approved cable joint boxes. Jointing of cables in the joint boxes and the filling in of compound shall be done in accordance with the
best practice in trade, in accordance with manufacturer's instructions and in an approved manner. All straight T-joints shall be done in epoxy mould boxes with TROPOLIN/M-SEAL epoxy resin or approved equal. All jointing accessories shall also be manufactured by Indian Cable Corporation/CCI or approved equal. All terminal ends of conductors shall be heavily soldered up to at least 50mm length.

All cables shall be jointed colour to colour and tested for continuity and insulation resistance before jointing commences. The seals of cables must not be removed until preparations for jointing are completed. Joints shall be finished on the same day as commenced and sufficient protection for the weather shall be arranged. Joints shall be made by means of suitable solder for conductors, the conductors being firmly butted into the connections or thimbles or ferrules and the whole soldered with proper solder and soldering flux or resin. The conductors shall be efficiently insulated with high voltage insulating tape and use of spreaders of approved size and pattern. The joints shall be completely filled with epoxy compound being topped as necessary to ensure that the box is properly filled.

7.0 CABLE TERMINATIONS:

Cable termination shall be done in terminal cable box using cable glands and the cable ends sealed with sealing compound. The cable boxes of transformers shall be filled with bituminous compound manufactured by CCI or approved equal.

8.0 BONDING OF CABLES:

Where a cable enters any piece of apparatus, it shall be connected to the casing by means of an approved type of armoured clamp and gland. The clamps must grip the armouring firmly to the gland or casing, so that in the event of ground movement no undue stress is passed into the cable conductors.

9.0 LAYING OF CABLES:

H.V. cables shall be laid either buried directly underground or in Masonry/Concrete trenches. The cable buried underground shall be at minimum depth of 1.2 mtr. from the ground level. Sand cushion of not less than 80mm shall be provided both above and below the cable with a protective concrete slab on the top of the sand layer. The cable trench shall be back filled and compacted.

10.0 PROTECTION OF CABLES:

The cable shall be protected by placing precast reinforced 50mm, thick (1:2:4) concrete slabs 200mm wide on the top layer of sand for the length of the cable. Where more than one cable is running in the same trench, the concrete blocks shall cover all the cables and shall project minimum 80mm on either side of the cables.

Cables under road crossings and any surfaces subjected to heavy traffic, shall be protected by running them through Hume pipes of suitable size.

11.0 EXCAVATIONS AND BACK FILL:

All excavations and back fill including timbering, shorting and pumping required for the installation of the cables shall be carried out by the Contractor in accordance with the drawings and requirements laid down elsewhere. Trenches shall be dug true to
Technical Specifications for Construction of Township

line and grades. Back fill for trenches shall be filled in layers not exceeding 150 mm. Each layer shall be properly rammed and consolidated before laying the next layer. The contractor shall restore all surfaces, roadways, side walks curbs, walls or other works cut by excavation to their original condition, satisfactory to the Owner/Consultants.

12.0 MARKERS AND WARNING PLATES:

Approved C.I. cable markers shall be provided along the route of the cable at every 30 M distance and at both ends of road crossing, indicating H.V. cables. Special C.I. markers shall be provided at all buried cable joints indicating Electrical cable joint.

13.0 TESTING OF CABLES:

Prior to burying cables, following tests shall be carried out:

a) Insulation between phases and between phase and earth for each length of cables, before and after jointing.

b) For H.V. cables, high voltage test by applying 17.5KV DC voltage for 15 minutes for each core and earth.

On completion of cable laying work, the following tests shall be conducted in the presence of the Owner/Consultants.

a) Insulation Resistance Test (sectional and overall)

b) Continuity resistance test.

c) Sheathing continuity test.

d) Earth test.

All tests shall be carried out in accordance with relevant Indian standard code of practice and Electricity Rules. The contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests.
K) BUS DUCT:

1.0 SCOPE

This specification covers the technical requirements of Design, manufacture, test at works, supply of 415V, LT Bus bar trunking.

2.0 STANDARDS

The equipment covered by this specification shall unless otherwise stated, be designed, constructed and tested in accordance with the latest revisions of relevant International standards.

3.0 GENERAL

Metal enclosed, Low impedance, air insulated type aluminum conductors Bus bars.

Bus bar trunking system shall have nominal current rating up to 4000 Amp, and shall be supplied for the Sub Distribution of Electrical energy.

Bus bar trunking shall have provision for plugging of tap off boxes into the live busbar and designed for feeding to industrial machines and equipment supply.

These systems shall be installed at building truss level and fixed to the lower beams of the roof structure.

The supply of support materials like clamps, steel channel etc., shall also be included in the scope of this tender.

Bus bar trunking enclosure shall be dust and vermin proof, rectangular in cross section and shall be fabricated out of 1.5 mm thick GI sheet. It shall be rigid and robust in construction and shall be treated to prevent any possibility of corrosion. Joints in the enclosure shall be bolted and shall be provided with neoprene gaskets. All retaining catches, screws, bolts and nuts etc. Bus bar trunking shall be manufactured in standard lengths of 3.0 Mts. With arrangements for 2 to 3 tap off in 3 meter length.

4.0 BUSBAR SYSTEM

The BusBar systems shall be produced and tested as “type-tested Switchgear combinations” (TCS), and shall be equipped with fully covered connectors having at least four poles for plug-in tap off boxes.

The Busbars shall be Air Insulated type and made up of Aluminum. The Busbars shall have a continuous current rating as mentioned in Particular Specification and shall have fault withstand capacity of 36 KA/ 1Sec(rms) to 150 kA/ 1sec (rms) for 1 Sec depending on the current rating of bus bar.

The Bus Bar surface shall be tinned, with the contact and butt connection points silver plated. The individual conductors shall have a high quality, heat-resistant insulation rated for conductor.

In their functional position, they shall be horizontally pluggable, on edge or flat, and in each position they shall be operable at continuous nominal current and at an ambient temperature of 40°C the type of protection shall be upto IP-54/66 with accessories.
The cross section of neutral conductor should be same as phase conductor.

**INSULATION**

The bus bar should be insulated by glass reinforced polyester, B class insulation and Mylar tape throughout its entire length except tap off points.

4.1 **Feeding System**

All busbar systems shall be equipped with a central, or end feeder cabinet for suitably rated ACB.

Necessary extension chambers for easy terminations of incoming cable shall also be provided.

4.2 **Expansion Joints**

The bus bar systems shall be equipped with standard expansion joints or with expansion bolts in each unit length to compensate thermal elongation of the busbars.

As far as local conditions permit, the longest busbar unit lengths shall be used to minimize electrical losses at the butt or bolted connections of the busbars.

4.3 **Accessories**

All suspension fixings shall be fully tested and approved exclusively as suitable for the installation with particular regard to ambient temperature, environment and loading.

The bus system shall be assembled from standard approved components completed at the factory and suitable for the application. Fully certified fireproof bulkheads shall be incorporated within horizontal and vertical section direction changes and where the system penetrates fire rated sections of the building.

5.0 **EARTHING**

Bus bar trunking enclosure shall be earthed by a continuous copper / aluminium earth bar as mentioned in BOQ, running on the outside of the enclosure throughout the entire length of the Bus bar trunking.

Earth connection shall be brought to the end feed box to from connection to the 5 core incoming cable.

6.0 **TESTS**

Bus bar trunking shall be completely assembled, adjusted and tested for operation under stimulated conditions to ensure proper functioning of all equipments.
6.1 TYPE TESTS
The Bidder shall furnish two (2) sets of type test certificates for all the tests conducted on similar equipment.

1. Short time current test.
2. Temperature Rise Test

6.2 Routine Tests
1. Mechanical operation test
2. Dielectric tests

6.3 Drawings and Documents
The following drawings and documents shall be furnished in six (6) copies within (3) three weeks of receipt of order.

a. General arrangement drawing of the bus bar trunking showing,
   1. Overall Dimensions for Different rating.
   2. Terminal locations.
   3. Total weight / meter.
   4. Sectional views.
   5. Fixing details.
   6. Sectional view of Tap Off Box.

b. Single Line Diagram.

c. Technical details for Fuse switches.

d. Manufacturing schedule and test schedule.

e. Calculation for busbar sizing.

1. **SWITCH GEAR**

1.1 **VCB**

1.1.1 **SCOPE**

Manufacturing, testing and supplying of integrated cubicle type metal clad, form 3 a, floor mounted and draw out type free standing, front operated indoor type 33 KV switchgear as per specifications given below:

**System**

The switchgear enclosure shall conform to degree of protection IP 4 X.

The switchgear shall be made from MS sheet steel 2 mm thick (CRGO) and shall be folded and braced as necessary to provide a rigid support for all components.

The switchgear assembly shall form a continuous dead front line up of free standing vertical cubicles. Each cubicle shall have a lockable front hinged door and a removable bolted back cover. All covers and doors shall be provided with neoprene gaskets. Suitable arrangement for lifting of each cubicle shall be provided. Design and construction of the switchgear shall be such as to permit extension at either end.

Vacuum Circuit breaker shall be provided with surge arresting device for protection against lightning and switching over voltage. Two separate and distinct connections to earth shall be provided for each surge arrester.

1.1.2 **BREAKER COMPARTMENT**

Vacuum Circuit Breaker shall be mounted in draw out truck with front plate which covers the cubicle when the breaker is in service position. This front plate shall be provided with view glass to facilitate observation of mechanical ON/OFF indication of Circuit breaker, Spring charged / discharged indication and operation counter. Necessary orifice shall be provided for manual charging of the springs. ON/OFF push button for opening and closing of the circuit breaker shall also be provided. The draw out truck shall have two positions for the circuit breaker VIZ isolated / Test & Service.

1.1.3 **BUS BAR COMPARTMENT**

Bus bars of rectangular cross section of copper conductor supported by cast epoxy insulator to withstand full short circuit currents up to 26.3 kA for 1 sec. for 33 KV systems shall be provided at the rear. Bus bar chamber shall be provided with inter panel barriers with epoxy cast seal off bushings.

1.1.4 **CT AND CABLE COMPARTMENTS**

At the rear of the panel sufficient space shall be available to accommodate three numbers epoxy CT’s of double core and two numbers three core cable termination. The cable entry shall be from the top / bottom.
1.1.5 **SEPARATE COMPARTMENTS**

Circuit breakers, instrument transformer, bus bars, cable etc shall be housed in a district different compartments as required for form 3 a, compartmentalization. All relays, switches, lamps, etc. comprising the control, indication and protective devices shall be housed in a separate compartment on the front of the cubicle.
1.1.6 **TECHNICAL PARTICULARS OF VCB CIRCUIT BREAKER**

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESCRIPTION</th>
<th>33 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>Rated Current</td>
<td>630 A</td>
</tr>
<tr>
<td>ii.</td>
<td>Rated Voltage</td>
<td>36 kV</td>
</tr>
<tr>
<td>iii.</td>
<td>Rated Frequency</td>
<td>50Hz</td>
</tr>
<tr>
<td>iv.</td>
<td>Rated Short Circuit breaking Current</td>
<td>26.3 KA for 1 sec</td>
</tr>
<tr>
<td>v.</td>
<td>Rated short circuit making current (KAP)</td>
<td>66 kA</td>
</tr>
<tr>
<td>vi.</td>
<td>Insulation level (KV rms/KVP)</td>
<td>70 kV / 170 kV</td>
</tr>
</tbody>
</table>

1.1.7 **EARTHING SWITCH**

Cable earthing switch shall be provided in the cable chamber and shall be operated from the front of the panel. The ON/OFF position of switch shall be indicated by mechanical indicator. The earthing switch shall be suitably interlocked with the breaker, so that it can be operated only when the breaker is in OFF position.

Earthing switch shall also be provided on bus bar side. The ON/OFF Switch shall be indicated by mechanical indicator. The earthing switch shall be suitably interlocked with the breaker, so that it can be operated only when the breaker is in OFF position.

1.1.8 **ISOLATING CONTACTS**

The breaker isolating contacts shall consist of two parallel flat silver plated copper bars with ball point contacts to give a vertical tolerance of ±10 mm.

1.1.9 **LOW VOLTAGE PLUG AND SOCKET CONNECTOR**

A twenty pin plug and socket connection along with flexible leads shall be provided to connect control instrumentation and interlock circuits on the breaker truck and in the panel. The plug and socket assembly shall be suitably interlocked with the truck positions like service and test/isolated position.

1.1.10 **INTERLOCKS AND SAFETY DEVICES**

The following interlocks shall be provided:

a. The truck cannot be moved from either test to service position or vice versa, when the circuit breaker is ‘ON’.

b. The circuit breaker can not be switched ‘ON’ when the truck is in any position between test and service position.

c. Front part of the truck can not be removed when the breaker in ‘ON’ position.

d. The low voltage plug and socket can not be disconnected in any position except test/isolated position.
e. The truck can not be moved inside the panel, when the LT plug and socket is disconnected.

f. Earthing switch can not be switched 'ON' when the truck is inside the panel.

g. The truck can not be inserted when the earthing switch is 'ON'.
1.1.11 SAFETY DEVICES

The following Safety devices shall be provided for the safety of the operating personnel:

a. Individual explosion vents shall be provided for breaker/bus bar/cable chambers on the top of the panel to let out the gases under pressure generated in case of fault inside the panel.

b. Cubicle with front plate to withstand the pressure for internal arc fault as per PEHLA recommendation.

c. Circuit breaker and sheet metal enclosure shall be fully earthed.

d. Self locking shutters shall be provided which shall close automatically when the truck is withdrawn to 'Test position' and no separate padlocking of the shutter shall be required.

1.1.12 PROTECTIVE EARTHING

The earthing connection between the truck and the cubicle shall be by means of sliding contacts so that the truck is earthed in the isolated position when inserted and remains earthed when the truck is pushed further into the connected position or when the truck is being withdrawn until the truck has moved part the isolated position.

1.1.13 CURRENT TRANSFORMER

I. GENERAL REQUIREMENTS

Accommodation shall be provided in the circuit breaker panel, to mount one set of duel ratio CT. Access to the CTS for cleaning, testing or changing shall be from the front, back or top of the panel.

II. RATING

Duel ratio CTS of suitable burden (but each not less than 15 VA) shall be preferred with 5 amps secondaries.

Instrument Security Factor (ISF) of each CT shall not be more than 5.

The CTs shall conform 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. CT terminals shall be shorting type. Current & voltage circuits shall be laid in separate wire ways. Secondary terminals of CTS shall be brought out to a suitable terminal block which will be easily accessible for terminal connections. Test terminal block shall be provided in the front side of the panel for testing purpose.

CT’S shall have 2 Nos. of cores for following application:

Core -1 for metering

Core -2 for over current & earth fault protection.
Class of accuracy of each winding

Metering class  1
Protection class  5P10
1.1.14 POTENTIAL TRANSFORMERS

The potential transformers shall be confirming to IS 3156/ IEC 60185. The primary windings of the potential transformers shall be insulated and shall be of the cast rest in type.

Potential transformers (PT’S) shall be mounted on a draw out trolley and housed in separate metal compartment and shall have control fuses on the H.V. side and a miniature circuit breaker on the L.V. side of the windings. HT HRC Control fuses shall be confirming to IS – 9385/ IEC –60282. Miniature Circuit breaker shall comply with IS – 8828/ IEC – 60898.

Padlocking facilities shall be provided for both service and isolated position.

The potential transformer shall be as specified below:

<table>
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<tr>
<th>Ratio</th>
<th>33000 V3/ 110/ V3/ 110 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>V A Burdan</td>
<td>100 V A for 100/V3 and 110 V winding</td>
</tr>
<tr>
<td>Class</td>
<td>CL –1 for both the windings.</td>
</tr>
<tr>
<td>Basic Insulation level</td>
<td>Same as mentioned for VCB in clause -6.</td>
</tr>
<tr>
<td>Over voltage factor</td>
<td>1.2 Continuous</td>
</tr>
</tbody>
</table>

Single phase PT’S shall be used and shall be connected in Star/ Star.

1.1.15 PROTECTION AND TRIPPING ARRANGEMENT

PROTECTION

All protection relay shall be numeric type of approved make.

The protection and tripping arrangement of circuit breaker shall be:

i. Numeric type instantaneous short circuit protection Device No.50 Range 500 – 2000% shall be provided on all phases.

ii. Numeric type back up over current protection for Phase faults Device No.51 Range 50 – 200% shall be provided on all phases.

iii. Numeric type ground fault protection Device No.50G. CT’s. Range 20 – 80% shall be provided.

iv. Lockout and trip supervisory relays etc shall be provided with manual reset facility.

v. Auxiliary relay for transformer fault.

vi. Surge Arrestor

1.1.16 CONTROL WIRING
The control wiring shall be carried out with minimum 2.5 sq. mm. PVC insulated copper conductor cables. The wiring shall be securely fixed and neatly arranged to enable easy tracing of wires. Identification PVC ferrules shall be fitted to all wire terminals to render easy identification and facilitate checking in accordance with IS 5578 and 11353.

1.1.17 METERING INSTRUMENT PANEL ACCESSORIES

I. METERING

Digital type Trivector meter of approved make (Smart demand controller) shall be provided on the incomer feeder. Specification of the meter shall be as follows:

- Accuracy: Class 0.5, compliant to revenue class certification.
- Real time measurement per phase & average
- V, I, PF, KW, KVAR, KVA
- Peak demand, sliding window. Protected.
- V & I unbalance, Phase reversal
- Time of Use (TOU)

Power Quality Measurement:

- Total Harmonics

Logging & recording for all measurements:

- Interval or event-based, 32 channel measurement & recording
- Event logging
- "Bust" data recording
- Min/ Max recording

Alarming:

- Over & under measurement detection by 24 set point functions.

Multiport Communication:

- One each of RS 485 and RS 232 ports.

II. INSTRUMENT PANELS

The instrument panel shall be part of the housing. Relays, meters and instruments shall be mounted as per general arrangement drawings to be submitted by the vendors. They shall be of flush mounting type.

III. INSTRUMENTATIONS

a) Digital type Voltmeter of class 1.0 accuracy and 96 x 96 mm square in size as per IS-1248 shall be provided at incomer panel, with selector switch. The instrument shall be calibrated for the ranges specified.
b) Digital type Power factor meter of class of 1.0 accuracy conforming to IS : 1248 shall be provided at incomer panel.

c) Digital type Ammeter of specified range to class 1.0 accuracy and 96 x 96 sq mm in size as per IS - 1248 shall be provided at both incomer and outgoing panels along with necessary selector switches.

d) Digital type frequency meter class of 1.0 accuracy conforming to IS:1248 shall be provided at incomer panel.

IV. The following minimum indication lamps shall be provided in the front of cubicle.

Breaker open / closed / tripped, spring charged trip circuit healthy and control supply healthy. Lamps shall be clustered LED type and trip circuit supervision scheme shall be of continuous supervision type.

V. After meeting all necessary control and indication requirements 2 nos. NO and 2 nos.. NC auxiliary of the breaker shall be made available for the owner, wired up to terminal block.

VI. Separate MCB's shall be provided for lamps, heaters and other instrumentation etc. on each panel.

VII. Anti-condensation space heaters suitable for operation on 240 V single phas, 50 Hz A.C. for each cubicle and with thermostat control one incandescent lamp with switch and 3 pin 5 amps plug socket.
1.1.18 DRAWINGS/DOCUMENTS REQUIRED FOR REVIEW/APPROVAL

Following drawings documents shall be submitted by the manufacturer for approval.

a. General arrangement (GA) of equipment layout.

b. Equipment list.

c. Relay and metering system schematics.

d. Supply and erection schedule.

e. Catalogue and specification sheets.

1.1.19 INSPECTION AND TESTING

After manufacturing of switchgear panels tests shall be carried out on the equipment as per relevant IS and Electricity Regulations.

1.1.20 QUALITY ASSURANCE

Vendor shall submit in substantial detail a quality assurance plan indicating all activities step by step at various manufacturing/fabrication stages to meet the requirement of this specification and various standards/regulations/practices to enable comprehensive assessment of its merits and reliability.
2. **AUXILIARY EQUIPMENT FOR SUB-STATION**

2.1 **BATTERY CHARGER UNIT**

i. **General**

The battery charger shall be Float cum Boost type Thyristor controlled. The charger shall have selector switch for Auto Float – Boost / Manual Float / Manual Boost Mode of operation. During Auto Float – Boost Mode, Automatic Changeover shall take place from Float Mode to Boost mode and Vice-Versa. This means that when the Batteries are fully charged the charging shall automatically change from Boost charge to trickle charge.

ii. **Construction Feature**

Float cum Boost charger and DC Distribution Board shall be housed in sheet steel cubicle with panels of 1.6 mm thickness, louvers for ventilation glands plate will be provided for cable entry from bottom. The cubicle shall be painted in Siemens grey shade RAL-7032. The battery charger is divided into two compartments. The upper compartment houses the battery charger with all the necessary controls. The lower compartment is suitable for housing the batteries.

iii. **Performance**

The D.C output voltage of Float / Boost charger shall be stabilized within $\pm 2\%$ for AC input variation of 230 V $\pm 10\%$, frequency variation of 50 Hz $\pm 5\%$ and DC load variation of 0-100%. The voltage regulation shall be achieved by a constant voltage regulator having fast response SCR control. The ripple content will be within 3% of DC output nominal voltage.

There shall be provision to select Auto Float / Manual Float / Manual Boost modes. During Auto Float Mode the battery charging shall automatically changeover from Boost Mode to Float Mode and Vice Versa. During Manual Float / Boost modes it shall be possible to set the output volts by separate potentiometers.

The battery charger shall have automatic output current limiting feature.

iv. **Components**

The battery charger shall essentially comprise of the following

1 No. double pole ON/OFF MCB at AC input.

1 No. pilot lamp to indicate charger ON.

1 No. Main Transformer : Double wound, naturally air cooled, having copper winding.

1 set single phase full wave bridge rectifier consisting of 2 Nos. diodes and 2 Nos. SCRs, liberally rated, mounted on heat sinks and complete with resistor / condensor network for surge suppression.
1 No. rotary switch to select auto float / manual float / manual boost. During auto float mode automatic changeover shall take place from float mode to boost mode and vice versa.

1 set solid state constant potential controller to stabilize the DC output voltage of the float cum boost charger at ± 2% of time set value for AC input voltage variation of 230 V ± 10%, frequency variation of ± 5% from 50 Hz and simultaneous load variation of 0-100% and also complete with Current Limiting Circuit to drop the Float Charger output voltage upon overloads to enable the battery to take over.

1 No. electronic controller to automatically changeover battery charging from boost to float and vice versa.

1 No. DC ammeter and toggle switch to read charger output current and battery charge / discharge current.

1 No. moving coil DC voltmeter to read the DC output voltage.

2 set potentiometer to adjust the output voltage during manual /auto float and boost modes.

1 No. double pole ON/OFF MCB for Charger Output (24 V DC Rating).

2 set DC output terminals. 1 set for the load and the other set for the battery.

Alarm Annunciation: Visual and audible alarm with manual accept reset facility shall be provided for the following:

a. AC mains fail
b. Charger Fail
c. Load / Output overvolt.

**Rating**

<table>
<thead>
<tr>
<th>AC Input</th>
<th>230 V ± 10% AC 50 Hz single phase.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Output</td>
<td>To float / boost charge 24 V / 200 AH batteries and also supply a continuous load.</td>
</tr>
<tr>
<td>Current Rating</td>
<td>30.0 Amps</td>
</tr>
<tr>
<td>Float Mode</td>
<td>27.0 V nominal (Adjustable) between 24-28.0 V.</td>
</tr>
<tr>
<td>Boost Mode</td>
<td>28.2 V nominal (Adjustable) between 24-29.0 V.</td>
</tr>
<tr>
<td>Voltage Regulation</td>
<td>± 2% for AC input variation of 230 V ± 10%.</td>
</tr>
</tbody>
</table>
Technical Specifications for Construction of Township

Frequency Variation of 50 Hz ± 5% and DC load variation 0-100%

Ripple : Less than 5%

v. **DC Distribution Board**

It shall be provided in the charging cubicle, it will comprises of the following:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Incoming</td>
<td>1 No. 63 A DP MCB</td>
</tr>
<tr>
<td>Outgoing</td>
<td>10 Nos. 16 A DP MCB</td>
</tr>
</tbody>
</table>

1.2 **SAFETY EQUIPMENT**

**Danger Plate**

Design plate shall be provided on HV and MV equipment. MV danger notice plate shall be 200 mm x 150 mm made of mild steel at least 2 mm thick with vitreous enamelled white on both side and with inscription in red colour on front side.

**Fire Extinguishers**

Portable CO₂ conforming to IS:2878-1976, and dry chemical conforming to IS:2171-1967 shall be provided in the Sub-station.

**Rubber Mats For Electrical Purpose**

Materials : Mats shall be of vulcanized rubber compound free from fabric insertions and fibrous materials.

The upper surface shall have ribbles or any other pattern, the thickness shall not be less than 6.5 mm at the root of the pattern.

The material shall be free from blisters, pin holes, cracks, embedded foreign matters and other defects.
OIL FILLED TRANSFORMERS WITH OFF LOAD TAP CHANGING ON HV SIDE

3.1 **SCOPE**
Design, manufacture, testing, supplying and commissioning of 33 kV / 0.415kV volts step down transformer complete with all the accessories and fittings for efficient and trouble free operation.

3.2 **CODES and STANDARD**

3.3 **RATING**
Selected transformer shall be of specified rating suitable for continuous operation.

3.4 **CONNECTIONS AND VECTOR GROUP**
Delta on High Voltage side and star on low voltage side with neutral terminal brought out for solid earthing corresponding to the Vector Symbol Dyn - 11.

3.5 **SYSTEM OF SUPPLY**
3 phase, 50 Hz 33 kV earthed system.

3.6 **TAPPINGS**
‘OFF’ load tap changing on HV side. The tapping’s to be provided for variation on HV side from +7.5% to –7.5% in steps of 2.5% each.

3.7 **TEMPERATURE RISE**
Continuously rated for full load, temperature rise not exceeding 45o C by thermometer in oil or 55 Deg C by resistance.

3.8 **TYPE**
Indoor type with HT side cable box & LT side bus trunking.

3.9 **TERMINALS**
The cable box with glands on HT side shall be suitable for 3 core XLPE cable of specified capacity. Flanges with bus duct on LT side shall be suitable for bus duct of size mentioned in BOQ. All cable glands shall be earthed.

3.10 **COOLING**
Natural cooling by means of pressed/round tubes around transformer tank.

3.11 **INSULATION**
The transformer shall be oil insulated type.
3.12 **EARTHING**

Two separate earthing terminals to be provided at the bottom on both sides.
FITTINGS AND ACCESSORIES

The following accessories and fittings shall be provided.

a) **Lifting Lugs**: The arrangement for lifting the active part out of the transformer tank along with the cover by means of lifting lugs without disturbing the connections.

b) **Swivel Type Rollers**: The transformer to be provided with 4 Nos Bi-Directional rollers fitted on cross channels to facilitate the movement of the transformer in both directions.

c) **Oil Conservator**: The transformer to be provided with an oil conservator with welded end plates. It is to be bolted to the cover and can be dismounted for purpose of transport. It has to be provided with magnetic oil level gauge and an oil filling hole 1 1/4” BSF size with a cap, which can be used for filtering oil. For draining purpose a plug shall provided. A connection pipe between the conservator and the main tank is to be provided which projects inside the conservator and the main tank is to be provided which projects inside the conservator.

d) **Air release Valve**: An air release valve is to be provided on the top of the tank cover facilitate the release of the entrapped air and filling of oil.

e) **Breather**: The transformer to be provided with an indicating dehydrating silicagel breather of sufficient capacity.

f) **Drain-cum-oil Filter Valves**: The transformer to be provided with a drain-cum-oil filter valve of 1 1/4” BSF size at the bottom of the tank.

g) **Diagram and rating plate**: Diagram and rating plate shall be provided indicating the details of transformer, connection diagram, vector group, tap changing diagram etc.

h) **Dial type thermometer for Oil (150 mm dia)** with maximum set pointer at 75 deg C and electrical contacts for electrical alarm at high temperature.

i) **Winding temperature indication and electrical contacts for trip / alrm.**

j) **Buchholz relay of double float type** with electrical contacts for low oil level alarm and high gas pressure trip suitable for 24 volts DC supply.

k) **Filter valve of 1 1/4” BSF at top.**

l) **Explosion vent.**

m) **Disconnecting chamber shall be provided for cable termination.**

3.13 **WINDING**

The transformer shall be copper wound.
3.14 **CORE**

The magnetic core shall be made up of cold rolled grain oriented low loss steel stampings.

3.15 **DRAWINGS AND LEAFLETS**

Three copies of operation and maintenance manual with complete instructions for the installation, operations, maintenance and repairs, circuit diagram, foundation and trenching details shall be provided with the transformer.
3.16 **TESTING**

The transformer shall be subject to the following tests at the factory before dispatching the same and test certificates shall be furnished.

b. Ratio polarity and phase relationship.
c. Impedance voltage.
d. Load losses.
e. No-load losses and no-load current.
f. Insulation resistance.
g. Induced over voltage withstand.
h. Separate - source voltage withstand.
j. Temperature rise.
k. Dielectric strength of oil.
### Technical Specifications for Construction of Township

#### 3.17. **TECHNICAL DATA FOR TRANSFORMER**

**TENDERER MUST FILL IN THE FOLLOWING TECHNICAL DATA**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Technical Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>Type and class of insulation</td>
</tr>
<tr>
<td>ii.</td>
<td>Output in KVA (Continuously rated)</td>
</tr>
<tr>
<td>iii.</td>
<td>Rated Voltage</td>
</tr>
<tr>
<td>a.</td>
<td>HV (Volts)</td>
</tr>
<tr>
<td>b.</td>
<td>LV (Volts)</td>
</tr>
<tr>
<td>iv.</td>
<td>Rated Current</td>
</tr>
<tr>
<td>a.</td>
<td>HV (amps)</td>
</tr>
<tr>
<td>b.</td>
<td>LV (amps)</td>
</tr>
<tr>
<td>v.</td>
<td>No. of phase</td>
</tr>
<tr>
<td>vi.</td>
<td>Type of cooling</td>
</tr>
<tr>
<td>vii.</td>
<td>Frequency</td>
</tr>
<tr>
<td>viii.</td>
<td>Winding Connection</td>
</tr>
<tr>
<td>ix.</td>
<td>Tapings</td>
</tr>
<tr>
<td>x.</td>
<td>Vector Group</td>
</tr>
<tr>
<td>xi.</td>
<td>Ref. Ambient temperature</td>
</tr>
<tr>
<td></td>
<td>Temperature rise winding</td>
</tr>
<tr>
<td></td>
<td>Class of insulation</td>
</tr>
<tr>
<td>xii.</td>
<td>Physical Dimensions</td>
</tr>
<tr>
<td>a.</td>
<td>Length (in mm)</td>
</tr>
<tr>
<td>b.</td>
<td>Width (in mm)</td>
</tr>
<tr>
<td>c.</td>
<td>Height (in mm)</td>
</tr>
<tr>
<td>xiii.</td>
<td>% Impedance</td>
</tr>
<tr>
<td>xiv.</td>
<td>X/R ratio</td>
</tr>
<tr>
<td>xv.</td>
<td>Iron losses at normal voltage ratio</td>
</tr>
<tr>
<td>xvi.</td>
<td>Copper losses at normal voltage ratio</td>
</tr>
</tbody>
</table>
at full load
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Technical Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>xvii.</td>
<td>Efficiency at unity power factor</td>
</tr>
<tr>
<td></td>
<td>a. Full load</td>
</tr>
<tr>
<td></td>
<td>b. 75% load</td>
</tr>
<tr>
<td></td>
<td>c. 50% load</td>
</tr>
<tr>
<td>xviii.</td>
<td>Regulation at unit power factor</td>
</tr>
<tr>
<td>xix.</td>
<td>Regulation at 0.8 power factor</td>
</tr>
<tr>
<td>xx.</td>
<td>Approximate weight</td>
</tr>
<tr>
<td></td>
<td>a. Core &amp; winding (Kgs.)</td>
</tr>
<tr>
<td></td>
<td>b. Total Weight (Kgs.)</td>
</tr>
<tr>
<td>xxi</td>
<td>Oil (Ltrs)</td>
</tr>
</tbody>
</table>
4. **HT CABLE**

**33 kV GRADE XLPE**

4.1 **GENERAL**

Cables shall be aluminium conductor, cross linked polyurethane construction and shall be supplied, inspected, laid, tested and commissioned in accordance with drawings, specifications, relevant Standard Specifications and cable manufacturers instructions.

4.2 **MATERIAL**

a. **Conductor**

The Conductor shall be made from electrical purity aluminum stranded wires compacted together.

b. **Insulation**

High quality TROPOTHEN - X (XLPE) unfilled insulating compound of natural color shall be used for insulation. Insulation shall be applied by extrusion process and shall be chemically cross linked in continuous vulcanization process.

c. **Shielding**

Cables shall be provided with conductor shielding as well as insulation shielding and shall consist of extruded semi-conducting compound, additionally insulation shield shall be provided with semi-conducting and metallic tape shield over the extruded insulation shield. XLPE insulation and outer core shielding shall be extruded in one operation.

d. **Armoring**

Armoring shall be applied over the inner sheath and shall comprise of flat steel wires (strips).

e. **Outer Sheath**

Tough outer sheath of heat resisting PVC compound shall be extruded over the armoring in case of armored cables or over extruded over the armoring in case of armored cables or over inner sheath in the case of unarmored cables.

4.3 **TESTS**

Cables shall be type tested and routine tested in accordance with IS:7098 (Part II).

a. **Conductor resistance test.**

b. **Partial discharge test.**

c. **High Voltage test.**

The following tests shall be carried out at site for insulation between phases and between phase and earth before and after cable lying.
a. Insulation Resistance Test.
b. Continuity resistance test.
c. Sheathing continuity test.
d. Earth test.
e. High Voltage test.

