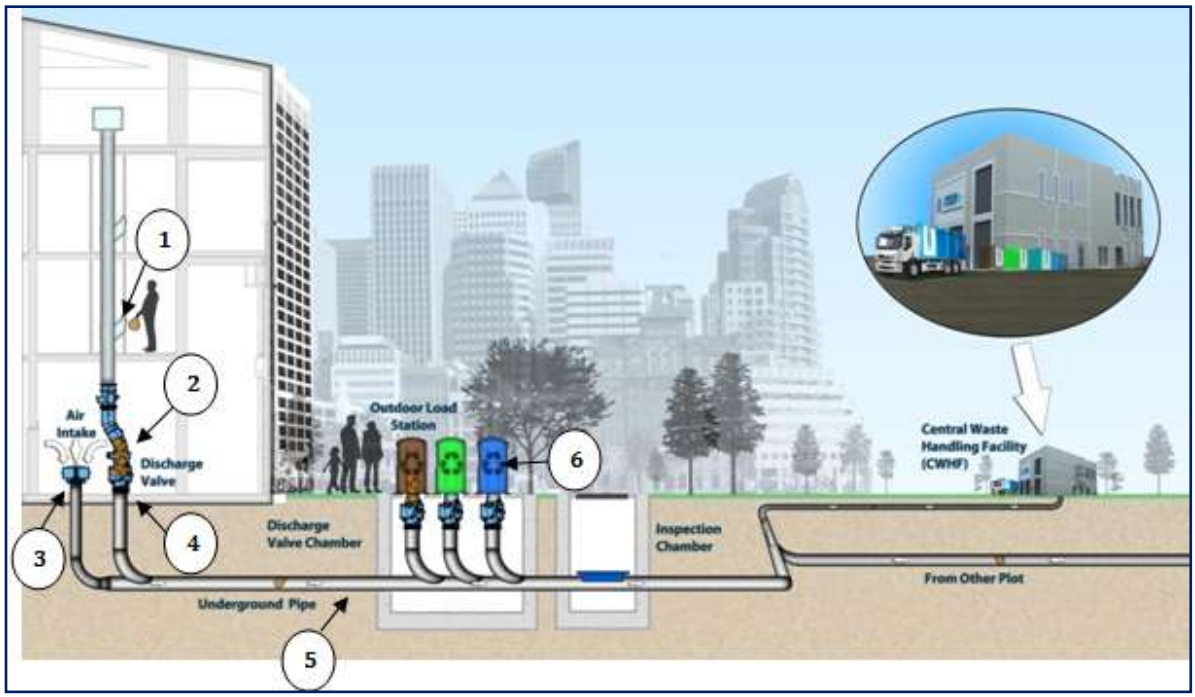
Bhopal Smart City Development Corporation Limited

DESIGN, SUPPLY, CONSTRUCTION, ERECTION AND TESTING, COMMISSIONING OF AUTOMATED SOLID WASTE COLLECTION,SEGREGATION AND TRANSPORTATION SYSTEM INCLUDING 5 YEARS O & M FOR AREA BASED DEVELOPMENT UNDER BHOPAL SMART CITY ON EPC BASIS.



REQUEST FOR PROPOSAL

Preparedby **Approvedby** **Recommendedby**

INDEX

VOLUME – I

SECTION-1

NOTICEINVITING TENDER

Bhopal Smart City Development Corporation Limited

NOTICE INVITING e-TENDER (NIT)

BSCDCL invites online percentage rate /item rate tender as per schedule as under:

Tendering Document No.	:	MPBSCDCL/TENDER NO -103
Name of the Work	:	**DESIGN, SUPPLY, CONSTRUCTION, ERECTION, TESTING AND COMMISSIONING OF AUTOMATED SOLID WASTE COLLECTION,SEGREGATION AND TRANSPORTATION SYSTEM INCLUDING 5 YEARS O & M FOR AREA BASED DEVELOPMENT UNDER BHOPAL SMART CITY ON EPC BASIS.**
Brief Scope of Work	:	Design, supply, construction, erection and commissioning of automated solid waste management in ABDarea under Bhopal smart city.
Estimated Cost	:	Rs. 58 Cr. (Rs Fifty Eight Crore only)
Period of Completion	:	(18Months including raining season for Construction) and (60 Months for O&M Aftercommissioning of building)
Earnest Money Deposit	:	Rs. 29,00,000/- (Twenty Nine lakhs rupees only)
Non-refundable cost of e- Tender Document	:	Rs. 50,000/-(Fifty Thousand rupees only)
Purchase of Tender Start Date	:	30/09/2019 17:30 Hrs
Purchase of Tender End Date	:	25/11/2019 17:00 Hrs
Last date & time of submission of Online Tender(Bid Submission)	:	25/11/2019 17:30 Hrs

Period during which hard copy of the documents as per NIT shall be submitted.(With all technical credentials)	:	26/11/2019, 12:00 Hrs
Date & Time of Opening of technical Tender	:	27/11/2019 15:00 Hrs
Date & Time of Opening of Financial Tender	:	Will be intimated later to successful Bidder
Validity of offer		180 days from the date of Submission of price bid
Pre-Tender Meeting & Venue		23/10/2019at 12.00 Hrs. At BSCDCL, Bhopal Office

Thetenderdocumentcanbedownloaded from www.mptenders.gov.in**" Corrigendum,if any,would appear only on the** www.mptenders.gov.in **website and not to be published in any News Paper".**

The tenderer if required may submit queries in writing on E-mail Id. tenderqueries@smartbhopal.citybefore 22/10/2019 **up to 23:59Hrs**.