Cables shall be laid with a clearance of at least 75 mm between two cables.
4.4 **END TERMINATION OF HT CABLE**

Pre-molded cable terminations for XLPE cable shall be used as per manufacturer’s instructions. The steel cone of M-seal Push-On shall consist of highly track resistant insulating section vulcanized to a semi-conducting section. The pad material shall have cold-flow properties and shall be flame retardant.

Each end terminal shall undergo Hi Pot Test.

4.5 **LAYING OF HT CABLES**

**Direct In Ground**

The work shall involve excavation of trench and laying of cable(s) as indicated in drawing and Schedule of Quantities.

The depth of the excavation shall not be less than 900 mm for 33 kV plus radius of cable, from the upper surface of ground. Where more than one multicore cable is laid in the same trench, a horizontal inter spacing of 250 mm shall be left in order to reduce mutual heating and also to ensure that fault occurring on one cable will not damage the adjacent cable.

Cable shall be laid in cement pipes encased in concrete or Hume pipes at all road crossing. Cables shall be laid in trenches over rollers placed inside the trenches. After the cable has been properly laid and straightened, it shall be covered with 80 mm thick layer of sand. Cable shall then be lifted and placed over this sand cushion. Again, the cable shall be covered with a 80 mm layer of sand. Over the sand a layer of cable protection tiles shall be placed by overlapping 50 mm on either side. Trenches shall then be back-filled with earth and shall be consolidated. Suitable cable markers made of cast iron with aluminum paint indicating the voltage grade and direction of run of the cables shall be installed at regular intervals.

4.6 **RCC/MASONRY TRENCH**

For laying of HT cable in RCC/Masonry trench refer detail on sub-station layout drawing and IS-1255-1983.
5. **Bus Trunking**

5.1 **SANDWICH BUS DUCT RATINGS: 4000A**

5.2 **SCOPE:**

The specification covers the technical requirements of design, manufacturer, test at works, supply, installation, testing & commissioning of 1000 V, LT, Non-segregated Phase, Sandwich type Bus bar Trunking and accessories for efficient and trouble free operation.

The Bus duct shall be erected from transformer to MV Pane suitable for Horizontal and vertical Runs.

5.3 **STANDARDS:**

The equipment covered by this specification shall unless otherwise stated, be designed, constructed and tested in accordance with the latest revision of relevant International Standards and shall conform to the regulations of local statutory authorities.

- **IEC-529**: Degree of protection provided by enclosures.
- **IEC/EN 60439-1 & 2**: Particular requirements for Bus Bar Trunking.
- **DIN IEC 68 Part 2-3**: Suitable for Constant/ cyclic Warm, Humid Climates.
- **EN 60695-2-1**: Incandescent Wire test for All plastic Parts.
- **UL 94**: Self-extinguishing Property for all plastic parts.
- **EN 60332-3**: Fire retardant.

5.4 **GENERAL:**

The Bus Bar Trunking shall be made from Hot-galvanized 1.5mm Thick sheet steel suitable for Indoor application.

Standard length of straight feeder shall not exceed 3000mm. Distribution element can be used for Vertical Rising Mains & Busbar Trunking.

5.5 **CONSTRUCTION:**

The Bus duct enclosure consists of four C-ribbed section bars, bordered and riveted, with overall dimension (130-130X480mm) with excellent mechanical, electric and heat loss efficiency.

The sheet metal is made of 1.5 mm thick hot-galvanized steel treated according to UNI EN 10327 and painted with RAL7035 resins with high resistance to chemical agents. It shall be rigid and robust in construction, compact in size and shall be treated to prevent any possibility of corrosion.

All the run elements (straight feeder, Elbows, etc) are supplied complete with a factory fitted monobloc. In monoblock there will be two Copper with Silver plated plates per phase and Use single bolt system to tighten the joints.

The enclosure shall provide a protection not less than **IP- 55 as per IEC-529.**
Single bolted Special monobloc must be used for connecting successive feeders/Elbows/flange etc. The junction contacts made from two silver plated copper plates for each phase, insulated with red class F thermosetting plastic material and factory fitted in one side of the each trunking components. Bolted type splice plate, Zinc plated bolts & nut with Bellevue washer must be used to achieve an efficient joint. Jointing method shall be as per International Practice

5.6 BUSBARS:

The Busbar conductors have a rectangular cross-section with rounded corner and made up of high conductivity Aluminum Alloy with Copper and Tin coating over the entire length of the conductors with 5 galvanic processes from current rating 630A to 4000A.

Following are the configurations for AL & CU conductor:
1. SCP (3L+N+PE)
2. SCP5C (3L+N+PE+FE)
3. SCP2N (3L+2N+PE)

Bus Bar shall have continuous current rating as mentioned in the Technical particulars and shall short circuit current with stand capacity as per given table.

<table>
<thead>
<tr>
<th>Rated Current</th>
<th>Short ckt With Stand Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aluminium Conductor</td>
</tr>
<tr>
<td>4000A</td>
<td>160KA, 1 Sec</td>
</tr>
</tbody>
</table>

The Busbars shall be TP & N, the cross-section of neutral bar being equal to the cross-section of the phase bar.

The insulation between the Bars is ensured by double sheath made with polyester film (Total thickness 0.4mm) and thermal class B. All plastic components have a V1 self extinguishing degree (as per UL94); they are fire retardant and comply with glow-wire test according to standard and halogen free.

The Busbars shall be fixed in the supports in such a way to allow for free movement of conductor due to thermal expansion without creating mechanical stresses.

5.7 EARTHING:

The Bus-duct enclosures shall be earthed by continuous copper/AL/ GI, Earthing as per specified, Running both sides of the enclosures through the entire length of Busducts.

5.8 TYPE TEST

The bidder shall furnish two copies of type test certificate along with the bid for the following:

a) Short time Current
b) Temperature Rise Test
ROUTINE TEST AT MANUFACTURER WORKS:

Following test must be done prior to dispatch at manufacturer works:

1) Verification of Dielectric Properties.
2) Verification of clearance and creepage distance.
3) Verification of mechanical operation.
4) Verification of degree of protection.
5) Verification of electrical characteristics of Bus Bar Trunking System.
6) Verification of structural strength.

DRAWING:

After award of the order the manufacturer shall submit the following documents for approval:

General arrangement showing the Plan, Elevation, different views, detailed typical cross-section of Busduct, details of end termination, bus bar arrangements, erection details with necessary supports.

LOVAG (ACAIE) Test certificates if needed.

Complete technical Particulars of the components of Busduct commissioning and maintenance instruction manual for the Busduct.

6. MEDIUM VOLTAGE 1.1 KV GRADE XLPE / PVC CABLES

6.1 GENERAL

The MV cables shall be supplied, inspected, laid, tested and commissioned in accordance with drawings, Specifications, relevant Standard Specifications and cable manufacturer’s instruction.

6.2 MATERIAL

The MV cables shall be cross linked polyethylene (XLPE) insulated PVC sheathed of 1100 volts grade as asked for in the schedule of quantities. Cables upto 16 sq.mm shall be with copper conductor and 25 sq.mm and above shall be with aluminium conductor.

6.3 TECHNICAL REQUIREMENTS

6.3.1 All XLPE Aluminium/Copper Power cables shall be 1100 Volts grade, multi core constructed as per IS : 7098 Part-1 of 1988 as follows:

a. Stranded Aluminium /Copper conductor in case of 10 sq.mm and above and solid conductor in case of 10 sq.mm and below.

b. Cores laid up

c. The inner sheath should be bonded over with thermo-plastic material for protection against mechanical and electrical damage.
d. Armoring should be provided over the inner sheath to guard against mechanical damage. Armouring should be Galvanised steel wires or galvanised steel strips. (In single core cables used in A.C. system armouring should be non-magnetic hard aluminium Wires/Strips. Round steel wires should be used where diameter over the inner sheath does not exceed 13 mm; above 13 mm flat steel armour should be used. Round wire of different sizes should be provided against specific request.)

e. The outer sheath should be specially formulated heat resistant black PVC compound conforming to the requirement of type ST2 of IS: 5831-1984 extruded to form the outer sheath.

6.3.2 Conductor shall be of electrolytic Aluminium/Copper conforming to IS : 8130 and are compact circular or compact shaped.

6.3.3 Insulation shall be of XLPE type as per latest IS general purpose insulation for maximum rated conductor temperature 70 degree centigrade.

6.3.4 In Inner sheath laid up cores shall be bonded over with thermoplastic material for protection against mechanical and electrical damage.

6.3.5 Insulation, inner sheath and outer sheath shall be applied by extrusion and lapping up process only.

6.3.6 Armouring shall be of galvanised steel wire/flat.

6.3.7 Repaired cables shall not be used.

6.3.8 Current ratings of the cables shall be as per IS : 3961.

6.3.9 The XLPE insulated cables shall conform to latest revision IS read along with this specification. The Conductor shall be stranded Aluminium/Copper circular/ sector shaped and compacted. In multi core cables the core shall be identified by red, yellow, blue and black coloring of insulation.

6.3.10 The XLPE insulated 1100 Volts grade power cables shall conform to latest IS and shall be suitable for a steady conductor temperature of 70° centigrade. The conductor shall be stranded Aluminium/ Copper as called for in the Schedule of quantities. The outer sheath shall be as per the requirement of type ST-2 of IS:5831 of 1984.

6.3.11 The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.

6.3.12 Progressive automatic in line sequential marking of the length of cables in meters at every one meter shall be provided on the outer sheath of all cables.

6.3.13 Cables shall be supplied in non returnable wooden drums as per IS : 10418.

Both ends of the cables shall be properly sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation, storage and erection.
6.3.14 The product should be coded as per IS :- 7098 Part-I as follows :-

<table>
<thead>
<tr>
<th>Aluminium Conductor</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>XLPE Insulation</td>
<td>2X</td>
</tr>
<tr>
<td>Steel round wire armour</td>
<td>W</td>
</tr>
<tr>
<td>Steel strip armour</td>
<td>F</td>
</tr>
<tr>
<td>Steel Double round wire armour</td>
<td>WW</td>
</tr>
<tr>
<td>Steel Double strip armour</td>
<td>FF</td>
</tr>
<tr>
<td>Non-magnetic (Al.) round wire armour</td>
<td>Wa</td>
</tr>
<tr>
<td>Non-magnetic (Al.) strip armour</td>
<td>Fa</td>
</tr>
<tr>
<td>PVC outer sheath</td>
<td>Y</td>
</tr>
</tbody>
</table>

6.4 INSPECTION

All cables shall be inspected by the contractor upon receipt at site and checked for any damage during transit.

6.5 JOINTS IN CABLES

The Contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoidance of cable jointing. This apportioning shall be got approved by the Owner’s site representative before the cables are cut to lengths. Where joints are unavoidable heat shrinkable type joints shall be made. The location of such joints shall be got approved from the Owner’s site representative and shall be identified through a marker.

6.6 JOINTING BOXES FOR CABLES

Cable joint boxes shall be installed with heat shrinkable sleeve and of appropriate size, suitable for XLPE armoured cables of particular voltage rating.

6.7 JOINTING OF CABLES

All cable joints shall be made in suitable, approved cable joint boxes and the filling in of compound shall be done in accordance with manufacturers’ instructions and in an approved manner. All straight joints shall be done in epoxy mould boxes with epoxy resin.

All cables shall be joined colour to colour and tested for continuity and insulation resistance before jointing commence. The seals of cables must not be removed until preparations for jointing are completed. Joints shall be finished on the same day as commenced and sufficient protection from the weather shall be arranged. The conductors shall be efficiently insulated with high voltage insulating tape and by using of spreaders of approved size and pattern. The joints shall be completely topped up with epoxy compound so as to ensure that the box is properly filled.

6.8 CABLE TERMINATIONS

Cable termination shall be done in cable terminal box using crimping sockets and proper size of glands of double compression type with earthing facility.
6.9 **BONDING OF CABLES**

Where a cable enters any piece of apparatus, it shall be connected to the casing by means of an approved type of armour clamp and gland. The clamps must grip the armouring firmly to the gland or casing, so that no undue stress is passed on to the cable conductors.

6.10 **LAYING OF CABLES**

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks.

The minimum width of trench for laying single cable shall be minimum 350 mm. Where more than one cable is to be laid in horizontal formation, the width of the trench shall be worked out by providing 200 mm gap between the cables, except where otherwise specified. There shall be clearance of 150 mm between the end cable and the side wall of the trench. The minimum dept of the cable trench shall not be less than 750 mm for single layer of cables. When the cables are laid in more than one tier the depth of the trench shall be increased by 300 mm for each additional tier.

**Excavation of trenches**

The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvature shall be provided. Where gradients and changes in depth are avoidable, these shall be gradual. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench. The bottom of the trench shall be level and free from stone, brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 100 mm in depth. Prior to laying of cables, the cores shall be tested for continuity and insulation resistance. The cable drum shall be properly mounted on jacks at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum and the spindle is horizontal. Cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire drum length shall be laid in one stretch. However, where this is not possible the remainder of the cable shall be removed by 'Flaking' i.e. by making one long loop in the reverse direction. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted off the rollers beginning from one end by helpers standing about 10 meters apart and laid in a reasonably straight line. Cable laid in trenches in a single tier formation shall have a cover of clean, dry sand of not less than 150 mm. above the base cushion of sand before the protective cover is laid. In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 300 mm shall be provided over the initial bed before the second tier is laid. Finally the cables shall be protected by second class bricks before back filling the trench.

**Back Filling**

The trenches shall be back filled with excavated earth free from stones or other sharp edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 300 mm. Unless otherwise specified, a crown of earth not less than 50
mm in the centre and tapering towards the sides of the trench shall be left to allow for subsidence.

6.11  **ROUTE MARKER**

Route marker shall be provided along straight runs of the cables not exceeding 100 meters also for change in the direction of the cable route and underground joints.

Route marker shall be of cast iron painted with aluminum paint. The size of marker shall be 100 mm dia with "Cable" and voltage grade inscribed on it.

6.12  **TESTING OF CABLES**

Cables shall be tested at works for the following tests before being dispatched to site by the project team.

a. Insulation Resistance Test.

b. Continuity resistance test.

c. Sheathing continuity test.

d. Earth test.(in armoured cables)

e. Hi Pot Test.

Test shall also be conducted at site for insulation between phases and between phase and earth for each length of cable, before and after jointing. On completion of cable laying work, the following tests shall be conducted in the presence of the Owner’s site representative.

a. Insulation Resistance Test( Sectional and overall)

b. Continuity resistance test.

c. Sheathing continuity test.

d. Earth test.

All tests shall be carried out in accordance with relevant Standard Code of Practice and Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Owner’s site representative.
7. **DISTRIBUTION PANELS/BOARDS**

Main Distribution Panels, Sub-Distribution Panels and Final Distribution Panels / Boards shall be suitable for operation on 3 Phase / single phase, 415 / 240 volts, 50 cycles, 4 wire system neutral grounded at transformer. All Distribution panels shall be CPRI approved and manufactured by a approved manufacturer.

Distribution panels shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

7.1 **CONSTRUCTION FEATURES**

Distribution panels shall be 2 mm thick sheet steel cabinet for indoor installation, dead front, floor mounting/wall mounting type and shall be form 3b construction. The Distribution panels shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket, padlocking arrangement and bolted back. All removable/ hinged doors and covers shall be grounded by flexible standard connectors. Distribution panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of Distribution panels shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Distribution panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum clearance of 275 mm shall be provided between the floor of Distribution panels and the lowest unit.

Distribution panels shall be of adequate size with a provision of spare switchgear as indicated on the Single Line Diagram. Switches shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Distribution panels in conformity with the location of cable/conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram engraved on PVC sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

7.2 **BUS BAR CONNECTIONS**

Bus bar and interconnections shall be of high conductivity electrolytic grade aluminium / copper as indicated in the bill of quantities complying with requirement of IS : 5082 – 1981 and of rectangular cross section suitable for carrying the rated full load current and short circuit current and shall be extendable on either side. Bus bars and interconnections shall be insulated with heat shrinkable sleeve of 1.1 KV grade and shall be colour coded. Bus bars shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case
of short circuit in the system. All bus bars shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area to be added to the bus bar to compensate for the holes. All connections between bus bars and breakers shall be through solid copper / aluminium strips of proper size to carry full rated current and insulated with insulating sleeves.

7.2.1 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 IS 8623(Part-2) 1993.

All main distribution panels and sub distribution panels shall be provided with MCCB of appropriate capacity as per Single Line Diagram. All final Distribution boards shall be provided with Miniature Circuit Breakers. Final Single Phase Distribution boards shall be connected to the incoming supply through double pole MCB units & earth leakage circuit breakers. All wiring for final distribution boards shall be concealed behind 5 mm thick bakelite sheet or M S sheet cover. All Distribution boards shall be completely factory wired, ready for connection. All the terminals shall be of proper current rating and sized to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits shall be distinctly marked with a small description of the service installed.

Continuous earth bus sized for prospective fault current shall be provided with arrangement for connecting to station earth at two points. Hinged doors/ frames shall be connected to earth through adequately sized flexible braids.

7.3 CABLE COMPARTMENTS

Cable compartment of adequate size shall be provided in the Distribution panels for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables.

7.4 MOULDED CASE CIRCUIT BREAKER (MCCB)

The MCCB should be current limiting type with trip time of less than 10 msec under short circuit conditions. The MCCB should be either 3 or 4 poles as specified in BOQ. MCCB shall comply with the requirements of the relevant standards IS13947 – Part 2/IEC 60947-2 and should have test certificates for Breaking capacities from independent test authorities CPRI / ERDA or any accredited international lab.

MCCB shall comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses

The breaking capacity of MCCB shall be as specified in the schedule of quantities. The rated service breaking capacity (Ics) should be equal to rated ultimate breaking capacities (Icu). MCCBs for motor application should be selected in line with Type-2 Coordination as per IEC-60947-2, 1989/IS 13947-2. The breaker as supplied with ROM should meet IP54 degree of protection.
7.5 MINIATURE CIRCUIT BREAKER (MCB)

Miniature Circuit Breaker shall comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 240/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B, C, D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values. MCB shall ensure complete electrical isolation & downstream circuit or equipment when the MCB is switched OFF.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP, TPN and 4 Pole miniature circuit breakers shall have a common trip bar independent to the external operating handle.

7.6 EARTHING

Earthing shall be provided as per IS:3043-1987.

7.7 PAINTING

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be as per BOQ confirming to IS Code No.5.

7.8 LABELS

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

7.9 METERS

i. All voltmeters and indicating lamps shall be through MCB’s.

ii. Meters and indicating instruments shall be flush type.

iii. All CT’s connection for meters shall be through Test Terminal Block (TTB).

iv. CT ratio and burdens shall be as specified on the Single line diagram.

7.10 CURRENT TRANSFORMERS

Current transformers shall be provided for Distribution panels carrying current in excess of 60 amps. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.
The CTs shall confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class I.

### 7.11 INDICATING PANEL

All meters and indicating instruments shall be in accordance with relevant Indian Standards. Meters shall be flush mounted type. Indicating lamps shall be of low burden, and shall be backed up with 2 amps MCB/MPCB as per relevant fault level and toggle switch.

### 7.12 TESTING

Testing of panels shall be as per following codes:

- **a.** IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages upto and including 1000 VAC.
- **b.** IS: 13947: 1993 Degree of protection
- **c.** IS: 5578 & 11353:1985 Arrangement of bus bars.

### 7.13 WIRING

In wiring a distribution panel it shall be insured that total load of various distribution panel and/or consuming devices is divided evenly between the phases and number of ways as per Consultants drawing.

### 7.14 ANTI-CONDENSATION SPACE HEATERS

1 No. 100 W, 240 volts, single phase, 50 Hz AC Anti Condensation space heaters controlled by thermostat and protected by 6 amps MCB's or MPCB's as per fault level at the panel shall be provided in each vertical section of main LT panel and 1 No. 60 watt Anti Condensation space heater with thermostat shall be provided in each cable alley of main distribution boards and sub distribution boards.
8. **EARTHING**

8.1 **EARTHING**

The system shall be TNS with four wire supply system (R, Y, B, N and 2 No. E) brought from the main L T Panel. All the non-current carrying metal parts of electrical installation and all metal conduits trunking, cable sheaths, switchgear, distribution panels, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All metal work such as pipe lines, ducts, cable trays, stair case railing etc shall be bonded to earth.

All earthing shall be in conformity with IS:3043 1987, and the basic system of earthing shall be TNS.

8.2 **EARTHING CONDUCTORS**

Earthing conductors shall be of copper / GI as mentioned in schedule of quantities and shall be protected against mechanical injury and corrosion.

8.3 **SIZING OF EARTHING CONDUCTORS**

The cross sectional area of earthing conductor shall not be smaller than half of the largest current carrying conductor subject to an upper limit of 80 Sq.mm. If the area of the largest current carrying conductor or bus bar exceeds 160 sq.mm then two or more earthing conductors shall be used in parallel, to provide at least half the cross sectional area of the current carrying conductor or bus bars. All fixtures, outlet boxes, junction boxes and power circuits upto 15 amps shall be earthed with PVC insulated copper wire.

All 3 phase switches and distribution panels upto 60 amps rating shall be earthed with 2 No. distinct and independent 4 mm dia copper / GI wires. All 3 phase switches and distribution panels upto 100 amps rating shall be earthed with 2 No. distinct and independent 6 mm dia copper / GI wires. All switches, bus bar, ducts and distribution panels of rating 200 amps and above shall be earthed with minimum of 2 No separate and independent 25 mm x 3 mm copper / GI tape.

8.4 **CONNECTION OF EARTHING CONDUCTORS**

Main earthing conductors shall be taken from the earth connections at the main L T panel to an earth electrode with which the connection is to be made. All joints in tapes shall be with four rivets and shall be brazed in case of copper and by welding bolting in case of GI, wires shall be connected with crimping lugs, all bolts shall have spring washers. Sub- mains earthing conductors shall run from the main distribution panel to the sub distribution panel. Final distribution panel earthing conductors shall run from sub-distribution panel.

Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution panel. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to distribution panel at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of the equipment shall
be earthed by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord. Switches, accessories, lighting fitting etc. which are rigidly secured in effective electrical contact with a run of metallic conduit shall not be considered as a part of the earthing conductor for earthing purposes, even though the run of metallic conduit is earthed.

8.5 PROHIBITED CONNECTIONS

Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lightning protection system conductors shall not be used as a means of earthing an installation or even as a link in an earthing system. The electrical resistance measured between earth connection at the main LT panel and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate or circuit breakers, and shall not exceed 1 ohm. All switches carrying medium voltage shall be connected with earth by two separate and distinct connections. The earthing conductors inside the building wherever exposed shall be properly protected from mechanical injury by running the same in GI pipe of adequate size. The overlapping in strips at joints where required shall be minimum 75 mm. The joints shall be riveted and brazed in case of copper and by welding / bolting in case of GI in an approved manner. Sweated lugs of adequate capacity and size shall be used for termination of all conductor wires above 6 sq.mm size. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substances and properly tinned. Equipotential bonding of all metallic structures shall be done.

8.6 EARTHING

The following must always be ensured in earthing system.

- All earths of the same applications must be interconnected.
- Provision of testing link in each pit.
- On the joints, the nut bolts shall be of brass and a coating of primer will be provided & covered with bitumen tape for protection from the atmospheric condition.

8.7 The Contractor shall get the soil resistivity test done at his own cost of the area where earthing pits are to be located before starting the installation.

8.8 RESISTANCE TO EARTH

The resistance of earthing system shall not exceed 1 ohm.
10. DIESEL GENERATOR SETS:

10.0 INTENT OF SPECIFICATION:

10.1 This specification covers the design, manufacture, assembly, packing, dispatch, transportation to site, supply, erection, testing, commissioning, performance and guarantee testing of Diesel Gen-Set, complete in all respects with all equipment, fitting and accessories for efficient and trouble free operation as specified here under.

10.2 SCOPE OF WORK:

10.3 Scope of Supply & Services:

General Scope of work shall include design, manufacture, assembly, packing, dispatch, transportation to site, supply, erection, testing and commissioning of the following:

a) Diesel engine complete with all accessories, an Alternator directly coupled to the engine through flexible/rigid coupling complete with all accessories for starting, regulation and control, including base frame, interconnecting piping and accessories, power and control cable, glands and lugs etc.

b) D.G. Local/Remote control panel including cables between D.G. Set’s local equipment and special cables if any.

c) Equipment necessary for engine cooling system, radiators, pumps, valves, inter connecting pipes etc.

d) Equipment necessary for fuel storing and distribution, day oil tank (990 Lt.) for 750 KVA piping’s, pumps, valves, level indicators etc.

e) Exhaust piping, flexible connections and residential type silencer of exhaust system, including thermal lagging, cladding etc.

f) Batteries with good quality iron battery stand and battery charging equipment, including their connections as necessary, along with tools & accessories for battery maintenance. (Contractor shall submit the list of tools along with Tender)

g) Anti Vibration Mountings etc.

h) Cooling Towers including fans, motors, weatherproof isolator enclosure, isolator etc.

i) Cooling tower pumps etc.

j) Cooling system piping including controls & accessories etc.

k) Electrical panel for local equipment, cooling tower pumps etc.

l) Power & Control cabling, cable tray etc.

m) Cu/GI plate earthing etc.

n) Preparing all related shop drawings for approval from client/consultant and all statutory bodies as required and as applicable.
o) Obtaining statutory approval of the installation including permission for operation of Diesel Generators by the Electrical Inspectorate, Pollution Control bodies and any other statutory bodies as applicable.

p) Minor civil works like chasing, grouting etc. for execution of jobs.

q) Carrying out performance and guarantee test at site at available load which shall not be more than the capacity of D.G. Set.

2.2 Specific Exclusions:

Following items of works are excluded from the scope of works under this specification:

a) All civil works relating to DG foundation & pumps foundation.

3.0 CODES AND STANDARDS:

3.1 The equipment furnish under this specification shall conform to the following latest standard, except where modified or supplemented by this specification:

BS:5514 : Specification for reciprocating internal combustion engine.

BS:5000 : Rotating electrical machines of particular type or for particular applications.

IS:1239 (Part-I & II) : Mild steel tubes and fittings.

IS:1651 : Stationary cells and batteries lead acid type (with tubular positive plates).

IS:9224 : Specification of low voltage fuses, General Purpose.

IS:4540 : Mono-crystalline semi-conductor rectifier assemblies and equipment.

IS:5 : Colours for ready mixed paints.

IS:4722 : Rotating electrical machines.


IS:10000 : Methods of tests for internal combustion engines.

IS:10002 : Specifications for performance requirements for constant speed compression ignition (Diesel) engine for general purposes (above 20 KW).

IS:2147 : Degree of protection provided by enclosure for low voltage switchgear and control gear.

IS:1600 : Code for type testing of constant speed IC engines for general purposes.
Technical Specifications for Construction of Township

IS:1601 : Performance of constant speed IC engines for general purposes.

ASME Power : Internal combustion engines.
Test Code PTC-17

3.2 The installation work shall conform to Indian Electricity act and Indian Electricity Rules as amended up to the date of installation.

The fuel oil installation shall meet all statutory requirements of Govt. of India as amended up to the date of installation. Any approval required from statutory authorities shall be obtained by the Contractor. Nothing in this specification shall be construed to relieve the contractor of these responsibilities.

3.3 The Indian standards mentioned above are available from:

Indian Standards Institution
Manak Bhawan,
9, Bahadur Shah Zafar Marg,
New Delhi - 110 002 (INDIA).

3.4 The Indian electricity Rules and the Electricity act mentioned above can be obtained from:

Kitab Mahal,
State Emporium Building,
Baba Kharak Singh Marg,
New Delhi - 110 001 (INDIA).

3.5 Equipment conforming to any other National/International Standard which ensures equal or better quality may be accepted. In such case the bidder shall furnish copies of the standards in English along with his bid and shall clearly bring out the salient features of comparison with corresponding listed standards.

3.6 The equipment furnished under this specification have to operate in a tropical climate and shall be given tropical and fungicidal treatment as per relevant specification.

3.7 Period of Operation/Duty Cycle:

The sets are intended to supply power only during an emergency for all services and may be idle for long periods except for periodic routine tests once in a week. When there is a total failure of main power supply, the sets shall be required to operate continuously at full load for a period which at times may exceed even 24 hours.

4.0 ENGINE:

4.1 Type:

The diesel engine shall be of stationary type four stroke/ two stroke with vertical in line or (V) type cylinder arrangement, Turbo-charged, cooled with radiators.

4.2 Rating:
a) Prime power BHP rating of the engine shall be such that the DG set deliver the specified net electrical output while supplying power/driving all electrical and mechanical auxiliaries connected to alternator terminals and engine shaft at specified site conditions and ambient temperature of 50°C. The bidder shall submit the deration calculations if the engine is not designed for 50deg C. ambient temperature.

b) It shall also be capable of satisfactorily driving the alternator at 10% over load at the rated speed for one hour in any period of 12 hours of continuous running. 

The bidder shall have to furnish copy of deration chart from the original manual of the engine manufacturer and supporting calculations to arrive at diesel engine rating.

4.3 Speed and Vibration Levels:

a) Speed shall be 1500 revolutions per minute. Speed governor/over speed protection shall be provided.

At due running conditions, speed shall be stabilized at plus or minus 2% nominal speed, regardless of load. At transient condition, engine speed shall vary not more than 10% plus or minus. Governor class shall be A1 (4% drop) for normal application unless otherwise specified.

b) The engine vibration level shall not exceed 100 microns.

4.4 Lubrications:

a) The engine shall have a closed cycle forced & splash lubricating system with positive oil pressure and a crank chamber for collection/storage of the lubricating oil during circulation. Lubricating oil shall be circulated in the engine by an engine driven pump.

b) A lubricating oil filter of an efficient full flow type of ample capacity shall be provided for operation under normal conditions for a period of 300 hours without the necessity of its replacement or cleaning. Filters shall be capable of removing all foreign matter above a particle size of 5 microns.

c) In case lubricating oil coolers are required it shall be supplied as an integral part of the Diesel Generator Set.

d) Necessary temperature and pressure gauges and other instruments shall be supplied and fitted on the lubrication system.

e) A lubricating oil level dipstick suitably graduated shall be provided and located in the accessible position.

f) The tenderers shall state the guaranteed lubricating oil consumption in litres per hour.

4.5 Fuel System:
a) The engine shall be capable of satisfactory running on all types of diesel fuel oil normally available locally/in India.

b) The fuel consumption of the engine shall be expressed by the Contractor in the bid in litres per gross/nett kWh output from the alternator (after supplying the requirements of auxiliaries) at full, three quarters and half of its rated power output and at 0.8 and unitary power factor.

If guaranteed fuel consumption is exceeded, the contractor shall make such amendments or alterations as are necessary to bring the consumption to within the guaranteed figures. Tolerance of +5% as defined in BSS-649-1985 shall be allowed.

c) A fuel service tank of required capacity with each D.G. Set shall be provided on a suitably fabricated steel platform. The tank shall be complete with level indicator marked in litres, filling inlet with removable screen, an outlet, a drain plug, an air vent and necessary piping. The fuel tank shall be painted with oil resistant paint. All pipe joints should be brazed/welded.

4.6 Air Intake System:

The diesel engine shall be provided with special dry type air filters having low resistance to air passage, high dust retaining efficiency and provision for easy cleaning. Filters shall be suitable for achieving satisfactory engine operation and ensuring the engine life under tropical humid conditions, with sulphur dioxide fumes, abrasive dust and coal particles of 5 to 100 microns present in the atmosphere. The minimum efficiency of filters shall be 90% down to 5 micron size.

4.7 Cooling:

The diesel engine should be water cooled with heat exchanger system which shall work in closed loop primary cooling water circuit circulated by an engine driven pump for jacket cooling of the engine. The secondary water cooling circuit of the heat exchanger shall be cooled through a cooling tower. The cooling system should include temperature gauge with high temp., alarm/trip corrosion resistor etc. In addition, primary closed loop cooling circuit shall be closed with corrosion inhibitors recommended by the engine manufacturer to minimize engine jacket corrosion/scaling.

4.8 Engine Governor:

The governor shall be Electronic ISO-Chronous type to maintain zero speed rate or regulation and shall be AI type as per BS:5514 in order to take care of heavy motor starting. It shall have necessary characteristics to maintain the speed substantially constant even with sudden variation in load. However, a tripping shall be provided if speed exceeds maximum permissible limit. The governor shall be suitable for operation without external power supply.

4.9 Turbo Charger:
It shall be of a robust construction, suitable of being driven by engine exhaust having a common shaft for the turbine and blower. It shall draw air from filter of adequate capacity to suit the requirements of the engine.

4.10 Quietness of Operation:

a) The engine shall be designed to achieve maximum quietness of operation.

b) Efficient residential silencer shall be provided as per engine manufacturer’s approved make only for the exhaust.

c) Noise level of the set shall not exceed 75 dbA at one meter distance from the enclosure surface.

4.11 Engine Starting:

a) Engine starting shall be by electric starting motor complete with manual/automatic starting arrangement. The starter motor shall conform to IS:4722 and shall be of adequate power for its duty and be of inertia or pre-engaged type. The pinion shall positively disengage when the engine starts up or when the motor is de-energized. The engine cranking shall be only from the panel both for AMF & DG sets (Manual) and any engine starting devices etc. that are given as original fitment on the engine by engine manufacturers shall be either removed or padlocking arrangement given for this so that all normal start/stop operations could be done only from panel whether the set is AMF or manual.

The engine wiring shall be appropriately modified, ferruled to totally match with schematic drawings of the panel.

b) Time for Run-up to Speed:

From the initial operation of the starting device, the engine shall start, run up to normal speed and be capable of accepting 60% of full load within a maximum time of 20 seconds, and full load within a further 20 second.

4.12 Starter Battery:

a) The battery shall conform to the requirement of IS:1651. Starting battery each of 12 V, heavy duty high performance approved make/quality shall be provided to enable crank & start the engine even in cold/winter morning conditions. Type/voltage/AH capacity of same on 20 hour rated discharge period shall be indicated in the offer. The battery set shall be capable of performing at least (5) five normal starts without recharging.

b) The battery shall be provided with good quality iron battery stand painted with acid proof black paint with min 3mm thick rubber mat below the battery.

c) Batteries shall be of load container type only and not with PVC moulded sealed container so that each individual cells are available for individual monitoring during its life span. Each cell shall be provided with electrolyte filling cap with level floats for easy monitoring of electrolytic level.
d) The battery shall be provided with 2 Nos. cables, minimum 1.5m long heavy duty rubber/PVC insulated cabling with brazed tinned lug at one end and with brazed tinned brass terminal lug at battery end - for connecting batteries to cranking system - with 0.25 m long inter battery connecting cable.

e) The lugs shall be clearly stamped (+) or (-) and positive cable also red sleeved for easy identification.

f) The batteries Set shall be supplied fully filled and first charged ready to use.

g) Batteries set shall be supplied with spring type hydrometer, thermometer with specific gravity correction scale and cell testing voltmeter etc.

4.13 Battery Charging System:

a) Float rate charging and quick rate charging system shall be provided at the generator panel with appropriate bridge charger system, LC network, rate selector switch and generously rated charging transformer and silicon one rectifier bridge, so that the cranking battery system can be kept fully charged at all times from E.B. supply network with quick charging rate limited to 0.8 times rated discharge current with provision in control transformer and Si rectifier present to enable boost charging the battery at 2 times rated discharge current in case of emergencies. To this and in the mode selector switch boost charge position shall be present which however shall be kept disconnected at mode selector switch normally.

b) DC ammeters to clearly indicate float charging current and quick/boost charging current shall be provided.

c) Dropper resistor network on the load side of battery charger system shall be provided so that higher charger voltages in quick or boost conditions does not get impressed on the I/L and Contactor coils, which voltage shall remain well within +10% of rated voltage.

d) Battery charging subsystem shall be designed for continuous operation at cubicle ambient of 50°C corresponding to 45°C ambient outside and should be designed to operate at 1.5 times rated maximum current corresponding to boost charge current which can reach in practice as high as 2.5 times or 3 times rated discharge current.

e) Any charger dynamo and dynamo charging current network present on the set shall be made in operative so that both for AMF and manual application the cranking battery system is kept charged from the charger at the panels at all times during or shut down periods of the set.

f) To the above and in case of manual DG sets, the input to charger subsystem viz., 240 V AC is foreseen to be provided from customer network from the portion that is normally supplied by manual DG Set during DG operation or being fed by E.B. System.

g) Battery charger shall form part of D. G. protection and PLC panel.

4.14 Engine Fitments:

The engine shall be provided with but not limited to following essential basic fitments:
- Crank case breather - Dry type element (Breather outlet shall be fitted with a filter cap capable of preventing entry of dust).
- Air Cleaner - Dry type mounted.
- Corrosion resistor - to control acidity and impurities from coolant.
- Lubricating Oil Cooler - Lub oil & fuel oil, paper element type.
- Filters - Gear Driven.
- Coolant Pump - Priming & Transfer
- Governor - Exhaust gas driven in case of turbo charged engines.
- Turbo Charger - SAE Type
- Flywheel with flywheel housing - One Set
- Vibration dampers
- Exhaust/Intake manifolds
- Oil Sump (crank case) with dip stick
- Engine Supports
- Residential type silencer in exhaust system
- Electrical starter 12 V or 24 V
- Safety controls & instruments
- Flexible coupling with guard

### 4.15 Engine Instrumentation:

The following instruments mounted on instrument panel shall be essentially present as minimum:

- Engine speed tachometer with service hour counter
- Lub oil pressure gauge
- Coolant water temperature gauge

The instrument panel shall be mounted on engine using rubber dampers for vibration isolation.

The gauges shall have clear red marking to identify the limiting dangerous levels, `Zone Markings’ on the scale to indicate the normal healthy & abnormal operating zones for the parameters concerned.

The metering could be either normal electro-mechanical analogue type or electronic digital type, latter being preferred as manufacturers fitment only.

The engine control panel must be supplied by the engine manufacturer only.

### 4.16 Mountings and Foundations:

The engine and direct coupled attenuator shall be rigidly secured to a common rigid base frame fabricated from MS section.

The DG set shall be placed on the RCC floor with approved make anti-vibration mountings. A lifting hook of required capacity shall be provided above the finalized
location of the DG set to facilitate installation and subsequent maintenance of the DG Sets.

The design of mounting arrangement with anti-vibration mountings shall be as recommended by the DG manufacturers and shall be such that a maximum of 2% vibration are transmitted to the structure.

The tenderer shall confirm the type & design of mountings provided and the vibration isolation efficiency in the tender.

4.17 **Exhaust Piping:**

The engine shall be fitted with a residential type silencer (design approved by manufacturer) to reduce the noise level. Silencer outlet shall be connected to exhaust piping carried to the top of the building through shafts provided for the purpose. Exhaust piping shall be fabricated from class ‘B’ MS pipes of size suitable to limit back pressure to within permissible limit (2.5” of Hg.). Tenderer shall submit design calculation in support of the back pressure being within limits along with the tender.

It is important to ensure that the surface temperature of the exhaust piping does not exceed 50°C. For this purpose, the entire length of exhaust piping shall be insulated with minimum 50mm thick layer of LRB rock wool (48 kg./m³ density covered with 26 SWG aluminium sheet cladding. Flanged joints in the exhaust piping shall be covered with removable insulation at suitable intervals for permitting access to the joint if and when required.

Exhaust piping shall connected to the engine by means of flexible section or an expansion joint and shall also be graded to a drain pocket inside the building. The pocket shall be fitted with a drain cock.

4.18 **Tools:**

Two sets of standard tools kit for maintenance shall be provided by Contractor. Tenderer shall submit a list of the tools along with the tender. (Cost shall be inclusive in the quoted rates)

4.19 **Safety Controls:**

**Low Lubricating Oil Pressure:**

Pressure sensors shall be fitted such that in the event of a fall in the lub oil pressure, an alarm and indication shall be actuated. In addition, the engine shall be automatically shut down in the event of lub oil pressure dropping to a predetermined low value.

**High Water Temperature:**

An alarm shall be given if the close loop engine jacket cooling water temperature exceeds safe limits stipulated by the engine manufacturer due to any reason (including low level of water in secondary cooling system cooling tower). The engine shall be shut down when a pre-determined set water temperature is reached.

**Over Seed:**
Speed control shall be so arranged that a 12 ½% increase over normal rated speed shall cut off fuel supply, thus stopping.

**Overload Protection:**

The engine shall be adequately protected against operating under overload conditions. The requirements shall be met by the provision of a fixed overload limit stop on the fuel pump rack control rod to prevent the set being subject to a load exceeding the site rating plus 10%.

**Excess Starting Time:**

The starting circuit for the automatic mains failure diesel generator sets shall be arranged to attempt upto three starting cycles, each not exceeding 10 seconds duration with a similar OFF period between each cycle. If the set fails to start upon completion of the third attempt the starting circuit shall be locked out until it is restored manually. An alarm shall be given and “Set failed to start” indication given on the panel.

**Fuel Level Protection:**

A level sensor shall be provided in the day fuel tanks to give visual and audible alarms if the level in the tank falls to below ¼ of full.

**5.0 ALTERNATOR:**

5.1 The alternator shall have brushless type with rotating field and static excitation circuit controlled by field control unit suitably compounded for voltage and load current for a self excited self regulated system.

5.2 The alternator shall be in SP-DP enclosure, foot mounted with ball and roller bearings on end shields.

5.3 The alternator shall conform to IS:4722/BS:2613 and shall be suitable for tropical conditions.

5.4 The alternator shall comply with the following specifications:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating</td>
<td>750 kVA (Shall be capable of 10% over loading at the rated speed for one hour of 12 hours continuous running without exceeding permissible temperature rise.)</td>
</tr>
<tr>
<td>Phase</td>
<td>3 phase, 4 wire</td>
</tr>
<tr>
<td>Voltage</td>
<td>415 V</td>
</tr>
<tr>
<td>Regulation</td>
<td>To be filled by the Tenderer</td>
</tr>
<tr>
<td>Speed</td>
<td>1500 RPM</td>
</tr>
<tr>
<td>Frequency</td>
<td>50 Hz.</td>
</tr>
</tbody>
</table>
Technical Specifications for Construction of Township

P.F. - 0.8 lag
Enclosure - IP:23
Insulation - H
Execution - Self excited, self regulated with brushless system and static voltage control unit suitably compounded for voltage and current to maintain terminal voltage constant at ± 5% at all load for p.f. not less than 0.8 lag.

Terminal Box - LV cable box
Earthing Studs - As per BOQ

5.5 Neutral Point:

The winding of the alternator shall be star-connected with the neutral connection brought out to a separate terminal.

5.6 Terminal Box and Connection:

The alternator output terminals shall be enclosed in a terminal box mounted in an accessible position on the alternator frame. As far as possible, connections between the exciter and alternator shall be contained within the machine frame and connections carrying A.C. and D.C. shall be segregated from each other. The terminal box shall be of sufficient size to conveniently terminate the size and number of the Owner’s cables, which shall be intimated during detailed engineering. Suitable tinned copper pads shall be provided for power cable termination along with all necessary hardware and cable lugs. Glands and lugs shall be provided for control cables also. For single phase cables, gland plate shall be of non-magnetic material. Gland plate shall be removable type.

5.7 The generating set shall be so designed that it is capable of reaching its full voltage and frequency and shall be ready to take full load within 30 seconds of a remote starting impulse being received.

6.0 ENGINE SAFEGUARDS:

Safeguards shall be provided and arranged when necessary to stop the engine automatically by the following:

a) Energising a solenoid coupled to the stop lever on the fuel injection pump rack.
b) De-energising the “fuel on” solenoid
c) Energising the “fuel - cut off” solenoid.

The operation of the safeguard shall at the same time give individual warning of the failure by illuminating an appropriate local visual indicator and remote alarm at generator panel.
The contractors, relays and other devices necessary for signal and control, for above purposes shall be provided at Generator panel.

At the set at a easily accessible place an “EMERGENCY STOP” mushroom head stay put type P.B shall provided to stop the set in emergency mode.

The safe guard to “STOP THE SET” shall stop the set irrespective of mode selection of the set viz Auto, Manual or test for following cases, with simultaneous isolation of alternator ckt.

a) Emergency stop P.B's operation
b) Over speed.
c) Low lube oil pressure.
d) Earth fault
e) Over current
f) High water temperature

7.0 TESTS:

7.1 The alternator of each type and rating shall be type tested for the following tests as per IS:4722, IEEE 115 & BS:5000. Test certificates to be provided for routine and type tests from the manufacturers.

8.0 ERECTION, TESTING, COMMISSIONING AND PERFORMANCE & GUARANTEE TESTS/PROCEDURE AT SITE:

The entire work of erection, testing and commissioning of equipment supplied under this package shall be carried out by contractor and performance and guarantee tests to be conducted at site are also included under the scope of this specification. For this purpose the contractor shall depute suitable qualified technical supervisor to site on advance intimation to the Owner along with all special testing equipment required for testing and performance and guarantee tests. The supervisor(s) shall be responsible for the installation, testing, commissioning checks and performance & guarantee tests mentioned in relevant clauses of this volume and the checks recommend by the contractor.

The contractor shall ensure that the equipment supplied by him are installed in a neat workman like manner such that they are leveled, properly aligned and well oriented. The tolerances shall be established in Contractors drawings and/or as stipulated by the Owner.

All special tools and tackles and spares required for erection, testing and commissioning of equipment shall be supplied by the contractor.

Erection, testing and commissioning manuals and procedures shall be supplied, prior to dispatch of the equipment.

The contractor shall ensure that the drawings, instruction and recommendations are correctly followed while handling, setting, testing and commissioning the equipment.

8.1 Commissioning Check Tests/Performance and Guarantee Test:
In addition to the checks and tests recommended by the manufacturer, the contractor shall supervise the following acceptance tests to be carried out on each test at site.

i. **Load Test:**

   The DG Set shall be given load test at site for a period of at least 6 hours depending upon the actual power factor of the load and set shall be subjected to the maximum achievable load without exceeding the engine or alternator capacity.

   This full load test is to be followed immediately by a 10% overload run for one hour. The performance of the engine, alternator shall be satisfactory at the end of this overload run.

   During the load test half hourly records of the following shall be taken:

   a) Ambient temperature  
   b) Cooling water temp.  
   c) Lubricating oil pressure.  
   d) Speed  
   e) Voltage, wattage and current output.  
   f) Oil tank level

ii. **Speed and Governing:**

   The speed of the engine shall be verified to ensure that it conforms to the requirement of BS:5514.

iii. **Check of Fuel Consumption:**

   A check of the fuel consumption shall be made throughout the test run of full load and overload.

iv. **Noise Level:**

   The noise level shall not increase beyond 75 dBA at 1 metre distance from DG Set enclosure surface.

9.0 **EARTHING**

9.1 **General**

This section covers the general arrangement of the earthing, i.e. all non-current carrying metal parts of the electrical installation shall be earthed as per IS 3043(1987) and general specifications for electrical works (part-1, internal) of CPWD specifications. All metal conduits, trunkings, cable sheaths, switchgear, distribution boards, meters, light fixtures, fans and all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to earth electrodes. Earthing shall also be in conformity with the provisions of Rule 32, 61, 62, 67 and 88 of IER 1956. The earth electrode shall not be situated less than 1.5 mtr.

9.2 **Earthing Systems**
It shall comprise of earth electrodes, earth strips, earth continuity conductor and all earthing conductors shall be of high conductivity copper, GI or aluminium and shall be protected against mechanical damage and corrosion. The size of earth conductors shall not be less than half that of the largest current carrying conductor. The connection of earth continuity conductors of earth bus and earth electrodes shall be strong and sound and shall be rigidly fixed to the walls, cable trenches, cable trays or conduits and cable by using suitable clamps made of non ferrous metals.

9.3 **Earthing Electrodes**

Earthing electrodes shall be designed as per the requirement of IS 3043 (1987). The number and size of earth electrodes shall be calculated so that under fault conditions no electrode is loaded above its maximum permissible current density. The resistance of earth electrode shall be as low as possible, the maximum allowable value being one ohm.

Earthing electrodes of either plate type or pipe type may be adopted. The choice of plate or pipe electrode shall be decided according to the anticipated fault level of the network and local soil conditions. Generally, plate electrodes shall be used for substations and large medium voltage network and pipe electrodes for small medium voltage network and installations.

9.4 **Location of Earth Electrodes**

Normally on earth electrode shall not be situated less than 1.5 m from any building. Care shall be taken that the excavation for earth electrode may not effect the column footings or foundation of the buildings. In such cases electrodes may be further away from the building.

The location of the earth electrode will be such where the soil has reasonable chance of remaining moist. As far as possible, entrances, pavements and road ways, are to be definitely avoided for locating earth electrode.

9.5 **Water Arrangement**

Method of watering arrangement shall comply with CPWD General Specifications.

9.6 **Plate Electrode**

Plate electrodes shall be made of GI plate of 6 mm thick and 60x60 cm. size. The plate shall be buried vertically in ground at depth of not less than 3.5 metres to the top of the plate, the plate being encased in charcoal to a thickness of 15 cm all round. It is preferable to bury the electrode to a depth where sub-soil water is present. Earth leads to the electrode shall be laid in a GI pipe and connected to the plate electrode with GI bolts, nuts and washers. A GI pipe of not less than 19 mm dia shall be placed vertically over the plate and terminated in a funnel at 5 cm. above ground. The funnel shall be provided with a wire mesh. The funnel shall be enclosed in masonry chamber of not less than 300 x 300 x 300mm dimensions. The chamber shall be provided with CI frame cover of 300 x 300mm size & thickness not less than 10mm. The earth station shall also be provided with a suitable permanent identification label/tag. A suitable test link shall be provided in the earth chamber.
Technical Specifications for Construction of Township

Note: If copper plate is used it shall be of 3mm thickness.

9.7 Pipe electrode shall comprise of a 2.5 Mtr. long 40 mm dia GI pipe buried vertically in a pit of 35 x 35 cm size and filled with alternate layers of charcoal, salt and river sand and connected at the top to a GI pipe of 19 mm, 1 Mtr. long with a funnel at the other end, 5 cm above the ground. The earth lead shall be properly fixed to the pipe electrode with brass bolts, nuts and washers. The funnel and earth lead connections shall be enclosed in a masonry chamber of 30 x 30 x 30 cm. dimensions. The chamber shall be provided with a CI frame and CI cover. Proper permanent identification tag/label shall be provided for each electrode.

9.8 Installation

9.8.1 All joints shall be reverted and sweated. Joints in the earth bar shall be bolted and the joints faces tinned. Where the diameter of the bolt for connecting earth bar to apparatus exceeds one quarter of the width of the earth bar, the connection to the bolt shall be made with a wider piece of flange of copper jointed to earth bar. These shall be tinned at the point of connection and special care taken to ensure a permanent low resistance contact to iron or steel. All steel bolts, nuts, washers, etc shall be cadmium plated. Main earth bars shall be spaced sufficiently away from the surface to which they are fixed, such as walls or the side of trenches to allow for easy connections. Copper earth bars shall not be fixed by ferrous fittings. The earthing shall be suitably protected from mechanical injury by galvanized iron within ground shall be buried at least 60 cm deep. The earthing lead shall be securely bolted and soldered to the plate or pipe as the case may be. In the case of the plate, the lead shall be connected by means of cable socket and then run to the masonry enclosure of not less than 30 cm x 30 cm x 30 cm. A cast iron cover having locking arrangement shall be suitably embedded in the masonry enclosure.

9.8.2 Method of Installation of watering arrangement

In the case of plate earth electrode a watering pipe of 20 mm dia of medium class GI pipe shall be provided and attached to the electrode. A funnel with mesh shall be provided on the top for watering the pit. In case of pipe earth electrode a 40 mm x 20 mm reducer shall be used for accessing the funnel. The watering funnel attachment shall be housed in masonry enclosure of not less than 30 cm x 30 cm x 30 cm. A cast iron cover having locking arrangement shall be suitably embedded in the masonry enclosure.

9.5 Precautions

9.5.1 Earthing system shall be mechanically robust and the joints shall be capable of retaining low resistance even after passages of fault currents.

9.5.2 Joints shall be soldered, tinned and double riveted. All the joints shall be mechanically and electrically continuous and effective. Joints shall be provided against corrosion.

9.5.3 The earthing lead from electrode onwards shall be suitably protected from mechanical injury by a 15 mm dia GI pipe in case of wire and by 40/80 mm dia medium class GI pipe in case of strips. Portion of this protection pipe within the ground shall be buried at least 30 cm deep (to be increased to 60 cm in case of road crossing and pavements). The portion within the building shall be recessed in walls and floor to adequate depth.
9.6 Testing

9.6.1 On the completion of the entire installation, the following tests shall be conducted and no earth electrode shall have ohmic resistance of more than 2 ohm and in rocky soil not more than 3 ohms.

   a) Earth resistance of electrodes
   b) Impedance of earth continuity conductors as per E-3 of IEE regulations.
   c) Effectiveness of earthing as per E-4 & E-5 of IEE regulations.

9.6.2 All meters, instruments and labour required for the tests shall be provided by the contractor. The test results shall be submitted in triplicate to the Architects for approval.

10.0 RADIO INTERFERENCE:

All equipment provided under this specification shall be so designed that it will not cause interference with radio equipment. In the event of the inherent characteristics of the equipment being such that radio interference is possible, efficient devices to nullify the same shall provided. Suppressers shall be as per the relevant IS/BS Standards. Nothing extra shall be paid to the contractor on this account.

11.0 PRE-COMMISSIONING CHECKS:

All standards checks including the ones elaborated in the specifications to ensure that the installation of the DG sets and associated systems has been carried out satisfactorily shall be done on completion of installation. These shall include:

   a) DG Sets:
      Checking of piping interconnections
      Checking of electrical interconnections
      Checking of insulation resistance
      Checking of earthing
      Checking of instruments and controls
      Checking of alignment
      Checking of vibration transmission to building a structure
      Checking of expansion joints

   b) Cooling Water System:
      Checking of piping interconnections
      Checking of electrical interconnections
      Checking of insulation resistance
      Checking of earthing
      Pressure testing of piping

   c) Exhaust System:
      Checking of silencer operation
      Checking of surface temperature of exhaust piping

   d) Fuel System:
12.0 PERFORMANCE TESTING AND TYPE TESTS:

13.1 Performance Testing:

DG sets shall be tested at varying loads at manufacturers works prior to dispatch of the sets to site. The performance tests at the works shall be carried out in presence of authorized representative from the Owners to enable them to arrange for their representatives for his inspection to be at manufacturers works for this inspection and testing. The costs for the arrangement shall be borne by the Contractor. Inspection waiver shall be solely as per owner wish.

The performance test on each DG sets shall be of minimum 8 hours duration.

All instruments, materials, consumables (fuel oil, lube oil etc.) load and labour required for carrying out of the test shall be provided by the Contractor.

Following test acceptance criteria shall be applicable:

<table>
<thead>
<tr>
<th>No.</th>
<th>Test Description</th>
<th>Acceptance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Fuel consumption at 50%, 75%, 100% and 110% load</td>
<td>±5% of guaranteed performance. Actual alternator efficiencies as determined in the manufacturers works tests shall be used as the basis of calculation of specific fuel consumption ratio.</td>
</tr>
<tr>
<td>2.</td>
<td>Voltage regulation from no load to full load</td>
<td>±1%</td>
</tr>
<tr>
<td>3.</td>
<td>Frequency regulation from no load to full load</td>
<td>±0.5%</td>
</tr>
<tr>
<td>4.</td>
<td>Maximum water temperature</td>
<td>±5% of guaranteed performance</td>
</tr>
<tr>
<td>5.</td>
<td>Maximum Lub Oil temperature</td>
<td>±5% of guaranteed performance</td>
</tr>
<tr>
<td>6.</td>
<td>Minimum Lub Oil pressure</td>
<td>±5% of guaranteed performance</td>
</tr>
<tr>
<td>7.</td>
<td>Lub Oil Consumption</td>
<td>±5% of guaranteed performance</td>
</tr>
</tbody>
</table>

14.2 Type Test:

Copies of manufacturers type test for the engine and the alternator of all ratings shall be enclosed along with the dispatch of the DG sets.

15.0 EXHAUST BLOWER:

16.1 The exhaust fans shall be propeller type with steel hub and blades, mounted directly on the shaft of a totally enclosed motor.

16.2 The fan blades shall be of pressed steel of aerofoil design for high efficiency and static pressure.

16.3 The mounting frame shall be of cast/sheet steel brackets to connect the frame, with the fan/motor assembly. Rubber mounts shall be provided between the mounting frame and the mounting brackets.

16.4 The fan motor shall be totally enclosed squirrel cage type.
17.0 DG CONTROL AND OPERATION:

Operation of DG Sets shall be monitored and controlled by a programmable logic controller (PLC) based logic panel provided by owners on the main LT Panel of the system. DG contractor shall coordinate this aspect with the electrical contractor appointed by the owner, to integrate his installation for successful operation. Nothing extra shall be paid to the contractor on this account.
### TECHNICAL PARTICULARS

(Technical Particulars to be filled in by tenderers and enclosed alongwith the tender)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Conformations or comments or data shall be furnished by tenderer against each item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel Generating Set</td>
<td>750 KVA</td>
</tr>
<tr>
<td>Packager of DG Set</td>
<td></td>
</tr>
<tr>
<td>Prime rating of the DG set based on continuous operation for 365 days in a year at varying loads. The prime rating as above shall be suitable for continuous operation over an ambient of 50°C. Tenderer to categorically confirm this operation and to furnish design calculation in support of this confirmation. DG set to be suitable for 10% overload capacity for 1 hour on 12 hours – over and above the governor capacity being suitable. DG Set Dimensions (LxWxH) DG Set Weight (in kgs.) Diesel Engines: Manufacturer of Diesel Engine Manufacturers Model No. BHP RPM No. of Cylinder Type of Cooling Type of Starting Aspiration Air cleaner type Fuel/Lub Oil Filter Type Governor type and class Flywheel to suit flexible coupling Flexible coupling with guard Fuel Pump Hot water auxiliary pump with thermostatic control to maintain the water temperature in the engine jacked at 40°C. Interconnection wiring, cabling and piping as required Cooling water quality Max. engine water temperature</td>
<td></td>
</tr>
</tbody>
</table>
### Technical Specifications for Construction of Township

**Construction of Township at Khilpara, Udaipur, Tripura**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Conformations or comments or data shall be furnished by tenderer against each item</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>750 KVA</strong></td>
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<tr>
<td>Lub Oil pressure</td>
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<tr>
<td>Max. Lub Oil temperature</td>
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<tr>
<td><strong>Fuel Consumption:</strong></td>
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<tr>
<td>Typical fuel consumption gms/BHP/hr</td>
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<tr>
<td>50% load</td>
<td></td>
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<tr>
<td>75% load</td>
<td></td>
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<tr>
<td>100% load</td>
<td></td>
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<tr>
<td>100% load</td>
<td></td>
</tr>
<tr>
<td>Fuel consumption figures vis-à-vis alternator electrical output – kWh/litre</td>
<td></td>
</tr>
<tr>
<td>50% load</td>
<td></td>
</tr>
<tr>
<td>75% load</td>
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<tr>
<td>100% load</td>
<td></td>
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<tr>
<td>100% load</td>
<td></td>
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<tr>
<td>Fuel air compression ratio</td>
<td></td>
</tr>
<tr>
<td>Suitability for locally available HSD</td>
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</tr>
<tr>
<td>Suitability of operation of DG set on cheaper fuel like LDO etc.</td>
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<tr>
<td><strong>Lub Oil Consumption:</strong></td>
<td></td>
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<tr>
<td>Lub oil consumption at 100% load</td>
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<tr>
<td><strong>Heat Balance:</strong></td>
<td></td>
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<tr>
<td>Typical heat balance</td>
<td></td>
</tr>
<tr>
<td>Heat rejected to cooling water</td>
<td></td>
</tr>
<tr>
<td>Heat rejected after cooler</td>
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<tr>
<td>Heat rejected to exhaust</td>
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<td>Heat rejected to Ambient</td>
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</tr>
<tr>
<td><strong>Alternator:</strong></td>
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<tr>
<td>Manufacturer</td>
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<td>Enclosure</td>
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<tr>
<td>Mounting</td>
<td></td>
</tr>
<tr>
<td>KW Rating</td>
<td></td>
</tr>
<tr>
<td>KVA Rating</td>
<td></td>
</tr>
<tr>
<td>Insulation class</td>
<td></td>
</tr>
<tr>
<td>Temperature Rise under continuous operation</td>
<td></td>
</tr>
<tr>
<td>Excitation unit</td>
<td></td>
</tr>
<tr>
<td>Voltage Regulation no load to full load</td>
<td></td>
</tr>
<tr>
<td>Wave from distortion on full load</td>
<td></td>
</tr>
<tr>
<td>Radio Interference</td>
<td></td>
</tr>
<tr>
<td>ITEM</td>
<td>Conformations or comments or data shall be furnished by tenderer against each item</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td><strong>750 KVA</strong></td>
</tr>
<tr>
<td>Telephone Interference</td>
<td></td>
</tr>
<tr>
<td>Stator winding thermistor with trip</td>
<td></td>
</tr>
<tr>
<td>Space heater</td>
<td></td>
</tr>
<tr>
<td>Single step load acceptance</td>
<td></td>
</tr>
<tr>
<td>Peak motor starting KVA</td>
<td></td>
</tr>
<tr>
<td>Sustained short circuit % of rated current for 10 seconds</td>
<td></td>
</tr>
<tr>
<td>Overload rating for:</td>
<td></td>
</tr>
<tr>
<td>15 seconds</td>
<td></td>
</tr>
<tr>
<td>60 seconds</td>
<td></td>
</tr>
<tr>
<td>10 minutes.</td>
<td></td>
</tr>
<tr>
<td>30 minutes</td>
<td></td>
</tr>
<tr>
<td>Terminal Box (Yes/No)</td>
<td></td>
</tr>
<tr>
<td><strong>Instruments and Controls</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Instruments:</strong></td>
<td></td>
</tr>
<tr>
<td>Oil temperature gauge</td>
<td></td>
</tr>
<tr>
<td>Oil pressure gauge</td>
<td></td>
</tr>
<tr>
<td>Water temperature gauge</td>
<td></td>
</tr>
<tr>
<td>A.C. voltmeter with 3 way and OFF selector switch</td>
<td></td>
</tr>
<tr>
<td>A.C. ammeter with 3 way and OFF selector switch</td>
<td></td>
</tr>
<tr>
<td>Frequency meter</td>
<td></td>
</tr>
<tr>
<td>Battery charging ammeter</td>
<td></td>
</tr>
<tr>
<td>Hour meter to show total engine hours run – 10000 hr capacity</td>
<td></td>
</tr>
<tr>
<td>R.P.M. indicator</td>
<td></td>
</tr>
<tr>
<td><strong>Switches:</strong></td>
<td></td>
</tr>
<tr>
<td>Emergency stop push button</td>
<td></td>
</tr>
<tr>
<td>Run/off-reset/auto engine start switch</td>
<td></td>
</tr>
<tr>
<td>Manual Voltage adjustment</td>
<td></td>
</tr>
<tr>
<td><strong>Indication Lamps:</strong></td>
<td></td>
</tr>
<tr>
<td>Battery Charger fault</td>
<td></td>
</tr>
<tr>
<td>Low battery voltage</td>
<td></td>
</tr>
<tr>
<td>Emergency stop</td>
<td></td>
</tr>
<tr>
<td>Generator switch not in auto</td>
<td></td>
</tr>
<tr>
<td>Low fuel</td>
<td></td>
</tr>
<tr>
<td>Low water temperature</td>
<td></td>
</tr>
<tr>
<td>Pre-alarm high engine temperature</td>
<td></td>
</tr>
<tr>
<td>Pre-alarm low oil pressure</td>
<td></td>
</tr>
<tr>
<td>System ready</td>
<td></td>
</tr>
</tbody>
</table>
### Technical Specifications for Construction of Township

#### 750 KVA

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Conformations or comments or data shall be furnished by tenderer against each item</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safety Controls:</strong></td>
<td></td>
</tr>
<tr>
<td>Safety Control – low lub oil pressure</td>
<td></td>
</tr>
<tr>
<td>Safety Control – high lub oil temperature</td>
<td></td>
</tr>
<tr>
<td>Safety Control – high engine temperature</td>
<td></td>
</tr>
<tr>
<td>Safety Control – Over crank</td>
<td></td>
</tr>
<tr>
<td>Safety Control – Over speed</td>
<td></td>
</tr>
<tr>
<td>Safety Control – Over Voltage</td>
<td></td>
</tr>
<tr>
<td>Safety Control – low water level in cooling towers</td>
<td></td>
</tr>
<tr>
<td><strong>Antivibration Mounting:</strong></td>
<td></td>
</tr>
<tr>
<td>Make</td>
<td></td>
</tr>
<tr>
<td>Vibration Isolation Efficiency</td>
<td></td>
</tr>
<tr>
<td><strong>Exhaust System:</strong></td>
<td></td>
</tr>
<tr>
<td>Exhaust silencer type</td>
<td></td>
</tr>
<tr>
<td>Number of Silencers provided</td>
<td></td>
</tr>
<tr>
<td>Noise level dB at 1m from silencer</td>
<td></td>
</tr>
<tr>
<td>Noise level 1m outside DG room and 1 m from the enclosure surface</td>
<td></td>
</tr>
<tr>
<td>Exhaust pipe diameter, material and thickness</td>
<td></td>
</tr>
<tr>
<td>Guaranteed Temperature on external face of exhaust pipe insulation</td>
<td></td>
</tr>
<tr>
<td>Details of insulation provided for exhaust pipe</td>
<td></td>
</tr>
<tr>
<td>Temperature of flue gases at exhaust manifold</td>
<td></td>
</tr>
<tr>
<td>Expansion joints in exhaust piping</td>
<td></td>
</tr>
<tr>
<td>Exhaust stack height – along with back pressure calculation</td>
<td></td>
</tr>
<tr>
<td><strong>Cooling Tower:</strong></td>
<td></td>
</tr>
<tr>
<td>Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td></td>
</tr>
<tr>
<td>Overall Dimensions (mm)</td>
<td></td>
</tr>
<tr>
<td>Weight with water (kg.)</td>
<td></td>
</tr>
<tr>
<td>Cooling capacity (TR)</td>
<td></td>
</tr>
<tr>
<td>Wet Bulb (Design) (Deg. F)</td>
<td></td>
</tr>
<tr>
<td>Approach to Design Wet Bulb (Deg. F)</td>
<td></td>
</tr>
<tr>
<td>Drift Loss (USGPM)</td>
<td></td>
</tr>
<tr>
<td>ITEM</td>
<td>Conformations or comments or data shall be furnished by tenderer against each item</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Evaporative Loss (USGPM)</td>
<td>750 KVA</td>
</tr>
<tr>
<td>Total Water Loss (USGPM)</td>
<td></td>
</tr>
<tr>
<td>Fan Capacity (CFM)</td>
<td></td>
</tr>
<tr>
<td>Fan Motor HP</td>
<td></td>
</tr>
<tr>
<td>Outlet Velocity (FPM)</td>
<td></td>
</tr>
<tr>
<td>Fan Speed (RPM)</td>
<td></td>
</tr>
<tr>
<td>Fan Diameter (mm)</td>
<td></td>
</tr>
</tbody>
</table>

### Pumps:
- Manufacturer
- Model
- Impeller dia. (mm)
- Capacity – LPM, Head and Motor HP
- Motor Speed (RPM)
- Type & Material of Seal
- Performance Curves (Whether enclosed with Tender)

### Piping:
- Pipe make
- Butterfly valve make
- Gate/Check valves make
- Pot Strainer
- Y-Strainer
- Mixing Valve
- Water Flow switch

### Blower Fan:
- S.No.
- Type
- Manufacturer
- CFM
- Static Pressure (mm WG)
- Motor HP
- Insulation Class
- Outlet Velocity (FPM)
- RPM
- Type of Drive
- Noise level (DB)

### Ventilation requirements:
- for DG set combustion
- for DG set ventilation to maintain 10°C rise in temperature over ambient

### Approvals from following shall be
<table>
<thead>
<tr>
<th>ITEM</th>
<th>Conformations or comments or data shall be furnished by tenderer against each item</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>750 KVA</strong></td>
</tr>
</tbody>
</table>

- Obtained by Contractor prior to commencement of work and after completion as required
- Chief Electrical Inspector to the Local State Government
- State Electricity Authorities/HERC
- Pollution Control Board for air and noise pollution
- Department of Explosives

**Noise Limit (Pollution Norms):**

Confirmation of compliance to noise limits stipulated in Central Government Notification dated July 9, 2002 to comply with Environment (Protection) Third Amendment Rules, 2002 or latest amendment in Pollution norms laid by Statutory Authority.
### D.G. SETS COST OF GENERATION:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Unit</th>
<th>Data shall be furnished by tenderer against each item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make of Engine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Make of DG set</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine Model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DG set rating</td>
<td>KVA</td>
<td>750 KVA</td>
</tr>
<tr>
<td>DG Set rating</td>
<td>KW</td>
<td></td>
</tr>
<tr>
<td>Average Load factor</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Units generated per hour</td>
<td>KWH/hour</td>
<td></td>
</tr>
<tr>
<td>Number of hours per year</td>
<td>Hour annum</td>
<td></td>
</tr>
<tr>
<td>Number of units generated per year</td>
<td>KWH/annum</td>
<td></td>
</tr>
</tbody>
</table>

#### Fuel Cost:

| Fuel rate                                  | Rs. Per litre |                                                   |
| Fuel consumption                          | Litres/hour   |                                                   |
| Number of units per litre of Diesel        | KWH/litre     |                                                   |

#### Fuel Cost:

<table>
<thead>
<tr>
<th>Fuel Cost:</th>
<th>Rs. Per KWH</th>
<th></th>
</tr>
</thead>
</table>

#### Lub Oil Consumption Cost:

| Lub oil consumption                       | Litres/hour   |                                                   |
| Cost of lub oil                           | Rs. Per litre |                                                   |
| Lub oil consumption cost                  | Rs. Per hour  |                                                   |

#### Lub Oil Consumption cost

<table>
<thead>
<tr>
<th>Lub Oil Consumption cost</th>
<th>Rs. Per KWH</th>
<th></th>
</tr>
</thead>
</table>

#### Lub Oil Replacement Cost

| Lub Oil replacement period                | Hours         |                                                   |
| Lub Oil replacement quantity             | Litres        |                                                   |
| Lub Oil replacement                       | Litres/hour   |                                                   |
| Lub Oil replacement cost                  | Rs./hour      |                                                   |

#### Lub Oil replacement Cost

<table>
<thead>
<tr>
<th>Lub Oil replacement Cost</th>
<th>Rs. Per KWH</th>
<th></th>
</tr>
</thead>
</table>

#### Maintenance Cost

| "B Check” maintenance period             | Hours         |                                                   |
| "B Check” maintenance kit cost           | Rs.           |                                                   |

#### "B Check” maintenance cost

<table>
<thead>
<tr>
<th>&quot;B Check” maintenance cost</th>
<th>Rs. Per KWH</th>
<th></th>
</tr>
</thead>
</table>

| "C Check” maintenance period             | Hours         |                                                   |
| "C Check” maintenance kit cost           | Rs.           |                                                   |

#### "C Check” maintenance cost

| "C Check” maintenance cost               | Rs. Per KWH   |                                                   |
### Technical Specifications for Construction of Township

#### 'C Check’ maintenance cost

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Data shall be furnished by tenderer against each item</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>750 KVA</td>
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</tbody>
</table>

#### 'D Check’ maintenance period

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Data shall be furnished by tenderer against each item</th>
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<tbody>
<tr>
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<td>750 KVA</td>
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</table>

#### 'D Check’ maintenance kit cost

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Data shall be furnished by tenderer against each item</th>
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<tbody>
<tr>
<td></td>
<td>750 KVA</td>
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</table>

#### 'D Check’ maintenance cost

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Data shall be furnished by tenderer against each item</th>
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<tbody>
<tr>
<td></td>
<td>750 KVA</td>
</tr>
</tbody>
</table>

#### Air Cleaner element change period

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Data shall be furnished by tenderer against each item</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>750 KVA</td>
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</table>

#### Air Cleaner Element cost

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Data shall be furnished by tenderer against each item</th>
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<tbody>
<tr>
<td></td>
<td>750 KVA</td>
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</table>

#### Air Cleaner Element replacement cost

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Data shall be furnished by tenderer against each item</th>
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<tr>
<td></td>
<td>750 KVA</td>
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</tbody>
</table>

#### Total Cost per KWH generated

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Data shall be furnished by tenderer against each item</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>750 KVA</td>
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</tbody>
</table>

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### DG SETS – EMISSION LEVELS – at 100% load

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Emission level as per Pollution Control Board Norms</th>
<th>Guaranteed emission level of the engine offered to be filled in by the tenderer</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx</td>
<td>9.2 g/kW-Hr</td>
<td>750 KVA</td>
</tr>
<tr>
<td>SOx</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>3.5 g/kW-Hr</td>
<td></td>
</tr>
<tr>
<td>HC</td>
<td>1.3 g/kW-Hr</td>
<td></td>
</tr>
<tr>
<td>Dust (particulate matter)</td>
<td>0.3 g/kW-Hr</td>
<td></td>
</tr>
</tbody>
</table>
SPECIAL INSTRUCTIONS TO TENDERERS FOR DG WORK

1.0 Compatibility & Coordination with PLC

A microprocessor based PLC panel for Automatic Mains Failure, Auto Changeover/Interlocking and Auto Load Searching & Auto Load Management Functions of the DG sets is incorporated in the Main LT Panel of the system being provided through the electrical contractor to be appointed by the Owners. Control cabling between the DG sets and the PLC is to be done under this contract. All parts of the DG set installation covered by this contract shall be compatible for being integrated with the PLC operation. The DG Contractor shall coordinate his work with that of electrical Contractor for achieving a fully coordinated and trouble free operation of the DG sets and their sub-systems through the PLC panel.

2.0 Completeness of contract

The Contractors shall undertake the complete installation and shall be responsible for the overall satisfactory operation of the DG sets with the associated accessories. The tenderer shall confirm as part of the tender that the associated equipments are suitable for the DG sets and the total system shall be compatible in all respects.

3.0 Quoted rates

Quoted rates shall be deemed to be inclusive of the cost (but not limited to) of the following.

Ø All equipments described hereafter shall be in accordance with the specifications.
Ø All equipments shall be selected and installed for the lowest operating noise level.
Ø Supply of various equipments shall include cost of correspondence with manufacturers, submission of shop drawings and documents and their approval by the Consulting Engineer, procurement of equipment, transportation, shipping, payment of all taxes and levies, storage, supply of equipments at site of installation, furnishing all technical literature required, replacement of defective components and warranty obligations for the individual equipment.
Ø Statutory approvals from all concerned authorities (State Electricity Authority, HERC, Pollution Control Board, Department of Explosive etc.)
Ø Installation of various equipments shall include all material and labour associated with hoisting and lowering of equipment in position, insulation of the components where ever required, vibration isolation as required, grouting and anchoring or suspension arrangements and all incidentals associated with the installation as per the specifications and manufacturer’s recommendation.
Ø Vibration isolators shall be installed with components as required. Performance ratings, power consumption and sound power data for each component shall be verified at the time of testing and commissioning of the installation, against the data submitted with the tenders.
Ø Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirit, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.

Ø Testing and commissioning shall include furnishing all labour, materials, equipment, instruments, fuel oil and incidentals necessary for complete testing of each component as per the specifications and manufacturer’s recommendations, submission of test results to the Project Manager and obtaining their approval and submission of necessary documents and completion drawings.

Ø All piping shall be installed conforming to the relevant Indian standards, approved shop drawings and shall be tested as per Standards.

Ø Fuel piping and installation shall be as per the requirement of Department of Explosive. Quoted rate shall include cost of radiographic tests of welded joints randomly selected by Project Manager in addition to hydrostatic pressure testing.

Ø Piping installation shall include all costs toward supplying and fixing pipes and fittings (elbows, tees, reducers) cutting, threading, joining, welding, soldering and effecting connection as required; providing non hardening sealing material as well as neoprene rubber gaskets for screwed flanges, providing and installing adequate number of clamps, hangers, saddles, brackets, rawl plugs and other accessories for pipe supports, providing minor dressing of walls and floor, providing and installing pipe sleeves etc. as required.

Ø Exposed steel pipes shall be given two coats of approved paint as per the relevant Indian standards for colour coding of pipes and direction of flow of fluid in the pipes shall be visibly marked with identifying arrows.

Ø All buried pipes shall be wrapped with Pipekote 4 mm thick wrapping as per manufacturers standards.

Ø Valves, unions, strainers, drain and air valves, expansion joints, pressure gauges and thermometers shall be provided in the various pipe lines as per the approved shop drawings and specifications.

Ø After completion of the installation, the entire piping system shall be tested for leakage as required.

Ø Payment for piping shall be made on the basis of linear measurement of piping system measured from flange face to flange face (in case of flanged joints) and shall included the length of all pipe fittings like bends, elbows, tees, couplers etc. but excluding the lengths of valves and strainers which shall be paid separately on unit rate basis. Quoted rates for piping shall be deemed to be inclusive of the cost of gaskets, nuts and bolts, pipe supports / hangers, vibration isolators / flexible connections and any other item required to complete the piping installation. In case of insulated piping, the quoted rates shall also be deemed to be inclusive of the cost of insulation with cladding. Measurement of insulated piping shall be done before providing the insulation.
Ø Proper co-ordination shall be done with architects and project managers for civil works such as Fuel lorry platform, bulk fuel area fencing etc. as required.

4. TESTING

4.1 GENERAL

At the completion of the work, the entire installation shall be subject to the following tests in the presence of the Owner’s site representative.

a. Wiring continuity test.

b. Insulation resistance test.

c. Earth continuity test.

d. Earth resistivity test.

e. Test as per Appendix ‘E’ of IS:732 -1989

Besides the above, any other test specified by the local authority shall also be carried out. All tested and calibrated instruments for testing, labour, materials and incidentals necessary to conduct the above tests shall be provided by the Contractor at his own cost.

4.2 TESTING OF WIRING

All wiring systems shall be tested for continuity of circuits, and earthing after wiring is completed and before installation is energized.

4.3 INSULATION RESISTANCE TEST

The insulation resistance shall be measured between earth and the whole system of conductors, or any section thereof, with all switches closed and except in concentric wiring all lamps in position of both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure provided that it does not exceed 660 volts for medium voltage circuits. Where the supply is derived from AC three phase system the neutral pole of which is connected to earth, either direct or through added resistance, pressure shall be deemed to be that which is maintained between the phase conductor and the neutral. The insulation resistance measured as above shall not be less than 50 divided by the number of points provided on the circuit, the whole installation shall have an insulation resistance greater than one megaohms. The insulation resistance between the frame work of housing of power appliances and all live parts of each appliance shall not be less than that specified in the relevant standard specification or where there is no such specification, shall not be less than one a megaohms. All equipments, cables shall be inspected at works by the Architect as per relevant IS and testing commissioning of installation as per Appendix ‘E’ of IS:732-1989 shall be done and all record to be maintained.

4.4 TESTING OF EARTH CONTINUITY PATH
The earth continuity conductor metallic envelopes of cables shall be tested for electric continuity and the electrical resistance of the same, along with the earthing lead but excluding any added resistance or earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation, shall not exceed one ohm.

4.5 TESTING OF POLARITY OF NON-LINKED SINGLE POLE SWITCH

In a two wire installation a test shall be made to verify that all non-lined single pole switches have been connected to the same conductor throughout, and such conductor shall be labeled or marked for connection to an outlet or phase conductor or to the non-earthed conductor of the supply. In the three or four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted to one of the outer or phase conductor of the supply. The entire electrical installation shall be subject to the final acceptance of the Owner’s site representative as well as the local authorities.
SECTION – 3.0

DETAILED TECHNICAL SPECIFICATION – PLUMBING WORKS
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Clause No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A)</td>
<td>Plumbing / Sanitary Works</td>
</tr>
<tr>
<td>B)</td>
<td>Sanitary Fixtures &amp; C.P. Fittings</td>
</tr>
<tr>
<td>C)</td>
<td>Water Supply</td>
</tr>
<tr>
<td>D)</td>
<td>Internal Drainage: (Soil, Waste, Vent and Rain Water Pipes)</td>
</tr>
<tr>
<td>E)</td>
<td>External Drainage System: (Sewerage &amp; Storm Water)</td>
</tr>
<tr>
<td>F)</td>
<td>Rain Water Harvesting</td>
</tr>
</tbody>
</table>
A) PLUMBING/SANITARY WORKS:

1.0 GENERAL:

1.1 The work shall be carried out in accordance with the drawings and design as would be issued to the Contractor by the Design Consultant duly signed and stamped by him. The Contractor shall not take cognizance of any drawings, designs, specifications etc. not bearing Design Consultant signature and stamp. Similarly the Contractor shall not take cognizance of instructions given by any other Authority except the instructions given by the Client's Representative in writing.

1.2 The work shall be executed and measured as per metric dimensions given in the Bill of Quantities, drawings etc.

1.3 The Contractor shall acquaint himself fully with the partial provisions for supports that may or may not be available in the structure and if are available then utilize them to the extent possible. In any case the Contractor shall provide all the supports regardless of provisions that they have been already made. Nothing extra shall be payable for situations where insert plates (for supports) are not available or are not useful.

1.4 Shop coats of paint that may be damaged during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.

1.5 The Contractor shall protect / handle the material carefully and if any damage occurs while handling by the Contractor then the sole responsibility shall be of the Contractor. Such damages shall be rectified/recovered by the Contractor at no extra cost whatsoever.

1.6 The Contractor shall, within twenty one (21) days of receipt of the Notice of Award for the Project, where applicable, complete the submission of shop drawings to the Client's Representative for approval by the Design Consultants in order to conform to the contract schedule.

1.7 Measurements:

All measurements shall be taken in accordance with relevant IS codes, unless otherwise specified.

2.0 APPLICABLE CODES AND STANDARDS:

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practice given below as amended upto the date of submission of Tender. All equipment and material being supplied shall meet the requirements of BIS and other relevant standard and codes.

Plumbing Works:

<table>
<thead>
<tr>
<th>Material</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitreous Chinaware - I</td>
<td>IS:2556 - 1974 (Part - I)</td>
</tr>
<tr>
<td></td>
<td>IS:2556 - 1981 (Part - II)</td>
</tr>
</tbody>
</table>
III) Technical Specifications for Construction of Township

- IS:2556 - 2556 (Part -

- IS:1703 - 1977
- IS: 775 - 1970
- IS:2548 - 1983
- IS:2326 - 1987
- IS:1729 - 1979
- IS:3989 - 1984
- IS:1239 - 1979
- IS:4736 - 1986
- IS: 554 - 1985
- IS:1879 - 1987
- IS: 780 - 1984
- IS: 778 - 1984
- IS:2692 - 1978
- IS: 651 - 1980
- IS: 458 - 1971
- IS:1536 - 1989
- IS:1538 - 1976
- IS: 782 - 1966
- IS:4691
- IS:1200
- IS:4984
- IS:782
- IS:783

3.0 QUALITY ASSURANCE AND QUALITY CONTROL:
3.1 The work shall conform to high standard of design and workmanship, shall be structurally sound and aesthetically pleasing. Quality standards prescribed shall form the backbone for the quality assurance and quality control system.

3.2 At the site, the Contractor shall arrange the materials and their stacking/storage in appropriate manner to ensure the quality. Contractor shall provide equipment and manpower to test continuously the quality of material, assemblies etc. as directed by the Client’s Representative. The test shall be conducted continuously and the result of tests maintained. In addition the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes and evenness of surface.

3.3 The Client’s Representative shall be free to carry out such tests as may be decided by him at this sole direction, from time to time, in addition to those specified in this Document. The Contractor shall provide the samples and labour for collecting the samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the samples.

3.4 The test shall be conducted at Standard Laboratory selected by Client’s Representative. Contractor shall keep the necessary testing equipment such as hydraulic testing machine, smoke testing machine, gauges and other necessary equipment required.

3.5 The Client’s Representative shall transport the samples to the laboratory.

3.6 Testing charges shall be borne by the Client’s Representative.

3.7 Testing may be witnessed by the Contractor or his Authorised Representative. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.
B) SANITARY FIXTURES & C.P. FITTINGS:

4.0 SCOPE:

4.1 Work under this section shall consist of transportation, furnishing, installation, testing and commissioning and all labour as necessary as required to completely install all sanitary fixtures, brass and chromium plated fittings and accessories as required by the drawings and specified hereinafter or given in the Bill of Quantities.

4.2 General Requirements

4.2.1 All fixtures and fittings shall be fixed with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Bill of Quantities, specifications, drawings or not.

4.2.2 All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per architectural design requirements. Wherever necessary the fittings shall be centered to dimensions and pattern desired.

4.2.3 Fixing screws shall be half round head chromium plated brass with C.P. washers wherever required as per directions of Client's Representative.

4.2.4 All fittings and fixtures shall be fixed in a neat workmanlike manner true to levels and heights shows on the drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, wall or ceiling surfaces shall be made good at Contractors cost.

4.2.5 All fixtures of the similar materials shall be by the same manufacturers.

4.2.6 All fittings shall be of the chromium plated materials.

4.3 Without restricting to the generally of the foregoing the sanitary fixtures shall include all sanitary fixtures, C.P. fittings and accessories etc. necessary and required for the building.

4.4 Whether specifically mentioned or not all fixtures and appliances shall be provided with approved fixing devices, nuts, bolts, screws, hangers as required. These supports shall have the necessary adjustment to allow for irregularities in the building area construction.

4.5 For the installation of the CP fittings, teflon tape shall be used.

4.6 EUROPEAN W.C:

4.6.1 European W.C. of glazed vitreous china shall be wash down, single or double siphonic type, floor or wall mounted set, flushed by means of flush valve as specified in Bill of Quantities. Flush pipe/bend shall be connected to the W.C. by means of suitable rubber adopter. Wall hung W.C. shall be supported by C.I. floor mounted chair.

4.6.2 Each W.C. seat cover shall be so fixed that it remains absolutely stationary in vertical
position without falling down on the W.C. Seat cover shall be of white solid plastic, elongated open front with heavy duty hinges. Exposed fixture trims shall be Chrome plated, and trims of similar function shall be by the same manufacturer.

4.6.3 Flush valves shall be of the best approved quality procurable with C.P. control valve and C.P. flush pipe.

4.6.4 The flush pipe/bend shall be connected to the WC by means of a suitable rubber adopter.

4.6.5 Alternatively if flushing cistern to be used shall conform to the requirements of IS:774-1971. High level cisterns shall be of cast iron unless otherwise specified. Low level cistern shall be of the same material as the water closet or as instructed by the Owner/Architect/Consultant.

The cisterns shall be mosquito proof & shall fulfill the requirements of the local Authority.

4.6.6 The levels of the WC should be checked by placing spirit level on the W.C. W.C. should be tested on completion of fixing by putting small paper balls and flushing out. If all the paper balls are not flushed out. The fixing will have to be rectified / re-aligned.

4.7 KITCHEN /PANTRY SINKS:

4.7.1 Sinks shall be of stainless steel material as specified in the Bill of Quantities/Drawings.

4.7.2 Each sink shall be provided with R. S. brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable angle iron clips or brackets as recommended by the manufacturer. Each sink shall be provided with 40 mm dia Chromium Plated waste with chain and plug or P.V.C. waste with Escutcheon plates. Fixing shall be done as directed by Client’s Representative.

4.7.3 Supply fittings for sinks shall be mixing fittings or C.P. taps, angle cocks etc. all as specified in the Bill of Quantities/Drawings.

4.8 WASH BASINS:

4.8.1 Wash basin shall be of white vitreous china of best quality manufactured by an approved firm and sizes as specified in the Bill of Quantities.

4.8.2 Wash basin shall be of under counter drop in type shall be supported on a pair of rolled steel brackets of approved design and shall be mounted on a countertop. So that rim and basin bowl is exposed from top.

4.8.3 Wash basin shall be provided with single lever mixer with chain and rubber plug, chromium plated brass bottle trap of approved quality, design and make where hot water required. Single tap where hot water is not required.

4.8.4 Wash basin shall be fixed at proper location and height and truly horizontal as shown on drawing or as directed by Client’s Representative.

4.9 HOSE BIBB’S:

4.9.1 Hose Bib of Chromium Plate tap is draw off tap with horizontal inlet and free outlet knurling on outer face to fix the hose pipe. Hose bib shall be of specified size and shall
be of screw down type and shall conform to IS:781-1984. The closing device shall work by means of a disc carrying a renewable non-metallic washer which shuts against the water pressure on a seating at right angle to the axis of the threaded spindle which operate it. The handle shall be either crutch or butterfly type securely.

4.10 URINALS:

Half stall wall hung urinals of glazed vitreous china shall be provided with 15mm dia, C.P. brass spreader, 32mm dia C.P. domical waste and C.P. cast brass bottle trap with pipe and wall flange and shall fixed to wall by one C.I. bracket and two C.I. clips as recommended by manufacturers complete as directed by the Client’s Representative.

Urinals shall be flushed by means of “NO-TOUCH” infrared operated flush valves.

Waste pipes for urinals shall be any one of the given material as directed by the Client’s Representative:

a) G.I. Pipes

b) Rigid PVC/High density polyethylene.

Waste pipes may be exposed on wall or concealed in chase as directed by the Client’s Representative.

4.11 BATH TUB:

Bath tub & panel shall be white enameled cast iron or pressed steel as specified in the Bill of Quantities of guaranteed quality and specifications.

Each bath tub shall be provided with 40mm dia CP brass waste with 32mm C.P. brass overflow, 40mm dia cast brass overflow-cum-waste trap with pop-up waste assembly.

Bath tub shall be provided with four Nos. C.P. brass concealed stop cocks, bath spout and overhead shower or as specified in the Bill of Quantities.

Bath tubs shall be fixed true to level firmly fixed to another or supports provided by the manufacturer. Edges touching the wall shall be slightly recessed in the wall finishing so as to ensure water tightness. The fixing shall be perfectly done so that the wall behind does not tend to get damp or patchy.

Contractor shall during the entire period of installation and afterwards protect the bathtub by providing suitable cover or any other protection so as to absolutely prevent any damage to the bathtub until handing over.

4.12 SHOWER SET IN STAFF LOCKERS:

Shower set shall comprises of two C.P. brass concealed stop cocks. Hot and cold water mixing shall be manually by means of concealed stop cocks. One overhead shower with shower arm.

Each shower set shall provide C.P. shower arm with wall flange and shower head of approved quality as specified in the Bill of Quantities.
Concealed stop cocks shall be as fixed as to keep the wall flange clear off the finished wall. Wall flanges embedded in the finishing shall not be accepted.

4.13 **MEASUREMENTS:**

4.13.1 Rate for providing and fixing of sanitary fixtures, accessories, urinal partitions shall include all items and operations stated in the respective specifications and Bill of Quantities, and nothing extra is payable.

4.13.2 Rates for all items under specifications para above shall be inclusive of cutting holes and chases and making good the same, C.P. screws, nuts, bolts and any fixing arrangement required.
C)  WATER SUPPLY:

5.0  SCOPE:

5.1  Work under this section consists of furnishing all labour, materials, equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the bill of quantities.

5.1.2  Without restricting to the generality of the foregoing, the water supply system shall include the following:-

i.  Pipe protection & painting.

ii.  Connections to all plumbing fixtures, tanks, pumps etc.

iii.  Providing hot water pipe lines and supply point with isolation valves, wherever required.

iv.  Control valves, masonry chambers and other appurtenances.

v.  Connections to all plumbing fixtures, tanks and appliances.

vi.  Excavation and refilling of pipe trenches, wherever necessary.

vii.  Internal galvanized water supply piping inside the toilets shaft/plant room/terrace.

viii.  Testing all line and fixtures as specified.

5.2  GENERAL REQUIREMENTS:

5.2.1  All materials shall be new of the best quality and shall be furnished, delivered, erected, connected and finished in every detail conforming to specifications and subject to the approval of Client’s Representative.

5.2.2  Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

5.2.3  Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections.

As far as possible all bends shall be formed by means of hydraulic pipe bending machine for pipes upto 65mm dia.

5.2.4  Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc. and shall be selected and arranged so as to fit properly into the allocated building space.

5.2.5  Pipes shall be securely fixed to walls by suitable clamps at intervals specified.

5.2.6  Valves and other appurtenances shall be located to provide easy accessibility for operation, maintenance and repairs.
5.2.7 Connection between dissimilar materials.

5.2.8 All G.I. pipes jointing shall be with white lead and spun yarn.

5.2.9 Drawings illustrating block out and penetration of pipes in the wall/floor/slab.

5.2.10 **Unions:** Contractor shall provide adequate no. of unions on all pipes to enable dismantling later and for servicing. Union shall be provided near each gunmetal valves.

5.3 **INTERNAL WORKS:**

5.3.1 **Materials (CPVC pipes, fittings & valves):**

5.3.1.1 All pipes inside the buildings and where specified, outside the building shall be CPVC pipes tubes conforming to Specific Gravity ASTM D 792 at 23°C should be 1.55 as specified. With Tensile Strength as per ASTM D 638 at 23°C should be 55 N/mm².

5.3.1.2 All special fittings and accessories like internally or externally threaded brass adaptors, ball valves, globe valves, unions, diaphragm valves, butterfly valves, etc shall be made of CPVC by Licensee.

5.3.1.3 The CPVC solvent cement used for installing CPVC piping systems shall conform to ASTM F493. Pipes from ½” upto 2” pipes and fittings, single step medium bodied CPVC solvent cement should be used. For CPVC pipes and fittings upwards of 2”, a primer shall be used followed by heavy bodied solvent cement conforming to ASTM F493. PVC solvent cement should not be used.

5.3.2 **Concealed Piping**

All internal concealed plumbing for water supply shall be done with CPVC. The pipes & fittings shall conform to CTS (copper tube size) SDR-11 as per ASTM D2846 OR SDR-13.5. All pipes and fittings from ½” upto 2” shall come under this category. Medium body CPVC solvent cement conforming to ASTM F493 should be used for joining pipes to fittings.

5.3.3 **External Piping:**

All external plumbing for water supply and distribution shall be done with CPVC pipes. The CPVC pipes above 2” for external water supply lines shall conform to ASTM F441 CPVC Schedule 40 & 80 pipe and will be the CPVC brand. The fittings above 2” size shall conform to ASTM F438 (Schedule 40 CPVC fittings) or ASTM F 439 (Schedule 80 CPVC fittings). All threaded CPVC fittings shall conform to ASTM F437 (threaded CPVC fittings schedule). Heavy bodied CPVC solvent cement shall be used along with a primer. IPS brand primer and heavy bodied CPVC solvent cement only should be used conforming to ASTM F493. All external CPVC pipes shall be coated with water based acrylic paint emulsion for enhanced UV protection.

5.3.4 **Installation procedure:**

All parameters pertaining to the installation of CPVC plumbing system such as cutting, joining, support spacing, expansion loops, insulation, type of support, special connections, etc. shall be as per the manufacturer’s specifications.
5.3.5 All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets.

5.3.6 Clamps

CPVC Pipes in shafts and other locations shall be supported by galvanized M.S. clamps of design approved by Project Manager. Pipes in wall chases shall be anchored by G.I. hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from M.S. structuralics. Pipes in typical shafts shall be supported on slotted angles/channels as per standard drawings.

5.3.7 Spacing of clamps, hooks etc. shall be as per good engineering practice approved by the Project Manager.

5.3.8 Unions

Contractor shall provide adequate number of unions on pipes 50 mm and below to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop cock, or check valve and on straight runs as necessary at appropriate locations as required and/or directed by Project Manager.

5.3.9 Testing:

After laying and jointing, the pipes and fittings shall be inspected under working condition of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost. Use of any compound or stop leak compound will not be permitted. The pipes and fittings after they are laid shall be tested to hydraulic pressure of 1.5 times the working pressure or 7.5 Kg/Sq.cm which ever is more. The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw of taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least two hours. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing.

5.4 Measurements:

The length above ground shall be measured in running meter correct to a cm for the finished work, which shall include CPVC pipe and CPVC fittings such as bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, unions etc.. Deductions for length of valves shall be made. Rate quoted shall be inclusive of all fittings, clamps, cutting holes chased and making good the same and all items mentioned in the specifications and Bill of Quantities.

5.5 VALVES:

5.5.1 Butterfly Valves:

All the isolation valve 50cm and above on the equipment and water lines, where specified or shown on drawings shall be wafer type butterfly valves. They shall be designed to fit without gaskets, the water tight seal being obtained by EPDM seat projection at the faces compressed between the flanges. The valves shall be supplied inclusive of M.S. pipe flanges and high tensile steel bolts of dimensions recommended by...
suppliers of valves. The valves shall comply with following specifications:

a) Test Pressure : Body 24 Bar, Seat 16 Bar

b) Valve Component : Material of Construction
   i) Body : Cast Iron, Gr. FG 260, IS:210
   ii) Disc : Nylon or Epoxy powder coated high duty iron, Gr, FG 260
   iii) Stem : Stainless Steel or carbon steel IS:1570, Part-II.
   iv) Seat : EPDM
   v) Hand Lever : Cast Iron (Mechanical Memory Stop)
   vi) Bearings : PTFE or Nylon covered S.S. bush bearings at stem and pivot.
   vii) Primary Seal : Reinforced PTEE slide bearings
   viii) Temperature : 80 Degree C (max.)

5.5.2 Installation:

Valve shall be install in a manner that allows future removal and service of the valve. Packing and gasket shall not contain asbestos.
The valve shall be of the same size as the pipe to which they are install.
Valve above 150mm diameter shall be self locking warm gear type water proof and protory lubricated.
Provide chain operators with chain cleats for all valves more than 2.4 meter above floor.

5.5.3 Non Return Valves:

All non-return valves shall be provided as shown in the drawings conforming to relevant Indian Standards and in accordance with the following specifications.

<table>
<thead>
<tr>
<th>Size</th>
<th>Construction</th>
<th>Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 50 mm.</td>
<td>Gun metal</td>
<td>Screwed</td>
</tr>
<tr>
<td>65 mm and above</td>
<td>Gun metal/cast iron</td>
<td>Flanged</td>
</tr>
</tbody>
</table>

Non-return valves shall be of approved make. Flap type non-return valve shall be used and tested to 15 Kg/Sq.cm. pressure.

5.5.4 Ball Valves (Float Valve):

The ball valve shall be of high pressure class and shall be confirm to IS:1703 of sizes as specified. The nominal size of a ball valve shall be that corresponding to the size of the pipe to which it is fixed. The ball shall be of brass or gun metal as specified and the float shall be of polythene sheet. The minimum gauge of copper sheet used for making the float shall be 0.45mm for float upto 115mm dia and 0.55mm for float exceeding 115mm
dia and shall be special in shape. The valve shall be constructed to permit replacing without console of the valve body from the valve line and the system shall not blow out under pressure. The jointing of the float shall be made by efficiently burnished, lapped and soldered seam or by bracing. Plastic float may also be used if specified. The body of ball valve when assembled in working conditions with the float immersed to not more than half of its volume shall remain closed against a test pressure of 10.5 Kg/Sq.cm. All ball valves shall be capable of withstanding a pressure of 14 Kg/Sq.cm.

The ball valve shall generally conform to IS specifications No. 1703-1962.

5.5.5 Ball Valves:

The ball valve shall be of Brass or Gunmetal as specified conforming to IS:1703. The ball valve shall be as given below:

**High Pressure:**

Indicated by the abbreviation ‘HP’ for use on mains having pressure. These shall remain closed at a test pressure of 10.5 Kg/Sq.cm.

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>15 mm</th>
<th>20 mm</th>
<th>25 mm</th>
<th>32 mm</th>
<th>40 mm</th>
<th>50 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diameter of spherical float (mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Pressure</td>
<td>127</td>
<td>152</td>
<td>203</td>
<td>229</td>
<td>254</td>
<td>305</td>
</tr>
<tr>
<td>Low Pressure</td>
<td>114</td>
<td>127</td>
<td>178</td>
<td>203</td>
<td>203</td>
<td>254</td>
</tr>
<tr>
<td>Minimum weight of ball valve including back nut, body and piston (gms)</td>
<td>283</td>
<td>446</td>
<td>823</td>
<td>1149</td>
<td>1589</td>
<td>1852</td>
</tr>
</tbody>
</table>

The ball valves shall be of following nominal sizes 15mm, 20mm, 25mm, 32mm, 40mm and 50mm. The nominal size shall correspond with the nominal bore of the inlet shanks.

5.5.6 Air Valves:

Air valves shall be provided in all high points in the system to prevent air locks as shown on the drawings or directed by Client’s Representatives.

5.5.7 Testing:

All valves shall be tested while installed in pipe by hydrostatic pressure of 1.5 time of the working pressure 7.5 Kg/Sq.cm which ever is more.

5.5.8 Measurements:

All valves as mentioned in Bill of Quantities shall be measured by numbers and shall
include all items mentioned in the Bill of Quantities.

5.6 **CHLORINATION OF DOMESTIC WATER LINES:**

5.6.1 After the completion of all the hot and cold water service piping, disinfect all the fresh water supply work and water reservoirs using a chlorine solution.

5.6.2 **Chlorinated Systems Shall Include:**

   i. Domestic fresh water tanks
   
   ii. Fire water tanks
   
   iii. All pipe work systems receiving suction from the above mentioned tanks apart from the fire systems.

5.6.3 Before handover of the system, submit to the consultant copies of the certification of performance and laboratory report (if required)

5.6.4 Under no circumstances the use of any portion of the fresh water system until it is properly disinfected, flushed and certified shall be permitted.

5.6.5 During the Chlorination work the Contractor shall take all necessary precautions to prevent site staff from drinking the system water. Such precautions shall include looking doors to ‘wet’ areas and providing warning signs in English and Hindi.
D) **INTERNAL DRAINAGE (SOIL, WASTE, VENT AND RAIN WATER PIPES)**

**6.0 SCOPE:**

6.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes as required by the drawings, specified hereinafter and given in the Bill of Quantities.

6.1.2 Without restricting to the generality of the foregoing, the soil, waste, vent and rainwater pipes system shall include the followings:

i. Cast Iron horizontal and UPVC vertical soil, waste and vent pipes, rainwater pipes and fittings, joints clamps and connections to fixtures.

ii. Floor traps, floor drain clean out plugs, inlet fittings and rainwater roof drain, area/local drains, trench drain.

iii. Waste pipes connections from all fixtures e.g. Wash basins, sinks, kitchen equipment.

iv. Testing of all pipes.

v. Connection of main.

**6.2 GENERAL REQUIREMENTS**

6.2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Client’s Representative.

6.2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

6.2.3 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

6.2.4 Pipes shall be securely fixed to walls by suitable clamps at intervals specified.

6.2.5 Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

6.2.6 All works shall be executed as directed by Client’s Representative.

**6.3 CAST IRON PIPES & FITTINGS**

6.3.1 Soil, waste, vent and anti-siphonage pipes shall be cast iron pipes with socket and spigot. All pipes shall be straight and smooth and inside free from irregular bore, blow holes, cracks and other manufacturing defects. Pipes shall be centrifugally spun iron soil pipes conforming to sand cast I.S. 3989.

6.3.2 Standard weight, dimensions and Drip Seal required for joints shall be as follows:
Technical Specifications for Construction of Township

For conforming to I.S. 3989 (sand cast iron soil pipes and fittings)

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Thickness</th>
<th>Overall weight 6' length or 1.83 M</th>
<th>Internal diameter of socket lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>5</td>
<td>11.41</td>
<td>76</td>
</tr>
<tr>
<td>75</td>
<td>5</td>
<td>16.52</td>
<td>101</td>
</tr>
<tr>
<td>100</td>
<td>5</td>
<td>21.67</td>
<td>129</td>
</tr>
<tr>
<td>150</td>
<td>5</td>
<td>31.91</td>
<td>181</td>
</tr>
</tbody>
</table>

6.3.3 Tolerance

Acceptable tolerance for pipes to I.S. 1729 shall be as follows:

a) Wall thickness - 15%
b) Length ± 20 mm
c) Weight ± 10%

6.3.4 Fittings

Fittings shall conform to the corresponding Indian Standard as for pipes. Contractor shall use pipes and fittings of matching specification.

Access door shall be secured air and water tight with 3mm thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal.

6.3.5 Jointing:

All soil, waste and vent pipes including fixture connections between traps and soil pipes shall be jointed with refined Drip Seal conforming to IS:27-1977 sufficient sken of jute rope shall be caulked to leave a minimum space for the Drip Seals as given in 6.3.2 to be poured in. After pouring the lead shall be caulked into the joint with caulking tool and hammer. All surplus lead shall be cut and joint left flush with the rim of the socket neatly.

6.3.6 Vent pipes penetration through roof shall be by means of sleeves. The sleeve will be kept 100mm higher the finish roof level and annular space filled with fire proof materials like putty, fire seal etc.

6.3.7 Pipes, Hangers, Supports, Clamps, Brackets etc.:

All vertical pipes shall be fixed by M.S. Clamps truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).

Inclined pipes running along ceiling shall be fixed on M.S. adjustable hangers of special design shown on the drawings or as directed. Pipes shall be laid to uniform slope and the hangers adjusted to the proper levels so that the pipes fully rest on them.

M.S. clamps shall be of standard design and fabricated from M.S. flat 40mm x 3mm x 3mm thick. They shall be painted with two coats of black bitumen paint before fixing.
Structural clamps shall be fabricated from M.S. structural members e.g. rods, angles, channels, flats, as per detailed drawing or as directed. Contractor shall provide all nuts, bolts, welding and paint the clamps with one coat of red oxide. Wooden saddles shall be provided free of cost.

Slotted angle/channel supports on walls shall be provided wherever shown on drawings or as required. Angles/channels shall be fixed to brick walls and bolts embedded in cement concrete blocks and to RCC walls with suitable anchor fasteners. Holes required in RCC walls shall be neatly drilled by electric drills and no manual chiseling will be allowed. The spacing of supports horizontally shall not exceed 1.8 M.

Wherever M.S. clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement and for making good with cement concrete 1:2:4 (mix 1 cement :2 coarse sand :4 stone aggregate 20mm nominal size) as directed by the Client’s Representative.

6.3.8 Testing:

All pipe work shall be tested before connecting any appliances and then again after connection of appliances. Pipe shall be tested after installation by one of the test given below as directed by the Client’s Representative.

Before use at site, all C.I. soil pipes shall be tested by filling up with water for at least 10 minutes at 3 meter head. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. All defective pipes shall be rejected and removed from the site within 48 hours.

Water Test:

Pipes shall be tested after installation by filling up the stack with water. All openings and connections shall be suitably plugged. The total head in the stack shall however not exceed 3 M. The level of water in the stack shall not drop within 8 hours. If there is a drop in level of water the leak shall be detected and rectified and test shall be re-conducted until satisfactory result is achieved.

Smoke Test:

Contractor may test all soil and waste stacks by a smoke testing machine. Smoke shall be pumped into the stack after plugging all inlet and outlet connections.

The stack shall then be observed for leakages and all defective pipes and fittings removed or repaired as directed by the Client’s Representative.

6.3.9 UPVC Pipes and Fittings:

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be designated by external diameter and shall conform to IS:4985-1981.

<table>
<thead>
<tr>
<th>Outer Dia (mm)</th>
<th>Pressure (Kg/cm²)</th>
<th>Inner Dia (mm)</th>
<th>Weight/Mt (Kg.)</th>
</tr>
</thead>
</table>
Technical Specifications for Construction of Township

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Length</th>
<th>Diameter</th>
<th>Length</th>
<th>Diameter</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>4</td>
<td>104.5</td>
<td>1.315</td>
<td>125</td>
<td>4</td>
</tr>
<tr>
<td>125</td>
<td>4</td>
<td>118.7</td>
<td>1.712</td>
<td>140</td>
<td>4</td>
</tr>
<tr>
<td>140</td>
<td>4</td>
<td>133.0</td>
<td>2.131</td>
<td>160</td>
<td>4</td>
</tr>
<tr>
<td>160</td>
<td>4</td>
<td>152.0</td>
<td>2.783</td>
<td>180</td>
<td>4</td>
</tr>
<tr>
<td>180</td>
<td>4</td>
<td>175.9</td>
<td>3.560</td>
<td>200</td>
<td>2</td>
</tr>
<tr>
<td>200</td>
<td>2</td>
<td>190.1</td>
<td>4.526</td>
<td>225</td>
<td>4</td>
</tr>
<tr>
<td>225</td>
<td>4</td>
<td>213.8</td>
<td>5.480</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fittings:**

Fittings shall be of the same make as that of pipes, injection moulded and shall conform to Indian Standard.

**Laying and Jointing:**

The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Alternatively, plastic clamps of suitable designs shall be preferred. Provision shall be made for the effect of thermal movement by not gripping or disturbing the pipe at supports between the anchors for suspended pipes. The supports shall allow the repeated movements to take place without abrasion.

Jointing for UPVC pipes shall be made by means of solvent cement for horizontal lines and ‘O’ rubber ring for vertical lines. The type of joint shall be used as per site conditions/direction of the Client’s Representative. Where UPVC pipes are to be used for rain water pipes, the pipe shall be finished with G.I. adopter for insertion in the R.C.C. slab for a water proof joint complete as directed by Client’s Representative.

**Supports:**

UPVC pipes require supports at close intervals. Recommended support spacing for unplasticised PVC pipes is 1400 mm for pipes 50 mm dia and above. Pipes shall be aligned properly before fixing them on the wooden plugs with clamps. Even if the wooden plugs are fixed using a plumb line, pipe shall also be checked for its alignment before clamping, piping shall be properly supported on, or suspended from clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency. Pipe supports shall be primer coated with rust preventive paint.

**Repairs:**

While temporary or emergency repairs may be made to the damaged pipes, permanent repairs should be made by replacement of the damaged section. If any split or chipout occur in the wall of the pipe, a short piece of pipe of sufficient length to cover the damaged portion of the pipe is cut. The sleeve is cut longitudinally and heated sufficiently to soften it so that it may be slipped over the damaged hard pipe.

**Testing:**

All lengths of PVC rain water pipes shall be fully tested for water tightness by means of water test maintained for not less than 30 minutes. All pipes shall be subjected to a test pressure of at least 1.5 metre head of water head. The test pressure shall, however, not exceed 6 meter head at any point. The pipes shall be plugged preferably with standard design plugs with rubber plugs on both ends. The upper end shall, however, be
connected to a pipe for filling with water and getting the required head.

6.3.10 Waste Pipe from Appliances:

i) Waste pipe from appliances e.g. wash basins, sinks, urinals, chrome plate where seen water coolers shall be of galvanised steel (heavy class) conforming to IS:1239-1979.

ii) All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on structural clamps. Spacing for clamps for such pipes shall be as follows:

<table>
<thead>
<tr>
<th></th>
<th>Vertical</th>
<th>Horizontal</th>
</tr>
</thead>
<tbody>
<tr>
<td>G.I. Pipes</td>
<td>300 cms</td>
<td>240 cms</td>
</tr>
<tr>
<td>P.V.C. Pipes</td>
<td>180 cms</td>
<td>120 cms</td>
</tr>
</tbody>
</table>

6.3.11 Painting

Soil, waste vent and rainwater pipes in exposed location, in shafts and pipe spaces shall be thoroughly cleaned to remove dirt, rust and other contamination, and painted with two or more coats of synthetic enamel paint to give an even shade.

Paint shall be of approved quality and shade, where directed pipes shall be painted in accordance with approved pipe colour code.

Waste pipes in chase shall be thoroughly cleaned to remove dirt, rust and other contamination, and painted with two coats of bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with two or more coats of synthetic enamel paint.

C.I. soil and waste pipes below ground and covered in cement concrete shall not be painted.

6.3.12 Measurements:

C.I./ UPVC/ G.I. waste/soil, waste, vent and rain water pipes shall be measured over all along the centre line correct to a centimeter including all fittings along its length. The rate for these pipes shall be inclusive of all fittings, holder bat clamps, lead caulked joint for C.I. and cement joints for UPVC and all other items described in the Bill or Quantities. The portion of the pipe within the collar for C.I./UPVC pipe at the joint shall not be included in the length of the pipe work.

6.4 TRAPS:

6.4.1 Nahani Trap or Floor Traps:

Nahani traps or floor traps shall be cast iron, deep seal with an effective seal of 50 mm. The trap and waste pipes shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1:2:3 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) mixed with water proof compound and extended to 40 mm below finished floor level. Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30 x 30 cms of the required
depth. The trap shall be installed at lowest point ensure no ponding occurs at perimeters of the drain.

6.5 **Floor Trap Inlet**

Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, the Contractor shall provide a special type galvanised iron inlet fitting without or with one, two or three inlet sockets to receive the waste pipe. Joint between waste and fitting shall be connected to a C.I ‘P’ or ‘S’ trap with at least 50mm seal (Hopper and traps shall be paid for separately). Floor trap inlet fittings and the trap shall be set in cement concrete blocks.

6.6 **C.P./Stainless Steel Gratings**

Floor and Urinal traps shall be provided with 100-150mm square or round C.P./Stainless steel grating as approved by Client’s Representative with rim, of approved design and shape. Minimum thickness shall be 4-5mm or as specified in the Bill of Quantities.

6.7 **Cleanout Plugs:**

Contractor shall provide cast brass cleanout plugs in all horizontal run more than 15 mtr length required one cleanout plugs shall be threaded and provided with key holes for opening. Cleanout plugs shall be fixed to the pipe by a G.I. socket and lead caulked joint.

6.8 **Pipe Sleeves:**

Pipe sleeves 50mm larger diameter than pipes shall be provided wherever pipes pass through walls and slabs and annular space filled with fire proof materials like putty, fire seal etc. All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burs removed before laying. Open ends of the pipe shall be closed as the pipe is installed to avoid entrance of foreign matters. Vertical sleeve shall finish 50mm above finish floor level.
E) EXTERNAL DRAINAGE SYSTEM (SEWERAGE & STORM WATER):

7.0 SCOPE:

i. Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install the drainage system as required by the drawings and specified hereinafter or given in the Bill of Quantities.

ii. Without restricting to the generality of the foregoing, the drainage system shall include:
   - Sewer lines including excavations, pipe lines, man holes, drop connections, underground storm water drains, including pipes, man holes, catch basins and open drains, thrust blocks.

7.1 GENERAL REQUIREMENTS:

All materials shall be new of the best quality conforming to specifications and subject to the approval of the Client’s Representatives.

Drainage lines shall be laid to the required gradients and profiles.

All drainage work shall be done in accordance with the local municipal bye-laws.

Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority and also existing invert levels required to enter sanitary system.

Location of all manholes, catch basins, etc. shall be confirmed by the Client’s Representatives before the actual execution of work at site.

All excavation, trenches etc shall be barricaded as per instruction of the Client's Representatives.

All works shall be executed as directed by the Client’s Representatives.

7.2 TRENCHES FOR PIPE & DRAINS:

7.2.1 Alignment and Grade:

The drains are to be laid to alignment and gradients in continuous shown on the drawings but subject to such modifications, as shall be ordered by the Client's Representative from time to time to meet the requirements of the works. No deviations from the line, depths of cutting or gradients of sewers shown in the plans and sections shall be permitted except by the express direction in writing of the Client’s Representative.

7.2.2 Opening out Trenches:

In excavating the trenches at the road metaling, pavement kerbing etc. are to be placed on one side and preserved for rein statement when the trench or other excavation shall be filled-up.
Before any road metal is replaced, it shall be carefully shifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Client’s Representative. The Contractor shall not cut or break down any live fence or trees in the line of the proposed works but shall tunnel under them unless the Client’s Representative shall order to the contrary.

Trench to be excavated to alignment + depth required. Trench to be properly dressed and de-watered. Trench shall be kept free of water at all time. Discharge of water shall be into nearest drainage channel not on the road.

All under ground pipe to be laid open in trench. Pipes to be laid and maintained at required levels and grade during course of work. All joints to be aligned and complete.

Trench shall be of 450mm wide than pipe. Concrete anchors at change in direction for C.I. pipe shall be provided. Pipe shall be rest on cushion in the trench.

The Contractor shall scrub up and clear the surface over the trenches and other excavations of all stumps, roots and all other encumbrances affecting execution of the work and shall remove them from the site to the approval of the Client’s Representative.

7.2.3 Construction Across the Roads:

All the pipe line or drain crossing existing road, the road crossing shall be excavated at a time, the second half being commenced after the pipes have been laid in the first half and the trench refilled. Necessary safety measure for traffic as directed shall be adopted. All type of pipes, water mains, cables etc. met within the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the electrical and communication cable removal of which is necessary, shall be arranged by the Client’s Representative or the Contractor shall arrange to support and protect them during excavation.

7.2.4 Excavation to be Taken to Proper Depth:

The trenches shall be excavated to such depth and width that the sewers pipe shall rest on cushion so that the inverts may be at the levels given on the section/plan. In bad ground the Client’s Representative may order the Contractor to excavate to a greater depth than that shown on the drawings and to fill up the excavation to the level of the sewer with such materials as decided by Client’s Representative in writing.

7.2.5 Refilling:

The filling shall be done in layers not exceeding 15mm in depth. Each layer shall be watered, rammed and consolidated. Ramming shall be done with iron rammers where possible and with blunt end of the crow brass where rammers can not be used. Special care shall be taken to ensure that no damage is caused to the pipes, drains, masonry or concrete in the trenches.

Filling in trenches shall be commenced soon after the joints of pipes, cables, conduits etc. have been tested and approved by Client’s Representative. The space around the pipes shall be cleared of all debris where the trenches are excavated in hard/soft soil. The filling shall be done with earth on the sides and tops of pipes in layers not exceeding 15mm in depth. Each layer shall be watered rammed and consolidated. The clods and
lumps of earth exceeding 8cm in any direction shall be broken or removed before the excavated earth is used for filling. Generally no test is done to determine the instu diversity of filled earth but on the discretion of Client’s Representative the 95 proctor’s compaction test may be done to ensure the in situ density after filling. Consolidation is removal of water from the pores and compaction is the explosion of air from the pores. In case of refilling consolidation places most important role as the watering of the each layer is being done properly. If required by the Client’s Representative proctors needle may also be used for the proper checking of the refilling items of in situ density.

7.2.6 Contractor Shall Restore Settlement and Damages:

The Contractor shall at his own cost make good promptly during the whole period the works are in hand, any settlements that may occur in the surfaces or roads, beams, footpaths, gardens, open spaces etc. Whether public or private caused by his trenches or by his other excavations due to not using the method of compaction as given in clause 7.3.5 and he shall be liable for any accidents caused thereby.

He shall also at his own expense and charges, repair and make good any damage done to the building and other properties.

7.2.7 Disposal of Surplus Soil:

The Contractor shall at his own cost and charge, dispose off from the site all surplus excavated material not required to be used on the works.

i. The width of excavated trench shall be as per table given below:

<table>
<thead>
<tr>
<th>Excavation upto</th>
<th>Upto 100 mm dia pipe</th>
<th>Upto 150 mm dia pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 cms depth</td>
<td>33 cms</td>
<td>33 cms</td>
</tr>
<tr>
<td>90 - 150 cms depth</td>
<td>60 cms</td>
<td>60 cms</td>
</tr>
<tr>
<td>150 - 300 cms depth</td>
<td>75 cms</td>
<td>75 cms</td>
</tr>
<tr>
<td>300 - 500 cms depth</td>
<td>90 cms</td>
<td>100 cms</td>
</tr>
</tbody>
</table>

7.2.8 Protection of Existing Services:

All pipes, water mains, cables etc encountered in the course of excavation shall be carefully protected and supported. In case of any damage caused the same shall be made good at no extra cost falling which necessary works will be carried out by the Clients Representative and contract charged to the Contractor.

7.3 RCC PIPES:

7.3.1 All underground storm water drainage pipes and sewer lines where specified (other than those specified cast iron) shall be centrifugally spun RCC pipes NP2 for general and NP3 where road crossing. Pipes shall be true and straight with uniform bore throughout. Cracked, wrapped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, prior to use on site, a certificate to that effect from the manufacturer.

The pipes shall be with or without reinforcement as required and of the class as specified. These shall conform to IS:458 - 1971. The reinforced cement concrete pipes
shall be manufactured by centrifugal (or spun) process.

All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding. The pipes shall be R.C.C. light duty, NP2 and NP3 type.

7.3.2 Laying:

R.C.C. spun pipes shall be laid on cement concrete bed or cradles as specified and shown on the detailed drawings. The cradles may be pre-cast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12mm below the invert level of the pipe and properly placed on the soil to prevent any disturbance. The pipe shall then be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and boning rods, etc. Cradles or concrete bed may be omitted, if directed by the Client's Representatives.

7.3.3 Jointing:

(Rigid Spigot and Socket Joint):

Hemp rope soaked in neat cement wash shall be passed round the joint and inserted in it by means of caulking tool. More skein of yarn shall be added and rammed home. Cement mortar with one part of cement and one part of sand and with minimum water content but on no account soft or sloppy, shall be carefully inserted, punched and caulked into the joint and more cement mortar added until the space of the joint has been filled completely with tightly caulked mortar. The joint shall then be finished off neatly outside the socket at an angle of 45 degree.

7.3.4 Curing:

The joint shall be cured for at least seven days.

7.3.5 Cement Concrete for Pipe Supports:

a) Unless otherwise directed by the Client’s Representative cement concrete for bed, all round or in haunches shall be laid as follows:

<table>
<thead>
<tr>
<th></th>
<th>Upto 1.5m depth (5')</th>
<th>Upto 3m depth (10')</th>
<th>Beyond 3m depth (10')</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipes in open ground (no sub soil water)</td>
<td>all round (1:5:10)</td>
<td>in haunches (1:3:6)</td>
<td>all round (1:5:10)</td>
</tr>
<tr>
<td>RCC/C.I pipes in sub soil water</td>
<td>all round (1:3:6)</td>
<td>in haunches (1:3:6)</td>
<td>in haunches (1:3:6)</td>
</tr>
<tr>
<td>RCC/C.I. pipes (in all conditions)</td>
<td>all round (1:3:6)</td>
<td>in haunches (1:3:6)</td>
<td>in haunches (1:3:6)</td>
</tr>
<tr>
<td>RCC/C.I. pipes under road or building</td>
<td>all round (1:3:6)</td>
<td>all round (1:3:6)</td>
<td>all round (1:3:6)</td>
</tr>
</tbody>
</table>

b) RCC pipes or CI pipes may be supported on brick masonry or pre-cast RCC or in situ cradles. Cradles shall be as shown on the drawings.
c) Pipes in loose soil or above ground shall be supported on brick or stone masonry pillars as shown on the drawings.

7.3.6 Testing:

All lengths of the sewer and drain shall be fully tested for water tightness by means of water head maintained for not less than 30 minutes. Testing shall be carried out from manhole to manhole. All pipes shall be subjected to a test pressure of at least 1.5 metres head of water at the highest point of the section under test. The pipes shall be plugged preferably with standard drain plugs (with rubber rings) on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the required head.

Permissible drops in water head should not exceed .....................

7.3.7 Measurement:

a) Excavation:

Measurement for excavation of pipes trenches shall be made per linear meter.

b) Trenches shall be measurement between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth upto 1.5 metre or as given in the Bill of Quantities.

Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in the Bill of Quantities and above the rate for depth upto 1.5 m.

c) RCC pipes shall be measured for the length of the pipe line per linear meter i.e.:

i. Length between manholes shall be recorded from inside of one manhole to inside of other manhole.

ii. Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole.

7.4 Sewer Appurtenances:

Inspection Chambers and Manholes:

i. Size of Chambers/Manholes:

The size given in Bill of Quantities and drawings shall be internal finished size of chamber. The work shall be done strictly as per standard drawing and following specifications.

ii. Bed Concrete:

Shall be in 1:4:8 cement concrete 200 mm thick).
iii. **Brick Work:**

Brick work shall be with best quality bricks in 1:6 cement mortar.

iv. **Plaster:**

Inside of the walls of chamber/manhole shall be plastered with 12/15 mm thick cement plaster 1:3 (1 cement :3 coarse sand) and finished smooth with a floating coat of neat cement. Manholes shall be plastered from out side as above but with rough plaster.

Water proofing compound as approved by the Client’s Representative shall be added in the cement sand mortar ratio as specified by manufacturer.

v. **Benching:**

Channel and benching shall be done in cement concrete 1:2:4 rendered smooth with neat cement. The following depth of channel and benching shall be adopted:

<table>
<thead>
<tr>
<th>Size of Drain</th>
<th>Top of channel at the centre above bed conc.</th>
<th>Depth of benching at side walls above bed conc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 cm</td>
<td>15 cm</td>
<td>20 cm</td>
</tr>
<tr>
<td>15 cm</td>
<td>20 cm</td>
<td>30 cm</td>
</tr>
<tr>
<td>20 cm</td>
<td>25 cm</td>
<td>35 cm</td>
</tr>
<tr>
<td>25 cm</td>
<td>30 cm</td>
<td>40 cm</td>
</tr>
<tr>
<td>30 cm</td>
<td>35 cm</td>
<td>45 cm</td>
</tr>
</tbody>
</table>

**Manhole Covers and Frames:**

The covers and frames shall conform to IS:1726-1960 and shall be of the following grades and types:

a) **Heavy Duty:**

These shall be denoted by the letters ‘HD’ circular solid type for use under heavy vehicular traffic conditions.

b) **Medium Duty:**

These shall be denoted by the letter ‘MD’ circular or rectangular solid type for use under light traffic conditions such as foot paths, carriage drives and cycle tracks.

c) **Light Duty:**

These shall be denoted by the letters ‘LD’ or rectangular size for use in domestic premises of where they are not subjected to wheeled traffic loads.

The covers and frames shall be leanly cast and they shall be free from air and sand holes and from cold shuts. They shall be nearly dressed and carefully
Technical Specifications for Construction of Township

trimmed. All castings shall be free from voids whether due to shrinkage gas inclusion or other causes. Covers shall have a raised chequered design on the top surface to provide an adequate non-slip grip.

The covers shall be capable of easy opening and closing and it shall be fitted in the frame in workmanship like manner. The cover shall be gas tight and water tight.

The size of covers specified shall be taken as the clear internal dimensions of the frame.

The approximate weights of the various type of manhole covers and frames shall be as in table given below:

<table>
<thead>
<tr>
<th>Description of C.I. Manhole Cover</th>
<th>Weight of Cover Kg.</th>
<th>Weight of Frame Kg.</th>
<th>Total Weight of Cover and Frame Kg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD 560 mm dia</td>
<td>108</td>
<td>100</td>
<td>208</td>
</tr>
<tr>
<td>LD, rectangular</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>455x610mm (single seal)</td>
<td>23</td>
<td>15</td>
<td>38</td>
</tr>
<tr>
<td>MD 500 mm dia</td>
<td>58</td>
<td>58</td>
<td>116</td>
</tr>
</tbody>
</table>

2 ½% variation in weight shall be permissible on either side.

Covers and frames shall be coated with a black bituminous composition. The coating shall be smooth tepacious. It shall not flow when exposed to a temperature of 63 Deg. and shall not be brittle as to chip off temp. of 0 Deg. C.

The frame of manhole cover shall be firmly embedded to correct alignment and levels in RCC slab or plain concrete, as the case may be on the top of the masonry.

After completion of the work, manhole covers shall be sealed by means of thick grease.

vi. Manhole Testing:

The selection of pipe per lot for testing & failure percentage no. of test Concrete mix & curing etc. shall be as per IS: 12592 (Part-I) for Pre-Cast Concrete Manhole Cover & Frame. The load of class AA shall be as per IRC guidelines. The contractor has to design the pre cast RCC cover slab for loading for given concrete mix & get it approved from Engineer. However, the testing to its full satisfaction and as per given criteria is the responsibility of the Contractor.

The testing shall be got done through party. The Manhole & Road Side Chamber cover and frame shall be heavy duty & medium duty (tested at 35 T load) respectively in Steel Fibre Reinforced Concrete (SFRC) and confirm to IS 12592 (Part I & II) except for the scraper manhole for which pre cast RCC strips are as shown in drawing.

The precast R.C.C. slab cover shall be tested as follows:

- Class AA loading = 6250 kg.
- Impact factor = 6250 x 1.25 = 7810 kg.
- Test load = 1.25 x 7810 = 9765 kg.

The test load 9765 kg distributed over an area 300 mm x 150 mm is placed at
the centre of the slab. The slab is tested under this load deflection recovery test as recommended in clause 17.6.2, 17.6.3, 17.6.3.1 of IS: 456-2000. The inspection and testing of manhole & road side chambers frames and covers shall be done at factory in presence of Engineer or his representative which shall be arranged by the Contractor at his own cost. The load test for covers shall be done in accordance with Table 1 of IS: 12592 (Part-I). The entire height of the manhole shall be tested for water tightness as per CPHEEO Manual, by closing both the incoming and outgoing ends of the sewer and filling the manhole with water and the drop in water level not more than 50 mm per 24 hours shall be permitted. The required water for testing and any other requirements shall be arranged by the Contractor at his own cost. The same procedure shall be adopted for road side chamber for water tightness test.

vii. **Foot Rests:**

All manholes deeper more than 0.6 m shall be provided with plastic foot rests (Polypropylene is injection moulded around a 12mm dia steel reinforcing bar). These shall be embedded 20cm, deep with 20 x 20 x 10cm blocks of cement concrete 1:2:4 (1 cement :2 coarse sand :4 graded stone aggregate 20cm, nominal size). The block with plastic foot rest placed it’s centre shall be cast in situ along the masonry and surface finished with 12mm thick cement plaster 1:3 (1 cement :3 coarse sand) finished smooth.

viii. All cast iron and Mild Steel items shall be provided with two coats of bitumastic paint.

**Measurement:**

Manhole shall be measured in numbers as indicated in the Bill of Quantity. The depth of manhole shall be measured from invert of channel to the top of manhole cover. Quoted rate shall cover the range of ± 0.24 metre on the depth specified in schedule and also the cost of items specified in the Bill of Quantities and Specifications viz.

Manhole with depth greater than specified under the main item shall be paid for under “Extra Depth” and shall include all items as given for manholes depth will be measured to the nearest cm. Depth of the manholes shall be measured from top of the manhole cover to bottom of channel.

i. Bed concrete.

ii. Brick work.

iii. Plastering.

iv. R.C.C. top slab, benching and channeling including drop connections.

v. Supply and fix M.S. foot rests.

vi. Keeping holes and embedding pipes for all the connections.
vii. Excavation, refilling, necessary dewatering and disposing off surplus soil to a place as directed by Client’s Representative.

viii. Curing.

ix. Cost of frame and cast iron cover including reinforcement, angle frame and embedding the frame in concrete bed.

x. Testing.

xi. De-watering of chambers.

**Gully Trap:**

Gully traps shall be fixed in cement concrete 1:5:10 mix and a brick masonry chamber 30 x 30cms C.I. sealed cover and frame weighting not less than 7.3 Kgs to be constructed as per standard drawings. Where necessary, sealed cover shall be replaced with C.I. grating of the same size (1 cement : 5 coarse sand : 10 stone aggregate : 40mm nominal size).

**Measurements:**

Gully traps shall be measured by the number and rate which shall include all excavation, foundation, concrete, brick masonry, cement plaster inside and outside, CI grating and sealed cover and frame.

**7.5 DROP CONNECTIONS:**

7.5.1 In case where branch pipe sewer enters the manhole of main sewer, a drop connection should be provided. H.C.I. pipes and specials conforming to IS:1729-1964 as revised from time to IS:1729-1964 as revised from time to time shall be of the size same as of the branch pipe sewer.

For 150 x 250mm main line, if the difference in level between the water line (peak-flow-level) and the invert level of branch line is less than 60cm, a drop connection may be provided within the manhole by giving ramp. If the different in level is more than 60 cm the drop should be provided externally.

7.5.2 Excavation:

The excavation shall be done for the drop connection at the place where the branch line meets the manhole. The excavation shall be carried upto the bed concrete of the manhole and to the full width of the branch line.

7.5.3 Laying:

At the ends of branch sewer line Cast Iron tee shall be fixed to the line which shall be extended through wall of the manhole by horizontal piece of Cast Iron pipe form an inspection on cleaning eye, the open end shall be provided with chain and lid. The Cast Iron drop pipe shall be connected to the tee at the top and to Cast Iron bend at the
bottom. The end shall be extended through the wall of the manhole by a piece of Cast Iron pipe which shall discharge into the channel. Necessary channel shall be made with cement concrete 1:2:4 (1 cement :2 coarse sand :4 graded stone aggregate to 20mm nominal size) and finished smooth to connect the main channel. The joint between Cast Iron pipe to fittings shall be lead caulked. The joint between Cast Iron tee and RCC branch line shall be made with cement mortar 1:1 (1 cement :1 fine sand). The exposed portion of the drop connection shall be encased around with minimum 15 cm thick concrete 1:3:6 (1 cement :3 fine sand :6 graded stone aggregate 40mm nominal size) and cured. For encasing the concrete around the drop connection, necessary centering and shuttering shall be provided.

The holes made in the walls of manholes shall be made good with brick work in cement mortar 1:5 (1 cement :5 fine sand) and plastered with cement mortar 1:3 (1 cement :3 coarse sand) on the inside of the manhole wall. The excavated earth shall be back filled in the trench in level with the original ground level.

7.6 Making Connections:

The Contractor shall connect the new sewer line to the existing manhole by cutting the walls, benching and restoring them to the original conditions. A new channel shall be cut in the benching of the existing manhole for a new connection. The Contractor shall remove all sewage and water if encountered in making the connection without additional cost to the Owner.

7.6.1 Measurements:

Item for making connection to municipal sewer shall be paid for by number and shall include all items given in the Bill of Quantities.

7.7 PUMPS & EQUIPMENTS:

Scope:
This specification covers the design, performance, manufacture, construction features, testing, delivery, installation and commissioning of portable, vertical submersible type drain pumps at pumping station.

Design Requirements:
The pump shall be capable of developing the total head at the required capacity. The total head capacity curves should be continuously rising towards the shut off with highest at shut off.
The power rating of the motor shall not be less than the power required throughout the range of operation.

Construction Features:
Pumps shall be of vertical motor, submersible, single stage with non clog type of impeller with mechanical seal. The bronze impeller shall be mounted on the extended staff of the motor.

Material of Construction:

<table>
<thead>
<tr>
<th>Component</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casing</td>
<td>IS 210 Gr. FG 260</td>
</tr>
<tr>
<td>Shaft</td>
<td>AISI – 410</td>
</tr>
<tr>
<td>Impeller</td>
<td>S.S. CF 8 M</td>
</tr>
</tbody>
</table>

Inspection & Testing:
The following equipments shall be got inspected by Engineer-in-Charge at works as stated earlier. The acceptance test as per latest relevant IS shall be carried out.
(i) Pumps  
(ii) Motor  
(iii) Sluice valves  
(iv) Reflux valves
F) **RAINFALL WATER HARVESTING:**

**8.0 General:**

8.1 Surface water is inadequate to meet our daily water demand and we have to depend on
ground water. Due to rapid urbanization, infiltration of rain water into the sub-soil has
declined drastically and recharging of ground water has diminished. The result of this
in decline in water levels in most of the country.

8.1.2 Two overcome with the problem mentioned above. The right solution is to use the rain
water harvesting techniques.

**8.2 Definition of Water Harvesting:**

8.2.1 In scientific terms, water harvesting refers to collection and storage of main water and
also other activities aimed at harvesting surface and ground water, prevention of losses
through evaporation and seepage and all other hydrological studies and engineering
interventions, aimed at conservation and efficient utilization of the limited water
endowment of physiographic unit such as a water shed.

8.2.2 In general, water harvesting is the activity of direct collection of rain water. The rain
water from the roof or from the surface can be directly stored for direct use or can be
recharged in the ground water.

8.2.3 Most of the people are not aware that the rain water is the first form of water in the
hydrological cycle, hence is a primary source of water for us. The other source like rivers,
lakes and groundwater are all secondary source of water. In present times, we depend
entirely on such secondary sources of water. In the process, it is forgotten that rain is
the ultimate source that feed the water to all the secondary sources and remain ignorant
of its value. Water harvesting means to understand the value of rain and to make
optimum of rain water at the place where it falls.

**8.3 Necessity of Water Harvesting:**

8.3.1 In India there is a lot of rain, yet there is no water. The annual rainfall over India is
higher compared to the global average rainfall. However, this rainfall occurs during short
spells of high intensity. Due to such high intensities and short duration of heavy rain,
most of the rain falling on the surface tends to flow away rapidly to these secondary
sources as mentioned above, and very little rain water is left for the recharging of the
ground water.

8.3.2 It is necessary to implement measures to ensure that rain falling over a region is tapped
as much as possible through water harvesting, either by recharging it into the ground
water aquifers or storing it for direct use.

**8.4 Amount of Water Harvested:**

8.4.1 The total amount of water that is received in the form of rainfall over an area is called
rain water endowment of the area. Now out of this the amount that can be effectively
harvesting is called the water harvesting potential. Water harvesting potential is rainfall
(mm) x collection efficiency.

8.4.2 The collection efficiency accounts for the fact that all the rain water falling over an area
cannot be effectively harvested because of evaporation, spillage etc. Factor like runoff
coefficient and the first flush wastage are taken into account when estimating the collection efficiency.

### 8.5 Advantages of Rain Water Harvesting:

#### 8.5.1 The advantages by adopting Rain Water Harvesting is as under:

i) Provides self-sufficiency to water supply system.

iii) Reduce the cost for pumping of ground water.

iii) Provides high quality water, soft and low in minerals.

iv) Improves the quality of ground water through dilution when recharged to ground water.

v) Reduces soil erosion in urban areas.

vi) The roof top rain water harvesting is less expensive.

vii) Rain Water harvesting system is simple which can be adopted by individuals.

viii) An ideal solution of water problem in areas having inadequate water resources.

ix) Reduces the runoff which chokes the storm water drains.

### 8.6 Method of Rain Water Harvesting:

#### 8.6.1 The method of rain water harvesting are of two types. One by storage of rain water on surface for future use. Second by recharging to ground water.

#### 8.6.2 The storage of rain water on surface is a traditional technique and structures used were underground tanks, ponds, check dams, weirs etc. and recharge to ground water is a new concept of rain water harvesting and name of few of them are recharge pits, trenches, dug wells, hand pumps, recharge wells, recharge shafts, lateral shaft and borewells shaft with borewells etc.
SEWAGE TREATMENT PLANT:

1. INTRODUCTION

In the following sections, the total scheme is given for treatment of sewage, meeting specified discharge norms for reuse for maintaining garden or otherwise, process equipment details, scope of supply and commercial terms and conditions. A sewage treatment plant in line with present day development based on latest Technology has been proposed.

2. WASTE WATER CHARACTERISTICS

As per the details furnished, the characteristics and the flow is as below which will form the basis for designing the treatment plant:

<table>
<thead>
<tr>
<th>Domestic Sewerage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Raw Sewage Generation &amp; Characteristics for Designing of the plant</strong></td>
</tr>
<tr>
<td><strong>Average Daily flow (cum/day)</strong></td>
</tr>
<tr>
<td><strong>PH</strong></td>
</tr>
<tr>
<td><strong>BOD (5 days at 20 degree C) (mg/l)</strong></td>
</tr>
<tr>
<td><strong>COD</strong></td>
</tr>
<tr>
<td><strong>Suspended solids (mg/l)</strong></td>
</tr>
<tr>
<td><strong>Oil &amp; Grease (mg/l)</strong></td>
</tr>
<tr>
<td><strong>Invert level of sewer</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Treated water Characteristics</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BOD</strong></td>
</tr>
<tr>
<td><strong>COD</strong></td>
</tr>
<tr>
<td><strong>Suspended solids</strong></td>
</tr>
<tr>
<td><strong>Oil &amp; Grease</strong></td>
</tr>
<tr>
<td><strong>Ph</strong></td>
</tr>
</tbody>
</table>

3. TREATMENT CONCEPT

### The sewage produced first passes through a coarse screen for the removal of large floatables. It then flows to Oil & Grease Trap & from there to Equalization Tank. Air Line is provided in equalization tank to convert the sewage to homogenous mixture & to prevent anaerobic growth of bacteria.

### From equalization tank sewage is pumped into aeration tank.

### Here BOD / COD load reduction takes place. In this tank the bacterial culture is developed. There is sufficient incorporation of air by blowers. The bacteria degrade / eat up complex organic matters from sewage and grow in number and size and become heavier. The mixture of bacterial mass and dissolved organic matter free water is transferred to secondary clarifier/ Tube settler.

### Secondary Clarifier is a tank having hopper shaped bottom. The sludge settles in the central pit and it is transferred to sludge drying bed via sludge regulating valve. The
Sludge shall be demoisturized in sludge bed. The supernatant clarified water passed thru tube media & flows by gravity to Filter Feed tank and from this point it is pumped to pressure sand filter for the removal of suspended solids. Again it passes through activated carbon filter for the removal of remaining BOD. Now the treated water is available for any means of disposal.

The Filter Press (optional) further concentrates the sludge and converts it into sludge cakes. The sludge cakes are removed and are ideal for use in land filling material as well as manure. The filtrate water is transferred to collection cum equalization tank.

Treated water can be used for horticulture application as well as toilet flushing. The sludge collected shall be used as manure for the plants.

4. SCHEME OF TREATMENT

1. SCREEN CHAMBER & GREASE TRAP UNIT.
2. EQUALIZATION-TANK FOR EQUALIZING EFFLUENT WITH DIFFUSERS
3. AERATION CHAMBER WITH DIFFUSERS & BIO-PACK MEDIA
4. SECONDARY CLARIFIER / TUBE SETTLER
5. PRESSURE SAND FILTER
6. ACTIVATED CARBON FILTER.
7. SLUDGE DRYING BEDS / FILTER PRESS.
8. TREATED WATER TANK

NOTE: The material like bio pack media, fill pack media, tube media, pipes and valves are always in excess quantity.
SECTION – 4.0

DETAILED TECHNICAL SPECIFICATION – HVAC WORKS
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Clause No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I)</td>
<td>System Introduction</td>
</tr>
<tr>
<td>II)</td>
<td>VRV System</td>
</tr>
<tr>
<td>III)</td>
<td>Package Type Air Conditioning Units</td>
</tr>
<tr>
<td>IV)</td>
<td>Double Skin Forced Draft Ventilation Units (FDV Units)</td>
</tr>
<tr>
<td>V)</td>
<td>Inline Fans</td>
</tr>
<tr>
<td>VI)</td>
<td>Duct Work and Outlets</td>
</tr>
<tr>
<td>VII)</td>
<td>Insulations</td>
</tr>
<tr>
<td>VIII)</td>
<td>Axial Flow Fans (Direct Drive)</td>
</tr>
<tr>
<td>IX)</td>
<td>Technical Data (To Be Furnished By The Bidder)</td>
</tr>
</tbody>
</table>
I SYSTEM INTRODUCTION

1. It is proposed to install Heat pump type inverter based VRF system in rooms along with treated fresh air units so that it can work on cooling mode during summer and heating mode during winter, if required.
2. It is proposed to install Ceiling / Floor Mounted Ductable package Type units in multipurpose areas depending upon the requirement.
3. All Ductable package Units shall be operated through corded remotes.
4. There will be 6 nos air cooled package units of 16.5 TR for multipurpose halls duly connected with ducts and fresh air.
5. Each indoor unit will work independently and we can set desired temperature, airflow in each area catered by individual unit.
6. There will be 6 Nos. VRF outdoor units (with suitable combinations) and approx. 79 Nos. of Indoor units of multiple capacities.
7. There will be 4 nos Treated fresh air units of VRV for room and for multipurpose hall, it is directly induced in return air of package units.
8. Zoning of indoor units connected with a particular out door unit shall be decided later and detail of the same is to be submitted before starting of project.
9. The details of units can be seen in the design summary sheet attached separately.
10. The GA drawing is also attached separately giving the unit locations and capacities in respective areas.
11. The kitchen area will have cooled ducted supply air of 5000 CFM and the ducted exhaust of 6000 CFM to have negative pressure in the kitchen.
12. All common toilets will have ducted inline fans to exhaust the air out.
Variable Refrigerant Flow (VRF) Equipment and associated works:

a) 6 Nos. Of VRF outdoor unit of capacity not less than 18 HP comprising of outdoor unit multi connect kit etc. for comfort air conditioning.
b) 4 Nos. Of VRF outdoor unit of capacity not less than 5 HP comprising of outdoor unit multi connect kit etc. for TFA.
c) 79 Nos. of cassette type and wall mounted Type indoor unit of capacity not less than 1 HP.
d) 6 Nos. of Ceiling Suspended Ductable Type package units of indoor unit of capacity not less than 16.5 TR.
e) Treated fresh air units of 25HP and 8HP.
f) Suction and Liquid refrigerant pipes including fittings with insulation etc.
g) PVC condensate pipes.
h) Factory fabricated Rectangular GI sheet metal ducts for supply air duly insulated.
i) Volume control Damper in ducts.
j) Aluminum powder coated Supply and Return air Diffuser or grills.
k) Flexible duct for connecting the Supply air diffusers to ducts.
l) Supply air washer for Kitchen area
m) Exhaust fan for kitchen
n) Inline exhaust fans for toilets
II  VRV SYSTEM

1.0  General

1.1 The scope of this section comprises of the design, supply erection, testing and commissioning of inverter technology based D.C Twin Rotary / Scroll Type VRV/VRF type system of air conditioning conforming to these specification and in accordance with the requirements of Drawing and Schedule of Quantities.

1.2 The prices quoted shall include all the equipment ancillary material as specified and all such items whatsoever and which may be required to fulfill the intent and purpose as laid down in the specification and the approved drawings.

1.3 The contractor shall calculate equipment capacity based upon design parameters specified for the system design & verify all the quantities and sizes of refrigerant pipe, fitting, cables, control cable, pipes, insulation, indoor units, and outdoor units etc. before installation to avoid any shortfall or surplus.

1.4 The tenderer shall also include all necessary minor civil work & MS frame work required for installation of outdoor and indoor units in VRF based air conditioning system.

1.5 The cost quoted by tenderer shall also include the refrigerant R-410A & its charging for proper & specified functioning of air conditioning system.

1.6 The scope in the tender schedule also covers detailed designing of complete air-conditioning system based on inverter technology based D.C Twin Rotary / Scroll VRV/VRF air conditioner with air cooled outdoor units system capable of cooling and heating (reverse cycle) as per individual or season requirement suitable for operation on 415 V, 3 Phase, 50 Hz AC electric supply.

1.7 Each indoor unit should have capability to cool or heat as per seasonal weather changes as per schedule of quantities.

1.8 This shall also include complete capacity calculation for indoor and outdoor units complete with CAD drawing, designing & layout of following.
   a. Outdoor units.
   b. Indoor units.
   c. Refrigerant piping
   d. Condensate water piping & disposal.
   e. Power & Control Cables between Outdoor units & Indoor units.

2.0  OUTDOOR UNIT

2.01 The outdoor unit shall be factory assembled, weather proof casing (Material of construction of casing shall be vendor’s standard design), constructed from heavy gauge GI sheets steel panels and coated with baked enamel finish. The outdoor unit shall be completely factory wired, tested with all necessary controls & filled with first charge of refrigerant before delivering at site.
2.02 The inverter technology based/ D.C Twin Rotary / Scroll / VRV / VRF equipment should be capable so that refrigerant piping between indoor units and outdoor unit shall be extendable up to 150m with maximum height difference between outdoor & indoor unit of 50m & level difference between two indoor units shall be maximum up to 10m.

2.03 Minimum acceptable value of Seasonal Energy Efficiency Ratio (SEER)/EER/IEER shall be conforming to Table No. 6.8.1A of ASHRAE standard 90.1-2007 addenda enclosed herewith.

2.04 The outdoor unit shall be factory tested and filled with first charge of refrigerant R-410A before delivering at site.

2.05 It should also be provided with duty cycling for D.C inverter Twin Rotary/ Scroll compressors capable of changing the rotating speed of compressor by inverter controller to follow variation in cooling & heating loads & switching starting sequence for better stability and prolonging equipment life or similar features if available in D.C Twin Rotary / Scroll will also be accepted.

2.06 The unit shall be provided with its own microprocessor control panel with provision for integration with the building management system for Air-conditioning system.

2.07 The outdoor units should have anti corrosion paint free or powder coated plate to ensure rusting do not occur on the same.

2.08 The machine must have a sub cool feature to use coil surface more effectively through proper circuit/ bridge so that it prevents the flushing of refrigerant from long piping due to this effect thereby achieving energy savings.

2.09 The outdoor unit should be fitted with low noise level and should not be more than 67 db (A) at normal operation when measured at 1.5m distance from ground level.

2.010 The outdoor unit should be fitted with low noise aero spiral design fan with aero fitting grill for spiral discharge airflow to reduce pressure loss and should be fixed with DC fan motor for better efficiency.

2.011 In case of trouble occurs in an indoor units (s), the continuous operation of system should be possible.

2.012 The unit shall be designed in such a way that cleaning of drain Pan should be easy & inspection/ replacement of compressor should be easy.

2.013 The condensing unit shall be designed to operate safely whey connected to multiple fan coil units.

2.1 Compressor
2.1.1 The compressor in inverter based D.C Twin Rotary / Scroll System shall be highly efficient. The system should respond efficiently in accordance to the variation in cooling or heating load requirement.

2.1.2 All outdoor units shall have multiple steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated stock. Forced lubrication may also be employed.

2.2 **Oil Recovery system**

2.2.1 Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigeration piping lengths.

2.2.2 The system must be provided with oil balancing circuit to avoid poor lubrication.

2.3 **Refrigerant Circuit**

2.3.1 The refrigerant circuit shall include liquid and gas shut-off valves and a solenoid valves at condenser end.

2.3.2 The equipment must have inbuilt refrigerant stabilization control for proper refrigerant distribution.

2.3.3 All necessary safety devices shall be provided to ensure the safe operation of the system.

2.4 **Heat Exchanger**

2.4.1 The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminium fins to form a cross fin coil.

2.4.2 The aluminium fins shall be covered by anti-corrosion resin film.

2.4.3 The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical discharge.

2.4.4 Each fan shall have a safety guard.

2.5 **Safety Devices**

2.5.1 All necessary safety devices shall be provided to ensure safe operation of the system.

2.5.2 Following safety devices shall be part of outdoor unit:-
   a. high pressure switch,
   b. fuse,
   c. fan drive overload protector,
   d. fusible plug,
   e. crankcase heater,
   f. over load relay,
   g. overload protection for inverter.
2.5.3 Noise levels for outdoor units shall not be more than 67 db (measured at a point 1 meter in front of the unit at a height of 1.5 meters.

3.0 INDOOR UNITS

3.1 All indoor units as specified shall have; in general, noise levels less than 46 db.

3.2 The address of the indoor unit shall be set automatically in case of individual and group control.

3.3 In case of centralized control system, it shall be possible to set the address of individual indoor unit through a liquid crystal remote controller.

3.4 The fan shall be dual suction, aerodynamically designed, Turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having support from housing.

3.5 Indoor unit shall have cleanable type filter fixed to an integrally moulded/ moulded plastic frame. The filter shall be slide in and neatly insertable type. It shall be possible to clean the filters either with compressed air or water.

3.6 Each unit shall have Electronic control expansion valve for variable refrigerant Flow Effect and to control refrigerant flow rate corresponding to load variation of the room.

3.7 Each indoor high wall unit shall be with cored/ cordless remote controller as standard features. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self diagnostic features for each and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flap (for high wall) individually as per requirement.

4.1 Refrigerant piping for the air-conditioning system shall be upto 19.1 mm dia of soft seamless copper tubes & for above 19.1 mm dia the pipe material shall be of hard seamless copper tubes with pipes material being hard drawn copper pipe.

4.2 The copper tube shall be bright annealed mirror finish product. No polish coating shall be on the inner surface.

4.3 The thickness of copper piping shall not be less than 18 SWG for pipes upto 19.1 mm and 16 SWG for larger dia.

4.4 Forged copper fittings shall be used for the refrigerant piping.

4.5 The refrigerant piping arrangements shall be in accordance with good engineering practices as applicable to the air-conditioning industry, and shall include charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits except Y joint/separation tubes.
4.6 Before jointing any copper pipe or fittings, its internals shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently it shall be thoroughly blown out using nitrogen gas.

4.7 After completion of installation of the refrigerant piping, the refrigerant piping system shall be pressure tested using nitrogen gas at a suitable pressure as specified by OEM (Original Equipment Manufacturer). Pressure shall be maintained in the system for 48 hours. The system shall then be evacuated to vacuum of not less than 700 mm Hg and held for 24 hours.

4.8 The supplier of air-conditioning system shall choose sizes as designed and erect proper interconnections of the complete refrigerant circuit.

4.9 The suction line pipe size and the liquid line pipe sizes shall be selected according to the manufacturer’s specified diameter.

4.10 All refrigerant pipes shall be properly supported and anchored to the building/structure using steel hangers, fasteners, brackets and supports which shall be fixed to the building/structure by means of inserts or expansion shields or anchor fasteners of adequate size and number to support the load imposed thereon.

4.11 The refrigerant piping should be laid in such a way that it should not distort the interior of the room, wherever the refrigerant pipe has to be laid across the room, it should be laid in a concealed manner in coordination with interior.

4.12 Entire liquid and suction refrigerant pipe lines including all fittings, valves and strainer bodies, etc. shall be insulated with 19mm thick closed cell/Cross linked Elastomeric / Polyethylene as specified in BOQ/ and as per specification.

5.0 Drain Piping duly insulated

5.1 The drain pipe connection of each fan coil unit to the main header should be 25 mm dia/32 mm dia as required as per schedule of quantities. The header pipe should be of 40 mm dia/32 mm dia as required.

5.2 The drain-pipe should be heavy duty PVC pipe ISI marked and conforming to relevant IS complete with fitting as required whereas the connection of the fan coil unit to the PVC pipe should be with flexible braided pipe.

5.3 The drain piping should be insulated with 6 mm thick tubular nitrile rubber Elastomeric insulation as per specification.

5.4 For proper drainage of condensate U trap shall be provided in the drain piping wherever required.

5.5 All pipe supports shall be prefabricated and pre-painted slotted angle supports, properly installed with clamps.

5.6 The condensate drain pipe arrangement for disposal of condensate water be made in such a way that there should not be any leakages of condensate water.
inside rooms as well in the route of drain water pipe line & water should be discharged at the location jointly decided with Engineer-in-Charge of work.

5.7 The arrangement of drain-pipe shall be made in such a way that it should not affect the aesthetic of the building as well as is maintenance friendly & easily accessible.

6.0 **Refrigerant Piping Insulation**

6.1 The Refrigerant piping insulation shall be tubular type 19mm thick material as per specifications given in the Insulation Chapter.

6.2 Protective Coating over Insulation in an area exposed to atmosphere.

6.2.1 To provide mechanical strength and protection from damage all pipes insulated with nitrile rubber / polyethylene foam in exposed area shall be covered with aluminium foil of 0.5 mm thickness.
III PACKAGE TYPE AIR CONDITIONING UNITS

1.0 The Package type Air Conditioning units shall be complete in all respects and shall comply with the following specifications.

2.0 Air Cooled Packaged Units

2.1 Each Package Air Conditioning units shall be complete with Hermetically sealed Scroll compressors with high EER, multi rows Cooling coil, Fan section with motor, Interconnecting piping, microprocessor based control panel with safety controls, switch gear and internal wiring and shall be enclosed in an polyester powder coated sheet metal cabinet.

3.0 Cooling Coil

3.1 The cooling coil shall have copper tubes of not less than 3/8” O.D. with continuous aluminium plate fins.
3.2 The tubes shall be staggered in the direction of the Air Flow.
3.3 The fins shall be spaced by collars forming an integral part of the fins.
3.4 The fins shall be uniformly bonded to the tubes by mechanical expansion of the tubes.
3.5 The complete tube and fins shall be assembled in a rigid aluminium frame.
3.6 The circuiting shall be suitable to maintain the required refrigerant flow.
3.7 The cooling coil shall be multi row deep with larger coil face area in order to keep velocity of air crossing cooling coil not more than 500 FPM.
3.8 The distance between the fins shall not be less than 1.8 mm and face velocity shall be less than 2.3 m/sec.
3.9 The cooling coil divided in to parts with separate connection as per number of refrigeration circuits.
3.10 Suitable cleanable air filters shall be provided before the coil.

4.0 Air Cooled Condenser

4.1 Each condenser shall be complete unit with condenser coil, condenser fans with motors, internal piping, switches and internal wiring and shall be enclosed in a weather proof outdoor type housing.
4.2 The condenser coil shall be air cooled type & shall have lowest possible foot print area with maximum heat transfer.
4.3 The fins should have special coating as per international standard JIS-Z-2371 specified for 500 hours of salt spray test so as to resist against environmental corrosion.
4.4 The exposed fins shall be finally protected with fin guard.
4.5 The condenser air fans shall be propeller type direct driven, each complete with motor.
4.6 The air quantity and area of the condenser shall be adequate for working in the specified outdoor conditions.
4.7 The casing shall be fabricated from galvanised steel, zinc phosphated and finished with baked enamel paint (pure polyester powder coating).
4.8 The casing shall make the whole unit fully weather proof, suitable for outdoor installation.

5.0 Fan Section
5.1 The fan section shall consist of forward curved fans, complete with scrolls, shaft and self aligning bearings, fan motor mounted on floating base and adjustable speed drive.

6.0 Electrical System
6.1 The unit shall have an internally mounted control panel with microprocessor based logic controller, housing the starters, safety controls, relays, etc.
6.2 The various electrical components shall be neatly pre-wired at the factory requiring only main power supply from external source.
6.3 Microprocessor panel shall have special feature of “RUN TIME EQUALISATION” which shall allow both compressors to run for equal amount of time so as to ensure longer life for compressors & for whole machine.

7.0 General
7.1 The units shall be complete with cooling thermostat, thermostatic expansion valve and other necessary controls/safety devices.
7.2 The units shall be provided with hermetic scroll compressors without any deviation as higher number of compressors installed in a unit offer better operational efficiency:
7.3 The compressor shall be complete with steel casing, scrolls, oil reservoir, bearings, hermetic motor, refrigerant connections etc.
7.4 All the components listed above and any other that may be required shall all be enclosed in factory built sheet metal cabinet.
7.5 The cabinet shall be divided into cooling section and fan section.
7.6 The whole cabinet shall be insulated with 25 MM Thick insulation. It shall have openings for fan outlets, suitable return air grille.
7.7 Unit shall be provided with dry media cleanable filter capable of filtering air to 80% @ 10 micron efficiency.
7.8 The unit shall be suitable for refrigerant R-407C.
7.9 The necessary charge of refrigerant gas and lubricated oil shall be provided to run the system.

8.0 Accessories
The following items shall be included as part of Package type Air Conditioning unit price.

8.1 Canvas connection between the Blower outlet and duct connection, if any.
8.2 Adjustable stands made of mild steel members.
8.3 Copper piping duly enamel painted to connect indoor units to outdoor condensing units.
8.4 Vibration isolation pads below the units.
8.5 All external control wiring.

**LIMITATIONS**
1. The filter velocity at face of filter shall be not more than 2.54 m/s.
2. The coil velocity at face shall be not more than 2.54 m/s.
3. The fan velocity at fan outlet shall be not more than 10 m/s

**IV DOUBLE SKIN FORCED DRAFT VENTILATION UNITS (FDV UNITS)**

1.0 **SCOPE**

The scope of this section comprises the supply, installation, testing and commissioning of packaged type of specific capacity.

2.0 **HOUSING/CASING**

2.1 The housing/casing of the Forced Draft Ventilation Unit shall be of double skin construction. The frame work shall be of Extruded Aluminium hollow sections. All the frame shall be assembled using pressure die cast nylon plastic joints to make a sturdy, strong and self supporting frame work for various section.

2.2 23mm thick double skin panels shall be made of 0.6mm pre-coated GSS on outside and 0.6mm epoxy coated GSS sheet inside the CFC free polyurethane foam of 38 Kg/cu.m in-house injected in between. These panels shall be screwed from inside on to the frame work with soft rubber gasket in between to make the joints air tight.

2.3 Frame work for each section shall be jointed together with soft rubber gasket in between to make the joints air tight. Suitable air tight access doors/panels with aluminium hinges and nylon locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on heavy duty aluminium channel base.

2.4 The water tank shall be made out of 1.2mm thick stainless steel SS:304.

2.5 The FDV unit shall be suitable to work at outdoor installation.

3.0 **FAN SECTION**

3.1 The housing shall be fabricated as specified above.

3.2 Variable pitch pulley shall be provided to affect reduction in speed in winter if required.

3.3 Fan housing with motor shall be mounted on a common steel base mounted inside the air handling housing on anti-vibration spring mounts.
3.4 The entire fan section shall be coated with epoxy (two coats) after two coats of primer from inside.

3.5 Inspection door shall be installed with micro-switch arrangement with marine light within the fan section.

3.6 Micro-switch shall be interlocked with blower and light with resetting arrangement.

3.7 Multi fan unit shall be provided with non return damper at each fan outlet.

4.0 FAN

4.1 The fans shall be aerofoil blade backward curved floor standing double inlet double width type of imported origin.

4.2 The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy-duty ball bearings.

4.3 The impeller and fan shaft shall be statically and dynamically balanced.

4.4 The fans outlet velocity shall not be more than 2000 FPM.

4.5 The fan outlet shall be connected to casing with the help of fire retardant canvass.

4.6 The centrifugal fan inside and outside shall be epoxy coated (two coats after two coats of primer) to avoid moisture abuse in the factory prior to delivery.

4.7 The fan shall be provided with access panel and drain plug.

4.8 The fan shall have belt guard and inlet screen.

4.9 The fan shall have non-overloading characteristics.

5.0 MOTOR & DRIVE

5.1 Fans shall be driven by an electric motors as specified in the schedule of quantities.

5.2 Motor ratings are only tentative and where a fan required a higher capacity motor, the contractor shall clearly point out the requirement and make his offer accordingly.

5.3 Motor ratings shall be at least 10% over limit load plus transmission losses.

5.4 Fan motors shall be suitable for operation on 415+ 10% volts 50 ±5 cycles, 3 phase, Combined Voltage and Frequency fluctuation of 10%, AC power supply and shall be TEFC squirrel case induction type totally enclosed fan cooled with IP-55 protection and shall be Energy Efficient EF1.
5.5 Motors shall be specifically designed for quite operation and motor speed shall not exceed 1440 RPM.
5.6 Drive to fan shall be provided through belt drive arrangement.
5.7 Belts shall be of the oil-resistant type.
5.8 Variable pitch pulley shall be provided to affect reduction in speed in winter if required.

6.0 **AIRWASHER SECTION**

6.1 The Air washer section shall incorporate cellulose base media of Imported origin having minimum 200mm thickness or as specified in the Schedule of Quantities.

6.2 The cooling pads shall be of rigid cross fluted honey comb design, having highly water absorbent cellulose media, impregnated with insoluble antiriot chemicals. It shall provide extended and sufficient wetted surface to provide a water absorbing efficiency of 90% with air velocity not exceeding 500 FPM (2.54 M/Sec).

6.3 The cooling pads section and tank shall be fabricated from 18 gauge SS-304A stainless steel sheets with bolted construction having suitable stiffeners.

6.4 The section shall be complete with FRP water distribution having parts and sized for uniform and adequate water flow through perforated PVC pipe / G.I. B Class pipe.

6.5 The tank shall be fitted with 1” (25 mm) industrial type float valve assembly of commercial grade brass.

6.6 The pad section shall have provision for fixing one or two sets of air filter sections as specified.

7.0 **PUMPS**

7.1 The water distribution pumps shall be of heavy duty vertical / monobloc type mounted outside the tank. It shall be complete with adjustable bleed off arrangement to prevent concentration of undesirable Salts.

7.2 The pump shall be provided with single phase preventer, self tripping starter and shall three phase.
8.0 AIR FILTERS

8.1 The standard pre-filters shall be with five layers of Aluminium wire mesh at least 50 mm thick fixed in a 20 gauge aluminium frame with handles for ease of removal.

8.2 The above set of filters shall be fixed in filter frames made of 20 gauge G.I. sheets shaped to prevent air leakage. The filters shall be easily removable. The filter section shall form part of the pad section.

V INLINE FANS

1.0 SCOPE

1.1 The scope of this section comprises of supply, erection, testing and commissioning of Inline Fans conforming to these specifications and in accordance with the requirements, Equipment Schedule, Schedule of Quantities and drawings.

2.0 TYPE

2.1 Fan shall be single inlet single width (SISW) type. Fan shall have directly driven forward curved centrifugal impeller, running in a metal scroll balanced to give quite and vibration free operation. Fan motor assembly shall be statically and dynamically balanced.

2.2 The fan shall be assembled in such a manner that the motor and impeller can be easily removed and reinstalled after servicing.

3.0 MATERIAL

3.1 Fan casing shall be manufactured from galvanized steel sheets.

3.2 All other metal parts shall be hot dip galvanized.

4.0 MOTOR

4.1 The fan shall be equipped with motor with speed regulator giving volume control from 0 to 100% of output.

4.2 Motors shall be with Class F insulation wired to an externally mounted weather proofed terminal box.

5.0 INSTALLATION

5.1 Fan shall have rigid supports and fitted to both ends of the casing.

5.2 Wherever the fans are to be suspended from ceiling or mounted on the wall, the Contractor shall include supply and fixing of all the material that may be required to complete the installation in all respects.
5.3 Fan inlet and outlet connections shall be by means of flexible canvas connections.

6.0 TESTING

6.1 Fan after installation shall be tested for capacities, power consumption, noise level and vibration and results shall confirm to the approved data furnished by the Contractor.

7.0 ELECTRIC POWER CONNECTIONS

7.1 Single phase, 220 V, 50 Hz power supply point within 2 meter from the fan shall be available. All further wiring shall be in the scope of Air-conditioning Contractor.

VI DUCT WORK AND OUTLETS

1.0 GENERAL

1.1 The work under this part shall consist of furnishing labour, materials, equipment and appliances as specified, necessary and required to install all sheet metal ductwork and other allied work to make the HVAC system complete & ready for operation as per drawings/schedule of quantities.

1.2 Ductwork shall mean all ducts, casings, dampers, access doors, joint, stiffeners and hangers. All duct work and related items shall be in accordance with these specifications.

1.2.1 The ducting shall be factory fabricated and assembled at site.

1.2.2 FABRICATION OF DUCTING AT SITE EXCEPT “TO SUITE AT SITE” PIECES WILL NOT BE ALLOWED. THE “TO SUITE” PIECES WILL REQUIRE PRIOR APPROVAL FROM ENGINEER-IN-CHARGE OR ARCHITECT.

1.3 DOCUMENTATION & MEASUREMENTS FOR DUCTING

1.3.1 All ducts fabricated and installed should be accompanied and supported by proper documentation viz.

1.3.2 Bill of material/packing list for every duct section supplied.

1.3.3 Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge wise.

1.3.4 Each and every duct piece to have a tag number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement and verification.
2.0 DUCT MATERIALS

2.1 The ducts shall be fabricated from galvanized steel sheets class VIII conforming to IS: 277 latest edition (120 gm/sq.m).

Galvanised sheet shall possess light coating of zinc nominal 120 gm./sq.m surface area (total coating on both sides) and Lock Forming Quality prime material along with mill test certificates. In addition if deemed necessary, samples of raw material, selected at random by Owner's Site Engineer-in-Charge shall be subjected to approval and tested for thickness and zinc coating at Contractor's expense.

2.2 All duct work, sheet metal thickness and fabrication unless directed otherwise, shall strictly meet requirements, as described in IS: 655-1963 with amendment-I (1971 edition).

2.4 The gauges, joints and bracing's for sheet metal ductwork shall further conform to the provisions as shown in 4.0.

2.5 Ducts larger than 450mm shall be cross-broken duct sections up to 1200-mm length may be used with bracing angles omitted.

2.6 Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible but not less than 1:4 ratio. All branches shall be taken off at not more than 45 Deg. angles from the axis of the main duct unless otherwise approved by the Engineer-in-Charge.

2.7 All ducts shall be supported from the ceiling/slab by means of M.S. rods of size as given above with M.S. angle at the bottom.

3.0 INSTALLATIONS

3.1 During the construction, the Contractor shall temporarily close duct openings with sheet metal covers to prevent debris to enter into the ducts and to maintain opening straight and square, as per direction of Engineer-in-Charge.

3.2 Great care should be taken to ensure that the ductwork does not extend outside and beyond height limits as noted on the drawings.

3.3 All ductwork shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be tight and shall be made in the direction of airflow. The ducts shall be reinforced where necessary, and must be secured in place so as to avoid vibration of the duct on its support.

3.4 All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration. All ducts shall be fabricated and installed in accordance with modern design practice. The sheet metal gauges and fabrication procedures as given in I.S.S. specifications shall be adhered to and shall be considered as an integral
part of these specifications. Turning vanes shall also be provided in masonry ducts as per schedule of quantities.

3.5 The ductwork shall be varied in shape and position to fit actual conditions at building. All changes shall be in accordance with accepted H.V.A.C. duct design and subject to the approval of the Engineer-in-Charge.

3.6 Self adhesive Neoprene rubber/UV resistant PVC foam lining 5mm thickness shall be installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns and filter casings. Sheet metal connections shall be made to walls and floors by means of galvanised steel angles anchored to the building structure with anchor bolts and with the sheet bolted to the angles. Sheet metal connections shall be as shown in the drawings or as directed by Engineer-in-Charge.

3.7 The ducts shall be supported from the structure by means of suitable supports as mentioned below by means of threaded G.I. rods anchored to RCC slab using metallic expansion fastners. In no case the duct will be rested upon the false ceiling/boxing or on supports grouted in the wall.

3.7.1 **HANGERS FOR DUCT OR GRIPPLE WIRE SUPPORT:**

<table>
<thead>
<tr>
<th>Duct Size (mm)</th>
<th>Spacing (M)</th>
<th>Size of MS Angle (mm x mm)</th>
<th>Size of Rod Dia (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 750</td>
<td>2.4</td>
<td>32 x 3</td>
<td>8</td>
</tr>
<tr>
<td>751 to 1500</td>
<td>2.0</td>
<td>40 x 6</td>
<td>10</td>
</tr>
<tr>
<td>1501 to 2250</td>
<td>2.0</td>
<td>50 x 6</td>
<td>12</td>
</tr>
<tr>
<td>2251 to above</td>
<td>2.0</td>
<td>50 x 6</td>
<td>12</td>
</tr>
</tbody>
</table>

3.71 Additional hangers shall be provided in ducts near smoke / fire dampers corrections and at bends.

3.8 Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.

3.9 Joints, seams, sleeves, splitters, branches, take off and supports are to be as per duct details as specified or as decided by Engineer-in-charge.

3.10 Joints requiring bolting or riveting may be fixed by hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Sale tapping screws must not be used. All fixing must have a permanently non-corrosive finish such as cadmium plating or galvanising as appropriate. Spot welds and bronze welds are to be coated on all surfaces with zinc rich paint as approved by Engineer-in-charge.

3.11 The flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by Engineer-in-charge. On all circular spigots the m flexible materials are to be screwed or clip band with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.
3.12 The flexible joints are to be not less than 75mm and not more than 250mm between faces.

3.13 The ductwork should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling Contractors.

3.14 INSTALLATION PRACTICE

The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these Specifications and Drawings. The work shall meet with the approval of Owner’s site representative in all its parts and details.

All necessary allowances and provisions shall be made by the Contractor for beams, pipes or other obstructions in the building, whether or not the same are shown on the drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes and conduits the ducts shall be transformed, divided or curved to one side (the required area being maintained) all as per the site requirements.

If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available in accordance with other services and as per approval of Owner’s site representative.

4.0 THE GAUGE JOINTS AND BRACING FOR SHEET METAL DUCT WORK SHALL BE AS FOLLOWING

<table>
<thead>
<tr>
<th>Maximum Side (mm)</th>
<th>Thickness of GI Sheet (mm)</th>
<th>Type of Transverse Joint Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 750 *</td>
<td>0.63</td>
<td>C &amp; SS CLEATS</td>
</tr>
<tr>
<td>751 to 1500</td>
<td>0.80</td>
<td>TDF FLANGES</td>
</tr>
<tr>
<td>1501 to 2250</td>
<td>1.00</td>
<td>TDF FLANGES</td>
</tr>
<tr>
<td>2250 TO ABOVE **</td>
<td>1.25</td>
<td>TDF FLANGES</td>
</tr>
</tbody>
</table>

* Exposed Ducts for Evaporating Air Cooling and other un-insulated exposed ducts shall have TDF Flanges.

** Ducts 2250mm and larger require special field study for hanging, supporting methods and also bracing for duct size above 1501 mm.

5.0 MISCELLANEOUS

5.1 All ducts above 450mm are to be cross-broken to provide rigidity to the ducts.

5.2 All duct work joints are to be true right angle or approaching with all sharp edges removed.
5.3 Sponge rubber gaskets also to be provided behind the flange of all grilles.

5.4 Each shoot from the duct, leading to a grill, shall be provided with an air deflector to divert the air into the grille through the shoot.

5.5 Inspection doors measuring at least 450mm x 450mm are to be provided in each system at an appropriate location, as directed by Engineer-in-charge.

5.6 Diverting vanes must be provided at the bends exceeding 600mm and at branches connected into the main duct without a neck.

5.7 Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by Engineer-in-charge.

5.8 The ducts should be routed directly with a minimum of directional change.

5.9 The ductwork shall be provided with additional supports/Hangers, wherever required or as directed by the Engineer-in-Charge, at no extra cost.

5.10 All duct supports, flanges, hangers and damper boxes etc. shall be given 2 coats of red oxide paint before installation and one coat of aluminium paint after the erection, at no extra cost.

5.11 All iron flanges to be welded electrically and holes to be drilled.

5.12 All the angle iron flanges to be connected to the GSS ducts by rivets at 100 mm centers.

5.13 The GSS ducts should be lapped 6 mm across the flanges.

5.14 The ducts should be supported by approved type supports at a distance not exceeding 2.4 meters.

5.15 Sheet metal connection pieces, partitions and plenums required shall be constructed of 1.25 (18 gauge) sheet thoroughly stiffened with 40mmx40mmx3mm angle iron braces and fitted with access doors.

5.16 Splitter damper must be provided wherever ducts are bifurcating. No extra payment shall be made separately since these form part of air-circulating system.

6.0 **GRILLES, DIFFUSERS, DAMPERS ETC.**

6.1 The supply and return air grills and ceiling diffusers
The supply and return air grills and ceiling diffusers shall be made of powder coated extruded aluminium sections. The supply air grills/diffusers shall be provided with screws operated opposed blade volume control device made of extruded aluminium in black anodised finish.
All grills/diffusers shall have soft continuous rubber/foam gasket between the periphery of the grills/diffusers and surface on which it has to be mounted. The colour of grills/diffuser shall be as per the approval of the Engineer-in-Charge.

6.2 Linear supply and return grills

The linear continuous supply/return air grills shall be made of powder coated extruded aluminium construction with fixed horizontal bars. The thickness of fixed bar louvers shall be 5mm in front and the flange shall be 20mm wide with round edges. The register shall be suitable for concealed fixing and horizontal bars of the grills shall mechanically crimped from the back to hold them.

The colour of grills shall be as per the approval of the Engineer-in-Charge. The volume control device made of extruded aluminium construction in black anodised finish shall be provided in supply air duct collars only.

6.3 Front fixed bar rear adjustable louvered grills

The grills shall be made of powder coated extruded aluminium construction with front fixed horizontal bar at 0 degree inclination with one way or two way deflection with rear vertical individually adjustable louvers in black shade mounted on Nylon bushes to hold deflection setting under all conditions of velocity and pressure.

The colour of grills shall be as per the approval of the Engineer-in-Charge. The volume control device of extruded aluminium construction in black anodised finish shall be provided in supply air duct collars.

6.4 Square/rectangular ceiling diffusers

The square/rectangular ceiling diffusers shall be made of powder coated extruded aluminium construction with flush fixed pattern. The diffusers shall have Anti-Smudge ring and spring loaded removable control core in various pattern for air flow direction. The diffusers shall be mounted by concealed screw fixing arrangement. The volume control device of extruded aluminium construction in black anodised finish shall be provided in supply air diffusers. The colour of diffuser shall be as per the approval of the Engineer-in-Charge.

6.5 Jet Diffusers

The Jet Diffusers shall be made of powder coated aluminium construction. These diffusers are with reversible cores for long / short throw patterns. For long throw it shall be at Jet made while for small throw diffuser mode shall be utilized. The Jet diffusers shall be used for large spaces preferably industrial application.

6.6 Swirl Diffuser

The Swirl Diffuser is made of housing which has a diffusing funnel mounted at the bottom. The direction of the discharged air is altered via the separately
adjusted blades. Housing consists of sheet aluminium and blades of pickled sheet steel. It shall have plenum with top entry.

6.7 Volume control device

The opposed blade volume control device shall be made of Powder Coated extruded aluminium construction in black anodised finish. Opposed blades shall be pivoted to extruded aluminium frame with Nylong bushes. Specially designed blade shall have an overlapping lip which shall ensure a tight closure.

6.8 Fresh air intake louvers with bird screen

The fresh air intake louvers at least 50mm deep will be made of powder coated extruded aluminium construction. Bird/insect screen will be provided with the intake louvers. The blades shall be inclined at 45 degree on a 40mm blade pitch to minimize water ingress. The lowest blade of the assembly shall be extended out slightly to facilitate disposal of rain water without falling on door/wall on which it is mounted.

The intake louvers shall be provided with factory fitted aluminium construction volume control dampers in black anodised finish.

7.0 PAINTING

7.1 All grills shall have either anodized finish or powder coated as specified by Architect.

7.2 All ducts immediately behind the grills etc. are to be given two coats of black paint in matt finish.

8.0 TESTING

8.1 The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the final balance or air quantity through each outlet shall be submitted to the Engineer-in-Charge for approval.
VII INSULATIONS

1.0 GENERAL

The insulation of water piping and pumps, ducting, expansion tank etc., shall be carried out as per specifications given in the following:

2.0 MATERIALS

The insulation material of pipes, pumps, expansion tank ducting, acoustic lining etc. shall be as follows and as per specifications mentioned in this section regarding density and application procedure.

3.0 DUCTING

3.1 Insulation material for Duct insulation shall be closed cell Elastomeric Nitrile Rubber or Cross linked polyethylene foam. Thermal conductivity of the insulation material shall not exceed 0.038 W m °K or 0.212 BTU/(Hr-ft2 °F/inch) at an average temperature of 30 °C. The product shall have temperature range of – 40 °C to 105°C. The insulation material shall be fire rated for Class O/Class-I as per BS 476 Part6:1989 or as per relevant standard. Water vapour permeability shall be not less than 0.024 per inch (7000 water diffusion resistance). The material shall have approval from the Chief Fire Officer.

3.1.1 Insulation material for Duct Acoustic Lining shall be resin boned fibre glass rigid board (25mm thick). The thermal conductivity of the fibre glass for air-conditioning application shall not exceed 0.034 K Cal/(hr-sq-deg. C/meter) or 0.23 BTU/(hr.sq.ft.-deg F/inch) at 32 deg. C (90 deg. F) mean temperature and density shall be 48 Kg./Cu.Mt.

3.1.2 Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer’s test certificate for thermal conductivity values, density, water vapour permeability and fire properties. Samples of insulation material from each lot delivered at site may be selected by Engineer-in-Charge and gotten tested for thermal conductivity and density at Contractor’s cost. Adhesive used for sealing the insulation shall be non-flammable, vapour proof adhesive strictly as per manufacturer recommendations.

3.2 DUCT INSULATION

External thermal insulation shall be provided as follows:

3.2.1 The thickness of nitrile rubber / polyethylene foam shall be as shown on drawing or identified in the schedule of quality. Following procedure shall be adhered to:

3.2.2 Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work. Measurement of surface dimensions shall be taken properly to cut closed cell elastomeric rubber sheets to size with sufficient allowance in dimensions.
3.2.3 Material shall be fitted under compression and no stretching of material shall be permitted. A thin film or adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface. When adhesive is tack dry insulating material sheet shall be placed in position and pressed firmly to achieve a good bond. All longitudinal and transverse joints shall be sealed by providing 6mm thick 60mm wide nitrile rubber taps. The adhesive shall be strictly as recommended by the manufacturer.

3.2.4 The insulation material shall be self adhesive type if mentioned in schedule of quantities.

3.3 DUCT EXPOSED TO ATMOSPHERE

The material for the insulation of the ducting which is exposed to atmosphere shall be 19mm nitrile rubber or polyethylene foam wrapped with two layers of polythene and then covered with 26 G aluminium sheet.

3.3.0 INSTALLATION

3.3.1 Follow the same procedure as above from 3.2.1 to 3.2.3

3.3.2 Clean the duct surface with wire brush to remove duct grease etc. and apply a coat of adhesive.

3.3.3 Now wrap two layers of 500G virgin white polythene sheets with overlapping longitudinal and circumferential joints. The joints shall be sealed with BOPP tape.

3.3.4 Finish the surface with 26G aluminium sheet fixed with hand operated grooving machine and anodized machined screws to get smooth surface at no more than 150mm distance.

3.3.5 Seal the joints of aluminium sheet cladding with silicone sealant liberally applied on joints so as to prevent water ingress.

4.0 ACOUSTIC LINING

4.1 The acoustic lining shall consist of 25mm resin bonded glass wool boards of density 48 Kg/Cu. M (Min) covered by 0.5mm perforated aluminium sheets having 3mm perforation at 6mm centers.

4.2 INSTALLATION

4.2.1 The duct surface shall first be cleaned from inside. Install GI channel framework of maximum 600mm length with G.I. rivets.

4.2.2 Fiberglass boards shall be fixed on inner surface of duct with cold setting CPRX Adhesive.
4.2.3 Insulation shall then be covered with glass cloth of 7 mil (0.18mm).

4.2.4 The aluminium sheet and the insulation shall be secured to the duct by means of cadmium plated bolts, nuts and cup washers. The ends should be completely sealed off, so that no insulation material is exposed to air stream.

5.0 REFRIGERANT PIPING INSULATION

5.1 All refrigerant and condensate drain piping shall be insulated in the manner specified herein. Before applying insulation all pipes shall be brushed and cleaned. The thermal insulation thickness shall be

Refrigerant Piping : 19mm/13mm
Condensate Drain Piping : 6mm

5.2 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 manufacture adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre. Wherever flat sheet 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 sealed by providing 6mm thick, 50mm 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.

5.3 Protective Coating over Insulation in area exposed to atmosphere.

5.3.1 To provide mechanical strength and protection from damage all pipes insulated with nitrile rubber / polyethylene foam in exposed area shall be covered with aluminium foil of 0.5 mm thickness properly wrapped and all joints sealed with aluminium tape.

6.0 GENERAL SPECIFICATIONS

6.1 All test lines pressure testing should be complete and recorded and all systems approved by the Engineer-in-Charge before insulation is applied to the equipment and piping. Insulation materials shall be manufactured by approved manufacturers and shall be of approved manufacture of the type specifically intended for the service specified.

6.2 Insulation material and finishes shall, be inherently proof against rotting, mould and fungal growth and attack by vermin, be non-hygroscopic and in all respects be suitable for continuous use throughout the range of operating temperatures and within the environment indicated.

6.3 Unless otherwise indicated all thermal insulating materials used within any building shall when tested in accordance with BS 476 Part 5 be classified non-combustible with a facing of combustible material providing the facing is not more than 0.8mm thick and it has Class 1 surface spread of flame when tested in accordance with BS 476 Part 7. Thermal insulating materials used within any
building shall be free from substances, which in the event of a fire, would generate appreciable quantities of smoke, noxious, or toxic fumes.

6.4 Insulation materials and their finishes shall be free from asbestos.

6.5 At all points of support both insulation and outer covering shall be continuous and shall not be punctured or folded by the supports. The insulation at supports shall be materials of sufficient compressive strength of P.U.F./phenolic material to take the loads transmitted to the supports. The load bearing insulation shall be extended on each side of the supports.

VIII AXIAL FLOW FANS (DIRECT DRIVE)

A. Fans shall be licensed to bear the AMCA Seal. The test standard used shall be ANSI/AMCA 210-85, ANSI/ASHRAE Standard 51-1985 “Laboratory Method of Testing Fans for Rating” and AMCA 300 “Reverberant Room Method for Sound Testing of fans”.

B. To achieve the minimum and equal clearance between the blade tips and casing, tube casing shall maintain its roundness by means of using one piece of sheet metal with 90 edge flanging up.

C. Fan motor base support shall be properly secured (locked and sealed) to the fan housing and be of adjustable type to have precise control of motor shaft central position as well as running clearance between blade tips and casing. Motor (KW/HP) shall be able to be changed or upgraded at site without changing fan housing or ducting construction.

D. Fans supplied shall be complete with factory fabricated mounting bracket (ceiling or foot mounted) and suction/discharge matching flanges as accessories.

E. All hubs shall be cast Aluminum alloy (Grade LM2) unless for Smoke Extractor Fans where high temperature (250C/2Hrs) air is expected then Aluminum alloy or steel fan impeller blades are required. Otherwise impeller blade material with Polypropylene (PP), Glass-reinforced Polypropylene (PPG) and Glass-reinforced Polyamide (PAG), to provide self-balancing, anti-static, anti-sparking characteristic is preferable.

F. Running clearance between blade tips and casing shall not exceed 1% of the impeller diameter, and 2% for smoke spill high temperature fan where mechanical expansion coefficient is different from normal ambient temperature. Fan manufacturer shall provide the fan assembled with the same clearance between blade tips and casing of the tested prototype. Note that the air performance and pressure loss are greatly affected by this clearance.

G. Impellers shall be secured to the drive shaft by a key and keyway. Axial location shall be provided by a collar or shoulder on the drive shaft together with a retaining washer and screw fitted into a tapped hole at the end of the shaft and locked in position. Blades shall be secured in place to the angle setting by setscrews, locking nuts or setting pins.

H. Fan motor shall be totally enclosed and external terminal box of at least IP55 shall be provided.

I. Fans shall not exceed 1000 RPM.
J. All fans after assembly shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade. A computer printout with vibration spectrum analysis shall be attached to the fans.

K. Fan should be of G.S.S., the Steel sheet should be JFE Galvazinc (Base metal cold rolled), JIS G3302, SGCC with Z22 (minimum coating weight on both sides @ 220 g/m2) zinc coating & Zero Spangle, skinpassed, chromated and dry.

IX TECHNICAL DATA (TO BE FURNISHED BY THE BIDDER)

1.0 VRF SYSTEM and PACKAGE UNITS

1.1 INDOOR UNITS

1.2 Area / Location Served :

1.3 Make :

1.4 Type of Indoor Unit :

1.4.1. Ceiling Mounted Ductable :

1.4.2. Ceiling Mounted Cassette :

1.4.3. Hi-wall :

1.5 Type of mounting of the Indoor Unit :

1.6 Casing Material :

1.7 Cooling Capacity (Btu/h) :

1.8 Airflow Hi/Med./Low (CMH/CFM) :

1.9 Number of Motors :

1.10 Motor Rating, Watt :

1.11 External Static Pressure mm of WC' :

1.12 Type of Fan :

1.13 Sound Level Hi/Med./Low dB(A) :

1.14 Dimension HxWxD (mm) :

1.15 Weight (Kg.) :

1.16 Power Supply :
Technical Specifications for Construction of Township

1.17 Power Consumption of each Indoor Unit at full load:

1.18 Maximum Number of Indoor Units connected to one circuit:

1.19 Type of Expansion Valve:

1.20 Make and number of Expansion Valve:

2.0 Refrigerant Piping

2.0 Dia and thickness of suction refrigerant pipe (mm):

2.1 Dia and thickness of liquid line refrigerant pipe (mm):

2.2 Field test pressure for the refrigerant piping:

2.3 Type of insulation material for the refrigerant piping:

VRF AND PACKAGE UNITS SYSTEM

3.0 OUTDOOR UNITS

3.1 Area / Location Served:

3.2 Make:

3.3 Model:

3.4 HP:

3.5 Cooling Capacity (in Btu/hr) at 43.3°C Ambient:

3.6 Power Input (Including Condenser Fan Motor) at 43.3°C Ambient (KW):

3.7 Starting Current Amps.:

3.8 Full Load Current Amps.:

3.9 Capacity Control Range:

3.10 Type of Capacity Control:

3.11 Make, Type and number of Compressor:

3.12 Power supply, voltage/phase/Hz:

3.13 No. of Condenser Fans:

3.14 KW of each Condenser Fan:

3.15 No. of Inverter Compressor:

3.16 Capacity of each compressor:

3.17 AC or DC Motor:

3.18 Type of starter for compressor motor:

3.19 Compressor Motor Output (KW):

3.20 Air Flow Rate (CMH/CFM):
Technical Specifications for Construction of Township

3.21 Dimension HxWxD (MM) :

3.22 Machine Operating Weight (Kg.) :

3.23 Sound Level dB(A) :

3.24 Refrigerant :

3.25 Refrigerant Charge (Kg.) :

3.26 Ozone Depletion Potential of refrigerant :

3.27 Global Warming Potential of refrigerant :

4.1 Saturated Suction Temperature (°C) :

4.2 Saturated Suction Pressure (Pa) :

4.3 Saturation Condensing Temperature (°C) :

4.4 Saturation Condensing Pressure (Pa) :

4.5 Highest Ambient Temperature (°C) :

4.6 Highest Working Condensing Pressure (Pa) :

4.7 Strength Test Pressure :

4.8 Leakage Test Pressure :

4.9 Quantity of Oil :

4.10 Method of Oil Return to Compressor :

4.11 Size of Refrigerant Receiver :

4.12 Size of Accumulator :

5.1 Energy Efficiency Ratio (EER) of Air Conditioner and Condensing unit at AHRI condition :

5.2 Integrated Energy Efficiency Ratio (EER) of Air Conditioner and Condensing unit at AHRI condition :

6. GRILLS/DIFFUSERS/DAMPERS

Please indicate make/material/gauge of the following:

<table>
<thead>
<tr>
<th>Make</th>
<th>Material</th>
</tr>
</thead>
</table>
| a)   | Duct Dampers :
| b)   | Grills/Diffusers :

7. DUCT INSULATION

<table>
<thead>
<tr>
<th>Make</th>
<th>Material</th>
</tr>
</thead>
</table>
| a)   | Manufacturers Name :
| b)   | Material :
| c)   | Density Kg. Per Cmt :
| d)   | Thermal Conductivity Kcal/Hr.Deg.C :

8. DUCT LINING

<table>
<thead>
<tr>
<th>Make</th>
<th>Material</th>
</tr>
</thead>
</table>
| a)   | Manufacturers Name :
| b)   | Material :
| c)   | Density Kg. Per Cmt :
| d)   | Thermal Conductivity Kcal/Hr.Deg.C :

9. PIPE INSULATION

<table>
<thead>
<tr>
<th>Make</th>
<th>Material</th>
</tr>
</thead>
</table>
| a)   | Manufacturers Name :

Construction of Township at Khilpara, Udaipur, Tripura
b) Material
   Density Kg. Per Cmt
   Thermal Conductivity Kcal/Hr.Deg.C

10. AIR WASHER

Make
Air Quantity
Static pressure

11. AXIAL FAN

Make
Air Quantity
Static pressure

12. INLINE FAN

Make
Air Quantity
Static pressure

NOTE:

All the above detailed must be furnished. Tenders with incomplete/wrong information would be rejected. The tenderer may enclose separate sheet in above format, if required.
A. LIST OF APPROVED MAKES: CIVIL

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Antitermite</td>
<td>Chlorpyriphos, Lindane emulsifiable concentrate of 20%, Permethrin,Cypermethrine, Fenvlurate.</td>
</tr>
<tr>
<td>2</td>
<td>Pre-Laminated Particle Board</td>
<td>Century, GreenPly, Marino,Durian</td>
</tr>
<tr>
<td>3</td>
<td>Pre-Laminated Ply Board</td>
<td>Century, GreenPly, Marino,Durian</td>
</tr>
<tr>
<td>4</td>
<td>Mineral Polymer Composite Jali</td>
<td>Ecoste,Alstone.</td>
</tr>
<tr>
<td>5</td>
<td>Toughened Glass &amp; Patch Fittings</td>
<td>Saint Gobain, Dorma, Geze, Ozone.</td>
</tr>
<tr>
<td>6</td>
<td>Cement</td>
<td>Ultratech, Birla, ACC , RAMCO, Ambuja, Shree, Devbhumi, Khyber, India Cements, Chetinad, Dalmia, Barak Valley, Cement Corporation of India Limited, Meghla Cement Ltd,Grasim Cement,Lafarge Cement, Century Cement, Cement Manufacturing Co. Ltd., Holcim(Bangladesh)</td>
</tr>
<tr>
<td>7</td>
<td>Structural Steel</td>
<td>TISCO , SAIL , VIZAG , Devbhumi, Kamdhenu, Kashmir Steel Rolling Mill , JISCO , IIISCO , Jyoti, Amba</td>
</tr>
<tr>
<td>8</td>
<td>MS Tubular Sections</td>
<td>TISCO , SAIL , VIZAG , JINDAL , Rathi, Prakash, Ravindra</td>
</tr>
<tr>
<td>9</td>
<td>Reinforcement Steel</td>
<td>TATA , SAIL , VIZAG, Kamdhenu, Rathi, Jyoti, Devbhumi, Amba, Barnala, Kashmir Steel Rolling Mill , Jindal or equivalent approved by OTPC</td>
</tr>
<tr>
<td>10</td>
<td>Glazed tiles</td>
<td>H &amp; R Johnson , Kajaria , Somany , Naveen , Bell, Asian</td>
</tr>
<tr>
<td>11</td>
<td>Ceramic tiles floor finish for Building</td>
<td>Kajaria, Nitco , Regency , Somany , Naveen , Bell, Asian, Rak</td>
</tr>
<tr>
<td>12</td>
<td>Ceramic tiles for toilet flooring</td>
<td>Kajaria, Nitco , Regency , Somany, Naveen, Bell, Asian, Rak</td>
</tr>
<tr>
<td>13</td>
<td>Vitrified Tiles</td>
<td>H &amp; R Johnson , Kajaria , Somany , Naveen, Bell, Nitco, Asian, Rak</td>
</tr>
<tr>
<td>14</td>
<td>Flush doors</td>
<td>India Plywood Mfg. Co., Kutty flush doors, Diamond, Lakshmi. (Exterior grade only) , Syntex, Kit Ply, Alpro Panels</td>
</tr>
<tr>
<td>15</td>
<td>Plywood</td>
<td>National , Kitply , Greenply , Anchor, Sitaboard, India Plywood Mfg. Co.</td>
</tr>
<tr>
<td>16</td>
<td>Water proofing compounds</td>
<td>Fosroc , Multi Plas , Cico , Impermo , Acco – Proof</td>
</tr>
<tr>
<td>18</td>
<td>Water proof cement paints</td>
<td>Snowcem plus , Surfacerem , Nitcocem , Nitcole , Birla Plus , Cico Cem</td>
</tr>
<tr>
<td>19</td>
<td>Glazing , Glass</td>
<td>Indo-Asahi , Modi Float , Saint Gobain</td>
</tr>
<tr>
<td>20</td>
<td>Aluminium doors, windows, partition etc</td>
<td>INDALCO , ZINDAL , Ajit India ,Alumilite , Naeco, Hindalco</td>
</tr>
<tr>
<td>21</td>
<td>Hardware</td>
<td>Shalimar , Garnish , Navbharat, Vision, Amarbhoj , Dossaji, EBCO, HETTICH, HAFFELE</td>
</tr>
<tr>
<td>22</td>
<td>Stainless Steel Railing</td>
<td>Dorma, Kitch, Jinadal Arch, Ozone.</td>
</tr>
<tr>
<td>23</td>
<td>Textured Paint</td>
<td>Spectrum , Coral</td>
</tr>
<tr>
<td>24</td>
<td>Wooden Flooring</td>
<td>Power Floor, Kronotek, Span, Floor Master, Pergo</td>
</tr>
<tr>
<td>25</td>
<td>Plaster of Paris</td>
<td>Shriram, JK, Aerostone</td>
</tr>
</tbody>
</table>
## Technical Specifications for Construction of Township

### Construction of Township at Khilpara, Udaipur, Tripura

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Make(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>Cement</td>
<td>Birla White, JK White</td>
</tr>
<tr>
<td>27</td>
<td>Hardware</td>
<td>EBCO, HETTICH, HAFFELE</td>
</tr>
<tr>
<td>28</td>
<td>Locks</td>
<td>Dorset with separate keyhole ring, Golden, Kitch</td>
</tr>
</tbody>
</table>

**B. LIST OF APPROVED MAKES: ELECTRICAL**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Make(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>ACB with short ckt, over load, Earth fault with time lag facility</td>
<td>L&amp;T (U-Power), MG (Masterpact), Siemens(3WL), ABB (E-MAX)</td>
</tr>
<tr>
<td>30</td>
<td>ACB with short ckt, over load, Earth fault with time lag facility</td>
<td>L&amp;T(C Power), Merlin Gerin (Enerpact), ABB (E MAX with PR III), Siemens (3-WL)</td>
</tr>
<tr>
<td>31</td>
<td>MCCB with short ckt, over load, Earth fault with time lag facility</td>
<td>L&amp;T (DSine), MG (compact), Siemens(Sentron-3VL), ABB (ISO MAX , TMAX)</td>
</tr>
<tr>
<td>32</td>
<td>MCB</td>
<td>Legrand, Hagger, MG, ABB</td>
</tr>
<tr>
<td>33</td>
<td>ELCB</td>
<td>Legrand, Hagger, MG, ABB</td>
</tr>
<tr>
<td>34</td>
<td>LT Cables</td>
<td>Skytone, Havells, Proflex</td>
</tr>
<tr>
<td>35</td>
<td>LT Cable (Control)</td>
<td>Skytone, Havells, Proflex</td>
</tr>
<tr>
<td>36</td>
<td>PVC Insulated Cu wires (FRLS)</td>
<td>Skytone, Havells, Proflex</td>
</tr>
<tr>
<td>37</td>
<td>Cable Gland Double Compression</td>
<td>Stripwel, Comet, Baliga</td>
</tr>
<tr>
<td>38</td>
<td>PVC Rigid Conduits</td>
<td>AKG, BEC, Polypack, SG</td>
</tr>
<tr>
<td>39</td>
<td>MS Conduits</td>
<td>AKG, BEC, NIC</td>
</tr>
<tr>
<td>40</td>
<td>Switches, Sockets, Plugs etc.</td>
<td>Crabtree, Clipsal Oval, Legrand Mosaic, SG Controls, Philcon</td>
</tr>
<tr>
<td>41</td>
<td>Industrial Socket in Steel Enclosure</td>
<td>Clipsal, MDS, SG Controls</td>
</tr>
<tr>
<td>42</td>
<td>Ceiling Rose</td>
<td>Anchor, Lisa</td>
</tr>
<tr>
<td>43</td>
<td>Telephone Cable, Telephone Outlets</td>
<td>Skytone, Gloster, Finolex</td>
</tr>
<tr>
<td>44</td>
<td>Tagblock with boxes</td>
<td>Krone Type or as approved</td>
</tr>
<tr>
<td>45</td>
<td>Luminaires</td>
<td>Philips, Syska (SSK), Osram, Bajaj</td>
</tr>
<tr>
<td>46</td>
<td>HT Cables</td>
<td>Gloster, Skytone, Havell's</td>
</tr>
<tr>
<td>47</td>
<td>HT Termination kit</td>
<td>Raychem, M-Seal, Birla3M, Denson</td>
</tr>
<tr>
<td>48</td>
<td>Cable Tray, Wire ways</td>
<td>Needo, Ricco, Pilco</td>
</tr>
<tr>
<td>49</td>
<td>Instrument Cable</td>
<td>Lapp Kabel, Nicco, Skytone</td>
</tr>
<tr>
<td>50</td>
<td>Lugs</td>
<td>Dowell's, HAX</td>
</tr>
<tr>
<td>51</td>
<td>Termination Control Cable</td>
<td>Elemex, Wega, Phonex, Belden, Reliance, Nicco, Paramount, Cords Cable, Pirelli or equivalent approved by OTPC</td>
</tr>
<tr>
<td>52</td>
<td>DB's</td>
<td>Legrand, Hagger, MG, ABB</td>
</tr>
<tr>
<td>53</td>
<td>Rubber Mats</td>
<td>Jyoti</td>
</tr>
<tr>
<td>54</td>
<td>Lightning Arrestor</td>
<td>Indlec, Unex, Jaipuria, Jaishree</td>
</tr>
<tr>
<td>55</td>
<td>Digital Meter</td>
<td>Enercon, Ducati, Secure</td>
</tr>
<tr>
<td>56</td>
<td>Bus Bar Aluminium</td>
<td>Jindal, Indalco, Century</td>
</tr>
<tr>
<td>57</td>
<td>Bus Bar Copper</td>
<td>Sterlite</td>
</tr>
<tr>
<td>58</td>
<td>Bus Duct (Air Insulated type)</td>
<td>System &amp; Power Control, Jackson, Havell’s</td>
</tr>
<tr>
<td>60</td>
<td>Elevators</td>
<td>Kone, Otis, Thyssenkrupp, Schlinder, Johnson Lifts, ECE</td>
</tr>
</tbody>
</table>
## Technical Specifications for Construction of Township

### 61 Isolators
- Siemens Ltd., Switchgear & Structural (I) Pvt. Ltd.

### 62 Cable
- Cords Cable Industries Ltd, Gemscab Industries Ltd, KEI Industries Ltd, Krishna Electrical Industries Ltd, Paramount Communications Ltd, Polycab Wires Pvt. Ltd.
- Prew Industries Ltd., Radiant Cables Pvt Ltd., Ravin Cables Ltd, Suyog Electricals Ltd, Torrent Cables Ltd

### 63 Auxillary Transformers

### 64 Distribution Board (AC & DC)
- Advance Panels & Switchgears Pvt. Ltd., Anand Power Ltd, Bose Corporation Control & Switchgears Co. Ltd., Danish Pvt. Ltd. (Formerly Expo Fyn)
- Mika Engineers, Popular Switchgears Pvt. Ltd., RSI Switchgear Pvt. Ltd., Unitec Engineers Ltd.

### 65 Al Tube (Bus Bar Material)
- Alom Extrusions, Hindalco Industries Ltd., Jindal Aluminium Ltd., Sudaf Industries Ltd.

### 66 Battery Charger

### 67 Battery
## Technical Specifications for Construction of Township

<table>
<thead>
<tr>
<th>Page</th>
<th>Description</th>
<th>Approved Makes</th>
</tr>
</thead>
<tbody>
<tr>
<td>68</td>
<td>Protection Relay</td>
<td>Areva T &amp; D India Ltd., Asea Brown Boveri Ltd., Easun Reyrolle Ltd.</td>
</tr>
<tr>
<td>69</td>
<td>Numerical Relays</td>
<td>Areva T &amp; D India Ltd., Asea Brown Boveri Ltd., Siemens Ltd., Schweitzer Engineering Lab. (SEL), GE India</td>
</tr>
<tr>
<td>70</td>
<td>KWH Meter (Energy Meter - Static)</td>
<td>Sems, Udaipur, Landy &amp; Gyr, Elster Metering, L &amp; T Mumbai, Schneider Conzerve Siemens Ltd.</td>
</tr>
<tr>
<td>72</td>
<td>Current Transformer (CT)</td>
<td>ABB (Sweden/India), ALSTOM (France/India), BHEL, India, Fuji Electric (Japan), Siemens (Germany/India), Telk (India), Mitsubishi (Japan), CGL (India)</td>
</tr>
<tr>
<td>73</td>
<td>Capacitive Voltage Transformer (CVT)</td>
<td>ABB (Sweden/India), ALSTOM (France/India), BHEL, India, Fuji Electric (Japan), Siemens (Germany/India), Telk (India), Mitsubishi (Japan), CGL (India)</td>
</tr>
<tr>
<td>74.1</td>
<td>DG Set- Engine</td>
<td>Cummins India Ltd., Caterpillar</td>
</tr>
<tr>
<td>74.2</td>
<td>Alternator</td>
<td>Leroy Somer, Cummins Ge tech. (Stamford)</td>
</tr>
<tr>
<td>74.3</td>
<td>DG Set Assemblers</td>
<td>Jakson Ltd., TIL Ltd., Sudhir, GMMCO, Powerica, Transgenerators, Sudhir</td>
</tr>
<tr>
<td>74.4</td>
<td>Battery bank</td>
<td>Exide, HBL Knife, Amaraja</td>
</tr>
<tr>
<td>74.5</td>
<td>Battery Charger</td>
<td>Chabbi Electrical, Amaraja, Jakson Engineers Ltd., Powerica</td>
</tr>
<tr>
<td>74.6</td>
<td>Control panels</td>
<td>Jakson Engineers Ltd., Powerica, Popular Switchgear, Lotus Power Gear, Control &amp; Switchgear</td>
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<tr>
<td>74.7</td>
<td>Aux. DB</td>
<td>Jakson Engineers Ltd., Powerica, Popular Switchgear, Lotus Power Gear, Control &amp; Switchgear</td>
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<tr>
<td>75</td>
<td>Switch Gear</td>
<td>Siemens, Crompton Greaves, BIECCO, AREVA, ABB</td>
</tr>
</tbody>
</table>

### C. LIST OF APPROVED MAKES: PLUMBING & FIRE FIGHTING

<table>
<thead>
<tr>
<th>Page</th>
<th>Description</th>
<th>Approved Makes</th>
</tr>
</thead>
<tbody>
<tr>
<td>76</td>
<td>Wash Basin</td>
<td>Hindware, Neycer Sheraton, Oval, Parry Noble, Cera, Kohler</td>
</tr>
<tr>
<td>77</td>
<td>Wash Basin Fixture</td>
<td>Hindware, Neycer Sheraton, Oval, Parry Noble, Cera, Kohler</td>
</tr>
<tr>
<td>78</td>
<td>Three Hole Basin Mixer With Pop-Up</td>
<td>Jaquar Continental Range, Gem</td>
</tr>
<tr>
<td>79</td>
<td>Bottle Trap</td>
<td>Jaquar Continental Range, Gem</td>
</tr>
<tr>
<td>80</td>
<td>Waste Coupling</td>
<td>Jaquar Continental Range, Gem</td>
</tr>
<tr>
<td>81</td>
<td>Angle Valve With Wall Flange</td>
<td>Jaquar Continental Range, Gem, Arco</td>
</tr>
<tr>
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<td>---</td>
</tr>
<tr>
<td>82</td>
<td>Water Closet</td>
<td>Hindware, Neycer Futura With Cistern, Cera With Cistern</td>
</tr>
<tr>
<td>83</td>
<td>Head Shower With Arm</td>
<td>Jaquar, Gem</td>
</tr>
<tr>
<td>84</td>
<td>Soap Dish</td>
<td>Jaquar, Gem</td>
</tr>
<tr>
<td>85</td>
<td>Robe Hook</td>
<td>Jaquar, Gem</td>
</tr>
<tr>
<td>86</td>
<td>Towel Rack</td>
<td>Jaquar, Gem</td>
</tr>
<tr>
<td>87</td>
<td>Kitchen Sink Mixture</td>
<td>Jaquar, Gem</td>
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<tr>
<td>88</td>
<td>C.P. Braass Bib Tap</td>
<td>Jaquar, Gem</td>
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<tr>
<td>89</td>
<td>Towel Rail</td>
<td>Jaquar, Gem</td>
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<tr>
<td>90</td>
<td>Towel Ring</td>
<td>Jaquar, Gem</td>
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<tr>
<td>91</td>
<td>Curtain Rod</td>
<td>Jaquar, Gem</td>
</tr>
<tr>
<td>92</td>
<td>Bottle Opener</td>
<td>Jaquar, Gem</td>
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<tr>
<td>93</td>
<td>Pressure Type Liquid Soap Container</td>
<td>Bobrick</td>
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<td>94</td>
<td>No Touch Hand Drier</td>
<td>Kopal, Euronics, Gem, Toshi</td>
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<td>95</td>
<td>C.P. Flate Nut Connector With</td>
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<td>96</td>
<td>C.P. Pipes 375 Mm Long</td>
<td>Gem</td>
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<td>97</td>
<td>Flush Valve For Urinal</td>
<td>Robo Flush, Jaquar, Euronics</td>
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<td>98</td>
<td>Kitchen Sink</td>
<td>Star Flow, Jayana</td>
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<td>99</td>
<td>Mirror</td>
<td>Modi Float Glass</td>
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<td>100</td>
<td>CPVC Pipes</td>
<td>Ajay Flowguard, Arestel</td>
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<td>101</td>
<td>CPVC Fittings</td>
<td>Ajay Flowguard, Arestel</td>
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<td>102</td>
<td>Ball Valves</td>
<td>Zoloto, C&amp;R, Fouress, KBL, R&amp;D multiples, BDK, L&amp;T, Akay industries, Crescent Valves Mfg., AV Valves, KSB, Leader valves, Fischer Sanmar Ltd., Valtech</td>
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<td>103</td>
<td>Butterfly Valves</td>
<td>Zoloto, KSB, C&amp;R, Fouress, KBL, R&amp;D multiples, BDK, L&amp;T, Advance valves, Tyco, Fluidline Valves</td>
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<td>105</td>
<td>Water Flow Meters</td>
<td>Copstion, Kranti</td>
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<td>107</td>
<td>Sanitaryware</td>
<td>Hindustan, Parryware</td>
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<td>108</td>
<td>Seat Cover</td>
<td>Commander (Heavy Duty)</td>
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<td>109</td>
<td>C.P. Fittings</td>
<td>Gem</td>
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<td>110</td>
<td>Plastic Water Tanks</td>
<td>Sintex, Polycon, Renu</td>
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<td>111</td>
<td>Stainless Steel Sink</td>
<td>Neelkanth, Amc</td>
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<td>112</td>
<td>CI Pipes, Fittings &amp; Manhole</td>
<td>Nicco</td>
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<td>113</td>
<td>CI Pipes</td>
<td>Nicco</td>
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<td>114</td>
<td>RCC Pipes</td>
<td>Anand, Local ISI Marked</td>
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<td>115</td>
<td>Stoneware Pipes, Traps</td>
<td>Perfect, Burn, Local ISI Marked</td>
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<td>116</td>
<td>PVC Pipes, Fittings</td>
<td>Supreme, Finolex</td>
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<td>117</td>
<td>Pump</td>
<td>Grundfos, KSB, Flowmore, WPIL, Mather &amp; Platt, Sulzer, KBL, Jyoti Ltd., Weir, Flowserve, Beacon Weir, Su Motors</td>
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## Technical Specifications for Construction of Township

### D. LIST OF APPROVED MAKES: HVAC

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Makes</th>
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<tbody>
<tr>
<td>121</td>
<td>VRF System</td>
<td>DAIKIN, MITSUBISHI, CARRIER, LG, TOSHIBA, HITACHI, MIDEA</td>
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<tr>
<td>122</td>
<td>Filter</td>
<td>Camfilfarr, Fruehberg</td>
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<tr>
<td>123</td>
<td>GSS Sheet</td>
<td>Jindal, Tata</td>
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<tr>
<td>124</td>
<td>Factory Made Ducts</td>
<td>Rollastar, Technofab, Ductofab</td>
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<tr>
<td>125</td>
<td>Propeller fans</td>
<td>Alstom, Crompton</td>
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<tr>
<td>126</td>
<td>Flexible pipe connection</td>
<td>Resistoflex, Knawal</td>
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<tr>
<td>127</td>
<td>Extruded Aluminum Grilles, Diffusers</td>
<td>Pine air, Smithsair, Greenair</td>
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<tr>
<td>128</td>
<td>Fire dampers, Volume Control Dampers</td>
<td>Greenair, Pine air</td>
</tr>
<tr>
<td>129</td>
<td>Flexible insulated ducts</td>
<td>ATCO, MAPRO</td>
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<tr>
<td>130</td>
<td>Fibre glass</td>
<td>OWENS CORNING, UP TWIGA</td>
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<tr>
<td>131</td>
<td>Extruded Polystyrene Board</td>
<td>SUPREME, EQLT</td>
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<td>132</td>
<td>Cross linked polyethylene</td>
<td>TROCELLEN, ARMAFLEX</td>
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<tr>
<td>133</td>
<td>Class ‘O’ Nitrile rubber insulation</td>
<td>EUROBATEX, ARMACELL</td>
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<td>134</td>
<td>Copper Pipe</td>
<td>RAJCO, MANDEV, MAXFLOW, TOTAL LINE</td>
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<tr>
<td>135</td>
<td>Conduit of electrical wires</td>
<td>AKG, MARSHAL, PLAZA</td>
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<tr>
<td>136</td>
<td>Expanded polystyrene</td>
<td>Styrene Packing, Indian Packing</td>
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<tr>
<td>137</td>
<td>Vibration Isolation Spring</td>
<td>Dunlop, Resistoflex</td>
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<tr>
<td>138</td>
<td>Paints</td>
<td>ICI, Asian</td>
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<tr>
<td>139</td>
<td>Dash Fasteners</td>
<td>Canon, Fisher, TKS, Hilti</td>
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<td>140</td>
<td>Welding Rods</td>
<td>Advani, L&amp;T</td>
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<td>141</td>
<td>ACB, M.C.B. &amp; MCCB</td>
<td>L&amp;T, GE, Crompton</td>
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<td>142</td>
<td>Power Cable</td>
<td>ICC, CCI, Gloster, Grandlay, ICL, Universal, Incab, Nicco Corp. Ltd, Torrent, Finolex, Radiant, KEI, Polycab, Krishna Electrical Industries or equivalent approved by OTPC</td>
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<tr>
<td>143</td>
<td>Centrifugal Fan</td>
<td>Kruger, Comfrei</td>
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<td>144</td>
<td>Inline Fans</td>
<td>Pine Air, Ostberg</td>
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<td>145</td>
<td>Axial Fans</td>
<td>Kruger, Greenhick</td>
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<td>146</td>
<td>Air Washer</td>
<td>RCS, Edgetech</td>
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### E. LIST OF APPROVED MAKES: FURNITURES

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
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</tr>
</thead>
<tbody>
<tr>
<td>147</td>
<td>Male Change Room Locker</td>
<td>Godrej, BP Ergo, Harmony Systems, Haworth, Durian</td>
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<tr>
<td>148</td>
<td>Female Change Room Locker</td>
<td>Godrej, BP Ergo, Harmony Systems, Haworth, Durian</td>
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<tr>
<td>149</td>
<td>Massage Room Bed</td>
<td>Godrej, BP Ergo, Harmony Systems, Haworth, Durian</td>
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<tr>
<td>150</td>
<td>Admin Office Furniture</td>
<td>Godrej, BP Ergo, Harmony Systems, Haworth, Durian</td>
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<tr>
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<td>------------------------</td>
<td>--------------------------------------------------</td>
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<tr>
<td>151</td>
<td>Cafeteria furniture</td>
<td>Godrej, BP Ergo, Harmony Systems, Haworth, Durian</td>
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<tr>
<td>152</td>
<td>Recliner chair/Rotton Lounger</td>
<td>Godrej, BP Ergo, Harmony Systems, Haworth, Durian</td>
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<td>153</td>
<td>Billiard Table</td>
<td>Godrej, BP Ergo, Harmony Systems, Haworth, Durian</td>
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<tr>
<td>154</td>
<td>Library Furniture</td>
<td>Godrej, BP Ergo, Harmony Systems, Haworth, Durian</td>
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<tr>
<td>155</td>
<td>Card Room Furniture</td>
<td>Godrej, BP Ergo, Harmony Systems, Haworth, Durian</td>
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<tr>
<td>156</td>
<td>Children's Room Equipment &amp; Furniture</td>
<td>Godrej, BP Ergo, Harmony Systems, Haworth, Durian</td>
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<tr>
<td>157</td>
<td>Full HDTV 55 &quot; LED</td>
<td>Samsung, Sony, LG</td>
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<tr>
<td>159</td>
<td>Fire Protection System</td>
<td>Gunnebo India Limited/Steelage, Thane</td>
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<tr>
<td></td>
<td></td>
<td>Kidde India Limited, Mumbai</td>
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<td></td>
<td>MINIMAX GmbH &amp; Co.KG</td>
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<td></td>
<td>General Mechanical Works</td>
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<td>Wormald Fire Systems</td>
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<td></td>
<td>Unitech Machines Ltd.</td>
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<td></td>
<td>New Fire Engineers Pvt.Ltd</td>
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<td>Mather &amp; Platt</td>
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<td>Nitin</td>
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<td>Agnica</td>
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<td>160</td>
<td>Portable Fire Extinguisher</td>
<td>Gunnebo India Limited/Steelage, Thane</td>
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<td></td>
<td>Nitin Fire Protection Industries Ltd</td>
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<td>KiddeIndia</td>
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<td>161</td>
<td>Sewage Treatment Plant</td>
<td>Driplex Water Engg. Ltd.</td>
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<td>Mecon Limited, Ranchi</td>
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<td>Shriram Epc Limited, Chennai</td>
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<td>Triveni Engineering &amp; Industries Ltd., Noida</td>
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<td>Gannon Dunkerley &amp; Co.Ltd., New Delhi</td>
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<td>Clear Water Ltd.</td>
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<td>Hindustan Dorr-Oliver Ltd.</td>
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<td>Geo Miller &amp; Co. Ltd.</td>
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## Technical Specifications for Construction of Township

<table>
<thead>
<tr>
<th>Page</th>
<th>Item</th>
<th>Suppliers</th>
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<tbody>
<tr>
<td>162</td>
<td>PA System</td>
<td>Byte Communications, Power Systems, Philips, Karthik Engrs, Chashmita Engineers, BPL telecom, BNA Technology</td>
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<td>164</td>
<td>Fire Sealing System</td>
<td>3M, Hilti, Signum Fire, Kidde, Lloyd Insulations, Neimex Enterprise, MultiFire</td>
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<td>165</td>
<td>Trefoil Clamps</td>
<td>Electromac Industries, Moulded Fibreglass</td>
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<td>166</td>
<td>Above Ground Earthing &amp; Lighting Protection Material</td>
<td>Industrial Perforation (India) Private Limited.</td>
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<td>Jamna Metal Company</td>
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<td>Premier Power Products (Calcutta) Pvt.Ltd.</td>
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<td>Patny Systems (P) Ltd.,Secunderabad</td>
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<td>Rukmani Electrical &amp; Components Private Ltd</td>
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<td>Ratan Engineering Company Pvt.Ltd.</td>
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<td>Rabi Engineering Works , Kolkata</td>
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<td>Unitech Fabricators &amp; Engineers Pvt.Ltd.,Kolkata</td>
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<td>Apex Automation Pvt. Ltd.</td>
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<td>Madhu Wire &amp; Metal Industries</td>
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<td>167</td>
<td>Non-Sagregated Busducts</td>
<td>Control &amp; Switch Gear ,Noida</td>
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<td>Starclure,Chennai</td>
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<td>S.R.Narkherc,Chennai</td>
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<td>Jasper,Noida</td>
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<td>168</td>
<td>Cathodic Protection System</td>
<td>M/S Raychem Rpg Ltd.,Thane (W)</td>
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<td>M/S Mitcorr Cathodic Protection Pvt.Ltd.,Baroda</td>
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<td>M/S Scientific Metal</td>
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<td>Engineers (P) Ltd.</td>
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<td>N.G.Resistor</td>
<td>Resitech Electricals Pvt.Ltd</td>
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<td>Lachhman Electronics</td>
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<td>Rsi Switchgear Pvt. Ltd.</td>
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<td>PLC</td>
<td>Larsen &amp; Toubro Ltd.</td>
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<td>Schneider Electric India Pvt.Ltd.,New Delhi</td>
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<td>Rockwell Automation India Ltd. (Allenbradley)</td>
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<td>Abb Limited</td>
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<td>Siemens Ltd</td>
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<td>171</td>
<td>Control Valves</td>
<td>Dezurik - COPES VULCAN LTD., U.K.</td>
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<td>172</td>
<td>Flow Elements</td>
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<td>Bristol Babcock Ltd., U.K</td>
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<td>Baliga Lighting Equipments Private Limited, Chennai</td>
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<td>Star-Mech Controls (I) Pvt. Ltd</td>
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<td>Micro Precision Products</td>
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<td></td>
<td>Instrumentation Ltd.</td>
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<td></td>
<td>Engineering Specialities Private Ltd</td>
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</table>
Detail Technical Specification and Process of 175 KLD STP for OTPC Township Project at Khilpara, Udaipur, Tripura

Design, Manufacture, Inspection, Supply, Installation, Testing & Commissioning of Pre-Fabricated Sewage Treatment Plant of 175 KLD based on MBBR Technology including allied Civil, Mechanical and Electrical works as described in Tender documents and Bill of Quantities. The scope of work will also include Operation and Maintenance (O&M) for 5 years and supply of 1 (one) set of Mandatory Spares for the Sewage Treatment Plant.

Scope of Work:

I. DESIGN & ENGINEERING

Following drawings/documents shall be submitted by the successful bidder within 15 days of award of work:

1. P&I Drawings.
2. Sewage treatment plant layout.
3. General arrangement & Detail drawings for civil units
4. Electrical arrangement & requisite load data.

II. ERECTION AND COMMISSIONING

1. Raw Sewage: From the outlet of Sewer collection network.
2. Treated water: At the outlet of Activated Carbon Filter.
3. Sludge: At the outlet of Filter Press.
4. Power: From the Panel provided near STP

III. MANDATORY SPARES

Bidder should classify and offer a set of mandatory spares for the following items in adequate quantity (at least 10% of total quantity) cost of which shall be included in their commercial offer.

1. Bio Pack Media
2. Fill Pack Media
3. Tube Media
4. Pipes
5. Valves

IV. OPERATION & MAINTANANCE

Scope includes Operation and maintenance of the STP and its related services for a period of 5 (five) years from the date of taking over of the completed work by owner (OTPC).

NOC from the Authority: - Owner shall provide NOC from Govt. Body if required.
Technical Details

A. Design Basis and Assumption

The Sewage Treatment Plant shall be adequate for the following sewage characteristics.

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>UNIT</th>
<th>RAW SEWAGE</th>
<th>TREATED SEWAGE (FOR REUSE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow</td>
<td>KLD</td>
<td>175</td>
<td>175</td>
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<tr>
<td>pH</td>
<td></td>
<td>6.5 – 7.5</td>
<td>6.5 – 7.5</td>
</tr>
<tr>
<td>BOD less than (&lt;)</td>
<td>ppm</td>
<td>400</td>
<td>20</td>
</tr>
<tr>
<td>COD less than (&lt;)</td>
<td>ppm</td>
<td>800</td>
<td>100</td>
</tr>
<tr>
<td>TSS less than (&lt;)</td>
<td>ppm</td>
<td>400</td>
<td>10</td>
</tr>
<tr>
<td>O &amp; G (&lt;)</td>
<td>ppm</td>
<td>50</td>
<td>10</td>
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</tbody>
</table>

The treatment scheme is for domestic sewage application with following parameters:

1. Plant is designed for COD, BOD, O&G, & TSS removal.
2. The oil present is in free-floating form.
4. Industrial effluents are not present in the influent sewage.

B. Process Description

Screen: Raw sewage from the source is received into the screening chamber by gravity. Screen provided will remove all floatables and big size matter such as plastic bottles, polythene bags, glasses, stones, etc., which may otherwise choke the pipeline and pumps.

Oil & Grease trap: Sewage generated from kitchen and canteen have higher concentrations of oil and grease in the raw sewage. It needs to be removed before biological treatment as it otherwise may cause problems for biological treatment. A civil construction tank with a baffle wall is provided. The oil and grease removed by gravity floats to the surface, which is removed manually.

Equalization Tank: Usually, sewage generation is more during morning hours and evening hours. Visually no sewage is generated during night hours. Any biological system needs constant feed for bacteria to work efficiently. Hence, it is important to put an equalization tank to collect the excess flow during peak hours and feed sewage in lean hours. A typical Equalization tank has a capacity of MINIMUM 6 (Six) hours of average flow rate. The tank is generally of civil construction. Provision of air grid is to be made for thoroughly mixing the sewage to make it of homogenous quality and to keep the suspended matter in suspension and to avoid septic conditions.

Biological Treatment: The main pollutants in the raw sewage are represented Chemical Oxygen Demand (COD). The bacterial ability to synthesize the organic matter to harmless end products like carbon dioxide and water molecules is utilized to treat the raw sewage. The bio-reactions are carried out in controlled environment in the bio-reactor. The bio-reactor comprises of a tank, fitted with aeration grid. The bacterial activity needs dissolved oxygen, to synthesize the organic matter. This is supplied by passing air in form of small bubbles. The air is passed at the bottom of the tank, so that complete volume of tank is utilized. Oxygen dissolves in liquid, which can now be used by the bacteria. The bacterial population grows on specially designed carrier media, which forms an integral part of the reactor system.
The media is made of small polypropylene elements. A very large surface area is available for the bacterial population to grow. The bacteria growth on the plastic media, by using the organic content in the raw sewage, and the dissolved oxygen available. Due to constant aeration, the media is set in whirling motion, so that continuous mixing takes place. The bacterial layer growth on the media surface increases to a certain extent, and then gets sloughed off after a specific period. This phenomenon is called sloughing. This creates new surface for further bacterial growth. Sloughing takes place only after complete growth and subsequent dying – off of the bacterial layer and hence the sloughed off material is completely digested. The bacterial reaction is carried out in two stages, for maximizing the BOD removal efficiency. Hence, two such reactors are provided in series. Within the reactors, arrangements are made to retain the plastic media in place. Air supply is done through coarse bubble diffusers.

**Tube Settler:** Tube settlers and parallel plates increase the settling capacity of circular clarifiers and/or rectangular sedimentation basins by reducing the vertical distance a floc particle must settle before agglomerating to form larger particles. Tube settlers use multiple tubular channels sloped at an angle of 60° and adjacent to each other, which combine to form an increased effective settling area. This provides for a particle settling depth that is significantly less than the settling depth of a conventional clarifier, reducing settling times. Coagulated suspended matter settles down and clearer water flows up, which is drained out from the hopper bottom of tube settler in the form of thick sludge.

**Disinfection:** The treated sewage is then added with chlorine to kill the pathogens / E-Coli coliforms, so that it becomes fit for disposal in the lake / water ways. Chlorine being a very strong oxidizing agent, a small dose of 3 – 4 mg / l is enough to achieve desired levels of dis-infection. Small residual chlorine (of the order of 0.2 – 0.25 mg / l) also ensures that there is no re-growth of E-Coli, till the final disposal point. The treated sewage, now substantially free from organic contamination, free from coliform bacteria can be safely disposed off in the river, or in other water bodies. This water can also be re-used for gardening / toilet flushing or for other secondary applications after suitable tertiary treatment.

**Tertiary Treatment:** Treated effluent is passed through DMF & ACF for further polishing.

**Dual Media Filter (DMF):** Dual media filter contains anthracite along with fine sand reinforced by pebbles and gravels. This filter consists of a layer of anthracite resting on a layer of fine sand. Anthracite is coarse and has more dirt holding capacity as compared to fine sand. The media in a dual- media filter are arranged so that the water moves through media with progressively smaller pores. The largest particles are strained out by the anthracite. Then the sand traps the rest of the particulate matter though a combination of adhesion and straining.

**Activated Carbon Filters (ACF):** Activated carbon filters are generally employed in the process of removing organic compounds and extracting free chlorine from water, thereby making the water suitable for discharge or use in manufacturing processes. Removes odor from the water.

**Sludge Holding Tank:** Sludge is transferred to a collection tank either by gravity or through pump depending on site condition. Sludge present in the tank is dispersed through private/municipal tankers in regular intervals.

**Filter Press:**

We have offered Filter Press for dewatering of sludge. It requires less space than sludge-drying beds. However, they offer a greater degree of operational control. They usually have to be preceded by a step, in which chemicals are added to the liquid sludge to coagulate solids and improve drain ability. The Filter press feed pumps will be screw pumps.
Flow Diagram:-

Scope of Supply:-

STP Components

<table>
<thead>
<tr>
<th>PRETREATMENT</th>
<th>Qty</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> SCREEN</td>
<td>1</td>
<td>To arrest floatables from entering the biological reactors and remove out oil and grease from the</td>
</tr>
<tr>
<td><strong>2</strong> AIR GRID</td>
<td>1</td>
<td>To homogenize the sewage and increase the dissolved oxygen in the water</td>
</tr>
<tr>
<td><strong>3</strong> SEWAGE TRANSFER PUMP</td>
<td>1W+1S</td>
<td>For pumping sewage from receiving tank to the stilling chamber with 100% standby. Make: Kirloskar/Eqv.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>AEROBIC TREATMENT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>AIR BLOWERS</td>
<td>1W+1S</td>
</tr>
<tr>
<td></td>
<td>Rotary type twin Lobe air blower is provided for aeration inside Equalization Tank, Sludge Holding Tank, and MBBRs. Make: Kay Int. /Eqv.</td>
<td>Nos</td>
</tr>
<tr>
<td>5</td>
<td>MBBR MEDIA</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Media helps in increasing protected surface area for bacterial growth. Acts as a medium to keep bacteria in suspended form. Also ensuring better oxygen contact.</td>
<td>Lot</td>
</tr>
<tr>
<td>6</td>
<td>MBBR CUM TS (PRE FABRICATED) (MSFRP)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>SIZE: 5.81m x 1.97m x 2.5m(H) or as per site</td>
<td>Nos.</td>
</tr>
<tr>
<td>7</td>
<td>AIR DIFFUSERS MBBR</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>To homogenize the effluent and increase the dissolved oxygen in the water to create aerobic degradation. Fine bubble, Header &amp; laterals type, with diffusers.</td>
<td>Set</td>
</tr>
<tr>
<td><strong>CLARIFICATION SYSTEM</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>TUBE SETTLER MEDIA</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>These are multiple tubular channels sloped at angle of 45/60 degree adjacent to each other which combine to form an increased and effective settling area.</td>
<td>Lot</td>
</tr>
<tr>
<td>9</td>
<td>WATER FLOW LAUNDER</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Set</td>
</tr>
<tr>
<td><strong>DISINFECTION SYSTEM</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>HYPO DOSING TANK</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>For Chlorine contact Tank</td>
<td>No</td>
</tr>
<tr>
<td>11</td>
<td>HYPO DOSING PUMP</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>For Chlorine dosing, Electronic metering</td>
<td>No</td>
</tr>
<tr>
<td><strong>TERTIARY TREATMENT SYSTEM</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>FILTER FEED PUMP</td>
<td>1W+1S</td>
</tr>
<tr>
<td></td>
<td>Centrifugal, Horizontal, Monobloc Type. Make: Kirloskar/Eqv.</td>
<td>Nos</td>
</tr>
<tr>
<td>13</td>
<td>DUAL MEDIA FILTER</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Filtration is achieved in 2 stages due to presence of 2 different beds of filtering media. Since both media (i.e. sand and anthracite) are employed, the dirt holding capacity of these filters is twice that of pressure sand filters.</td>
<td>Nos</td>
</tr>
<tr>
<td>14</td>
<td>ACTIVATED CARBON FILTER</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Contains activated carbon as the principle media which is highly porous in nature. Thus has ability to absorb and reduce free chlorine, colloidal organic matter and odor.</td>
<td>Nos</td>
</tr>
<tr>
<td><strong>SLUDGE HANDLING SYSTEM</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>AIR GRID</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>To homogenize the sludge and increase the dissolved oxygen in it to avoid</td>
<td>Set</td>
</tr>
</tbody>
</table>
The above scope of Supply may not comprehensive. Bidder may carefully check & include any other components/services/materials/items whatsoever if required for complete and successful commissioning of the STP and his cost shall deemed to be inclusive of any such item of work. Nothing extra shall be paid by EPI.
All dimensions are tentative and are liable for change depending on detailed engineering and prevailing site conditions.

Vendor will furnish GA & Detailed drawings on receiving order and get the drawings approved from Owner.

Tentative Area available: 20.0 M x 12.0 M

**Technical Specification**

**Mechanical Items**

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>DESCRIPTION</th>
<th>SPECIFICATION</th>
<th>MOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Screen</td>
<td>Suitable</td>
<td>MSEP</td>
</tr>
<tr>
<td>2</td>
<td>Air grid for Equalization Tank with lateral pipe without diffuser.</td>
<td>Suitable</td>
<td>UPVC</td>
</tr>
<tr>
<td>3</td>
<td>Sewage Transfer Pump from Equalization Tank to MBBR</td>
<td>10 m$^3$/hr. @ 12mwc</td>
<td>CI casing, CI Impeller</td>
</tr>
<tr>
<td>4</td>
<td>MBBR Tank CUM Tube Settler Tank</td>
<td>5.81m x 1.97m x 2.5m(H) (2NOS.)</td>
<td>MSFRP</td>
</tr>
<tr>
<td>5</td>
<td>Air Blower for Equalization Tank, Sludge Holding Tank &amp; MBBRs</td>
<td>225.5 m$^3$/hr. @ 4mwc</td>
<td>CI Twin Lobe type</td>
</tr>
<tr>
<td>6</td>
<td>MBBR media</td>
<td>Suitable</td>
<td>CI Twin lobe Type</td>
</tr>
<tr>
<td>7</td>
<td>Air distribution grids (SHT)</td>
<td>Suitable Header &amp; laterals type</td>
<td>UPVC</td>
</tr>
<tr>
<td>8</td>
<td>Air Diffusers for MBBR</td>
<td>Fine Bubble, Stick type</td>
<td>Membrane: EPDM Pipe:</td>
</tr>
<tr>
<td>9</td>
<td>Tube-settler Media</td>
<td>Suitable</td>
<td>PVC</td>
</tr>
<tr>
<td>10</td>
<td>Hypo Dosing Tank for Chlorine Contact Tank</td>
<td>100 Ltrs</td>
<td>HDPE</td>
</tr>
<tr>
<td>11</td>
<td>DMF</td>
<td>800 mm DIA</td>
<td>MSEP</td>
</tr>
<tr>
<td>12</td>
<td>ACF</td>
<td>900 mm DIA</td>
<td>MSEP</td>
</tr>
<tr>
<td>13</td>
<td>Filter Feed Pumps</td>
<td>10 m$^3$/hr. @ 30mwc</td>
<td>CI casing, CI Impeller</td>
</tr>
<tr>
<td>14</td>
<td>Interconnecting piping for Air blower Line</td>
<td>To Suit</td>
<td>MSEP</td>
</tr>
<tr>
<td>15</td>
<td>Interconnecting valves for Air Blower Line</td>
<td>To Suit</td>
<td>CI</td>
</tr>
<tr>
<td>16</td>
<td>Interconnecting piping for Sewage line</td>
<td>To Suit</td>
<td>UPVC</td>
</tr>
<tr>
<td>17</td>
<td>Interconnecting valves for Sewage Line</td>
<td>To Suit</td>
<td>UPVC</td>
</tr>
<tr>
<td>18</td>
<td>Puddle Pipes &amp; Flanges</td>
<td>To Suit</td>
<td>MSEP</td>
</tr>
</tbody>
</table>
Electrical & Instrumentation

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>DESCRIPTION</th>
<th>SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cable, Cable tray, Cable tie, earthing strip, glands, lock nuts etc.</td>
<td>All industrial grade electrical items</td>
</tr>
<tr>
<td>2</td>
<td>Air Flow Meter</td>
<td>Rota Meter Type</td>
</tr>
<tr>
<td>3</td>
<td>Pressure Indicator</td>
<td>Gauge Type</td>
</tr>
<tr>
<td>4</td>
<td>Level Switch</td>
<td>For Both High &amp; Low Level</td>
</tr>
<tr>
<td>5</td>
<td>Control Panel</td>
<td>06 Nos. Feeders</td>
</tr>
</tbody>
</table>

Load Calculation (To be Furnished by Bidder)

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>DRIVE</th>
<th>Connected Load (KW)</th>
<th>Operating Load (KW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sewage feed pumps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Air Blowers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Filter feed pumps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Filter press feed pumps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Filter press hydraulic motor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Other (please specify)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total:

LIST OF MAKES

(To be proposed by bidder in line with Owner’s list of approved makes enclosed in tender documents. For items whose makes are not available in Owner’s approved list, bidder shall propose the make he intends to use. The proposed make should be reputed, in compliance with BIS and acceptable to Owner)