INSTRUCTION TO BIDDER:

Bhopal Smart City Development Corporation Limited (BSCDL), hereinafter referred to as "the Employer" intends to invite bids for **"Design, Supply, Construction, Erection, testing, Commissioning and Operation & Maintenance (5 Years) of automated solid waste collection, segregation and transportation system for ABD Area under Bhopal Smart City and also obtaining all required permissions/licenses/NOC' from all the required competent authorities"**on EPC basis as defined in " Section 7, Scope of Work" of the bidding documents, hereinafter referred to as "**the Works**". Operation and maintenance is for **five years**, including defect liabilityperiod of 3 year.

1.1 The Contractor is required to complete the commissioning of all supplied equipment and make the system ready for operation within **Eighteen Months**(Including monsoon period and holidays observed by the Employer from the date of issue of the Notice to Commence (NOC)).

1.2 Bids not covering the entire scope of the package shall be treated as incomplete and hence are liable to be rejected.

1.3 Throughout these bidding documents, the terms "bid" and "tender" and their derivatives (bidder/Tenderer, bid/tender, bidding/tendering, bidding documents/tender documents, etc.) are synonymous, and "day" means calendar day.

1.0 ELIGIBILITY FOR SUBMISSION OF BIDS

2.1 Bidder may be a national or international company, partnership firm, consortium (Limited max to two members only) or Limited Liability Partnership (LLP).

2.2 Bidding documents are not transferable. Only those bidders who have bought the Bid documents are eligible to submit their bids. In case of Bidder is a consortium, then bid may be purchased by any of the member on their name or on the name of consortium.

2.3 A bidder (including all members of a Consortium and all subcontractors of a bidder) if affiliated with an entity which has provided consulting services during the preparatory stages of the Works (BSCDCL) of which the Works form a part, or which has been hired (or is proposed to be hired) as Engineer's Representative for the Contract shall not be eligible to participate in the bidding process.

2.4 **Joint Ventures/Consortium is not allowed**

ELIGIBILITYCRITERIAFORBIDDER:

To qualify for award of the contract, bidders are advised to note the minimum qualification criteria specified below;.

1. **Registration:**The Bidder shall be registered contractor in of appropriate class with the Central Govt. / State Governments or Central / State Government Undertakings. If not registered, the bidder should get registered himself before award of the work.
2. **Similar nature of Work:**The Bidder should have executed in any one project in last Sevenyears, the following minimum quantities of work:

a) Design, Supply, Construction, Erection, Testing, Commissioning, Operation and Maintenance of Automated Solid Waste Collection and Segregation System with minimum capacity of 10 Tons.

b) Transportation of Municipal Solid Waste for disposal of capacity not less than 10 TPD.

c) Operation and Maintenance experience for same project for minimum 2years.

OR

Similar nature of Work: The Bidder in their own name should have satisfactorily executed and commissioned the work of similar nature including O & M for atleast 2 years in any Semi Govt. / Govt. & Public / Private Sector Organizations in India, during last 7 years ending last day of month previous to the one in which bids are invited as a prime Contractor.

Three similar completed works of similar nature each costing not less than 40% of the estimated cost

OR

Two similar completed works of similar nature each costing not less than 50% of the estimated cost.

OR

One completed work of similar nature of costing not less than 80 % of the estimated cost.

Note:

a) The value of executed works shall be brought to current costing level by enhancing the actual value of work at compound rate of 10 % per annum; calculated from the date of completion to last date of receipt of applications for tenders.

b) Similar works means**Design, supply, construction, erection, testing and commissioning of Automated Solid Waste Collection, Segregation and TransportationSystem, as main contractor.**

c) Bidder should submit Client/Users Certificate of satisfaction for the work they have executed

3. **Turnover:**The average annual financial turnover during the last 3 years ending 2018-19 should not be less than 30% of the estimated cost. To ascertain this, Bidder(s) shall furnish the financial statement (Audited balance sheet) duly certified by Chartered Accountant.

4. **Bid Capacity:**The bid capacity of the bidder is required to be more than or equal to estimated cost of the work.

   The bid capacity of the prospective bidders will be calculated as under:

   Assessed Available Bid Capacity = (A* N* 2 - B)

   Where,

   A = Maximum value of Engineering works executed in any one year (year means Financial year) during the last seven years (updated to the price level of the Financial year in which bids are received at a rate of 10% per year) taking into account the completed as well as works in progress.

   N = Number of years prescribed for completion of the Project/Works,

   B = Value of existing commitments (only allotted works) on the last date of submission of bids as per bidding document and on-going works to be completed during the period of completion of the Project/Works for which these bids are being invited.

   Note: The statement showing the value of existing commitments and on-going works as well as the stipulated period of completion remaining for each of the works listed should be attached along with certificates duly signed by the Engineer- in- Charge, not below the rank of an Executive Engineer or CA Certified.

   Even though the bidders meet the above qualifying criteria, they are subject to be disqualified if they have: made misleading or false representation in the forms, statements and attachments submitted in proof of the qualification requirements; and/or Record for poor performance such as abandoning the works, not properly completing the contract, inordinate delays in completion, litigation history, or financial failures etc.

Financial Year	Turnover/ Cost of Executed work	Effective cost of executed work at previous completed financial year's price level
2012-2013	G	1.77 x G
2013-2014	F	1.61 x F
2014-2015	E	1.46 x E
2015-2016	D	1.33 x D
2016-2017	C	1.21 x C
2017-2018	B	1.10 x B
2018-2019	A	1.0 x A

5. **Net worth:** The Bidder(s) net worth should be positive in the last year (2018-19).
6. Bidder shall have valid registration in GST registration, EPF Registration Certificate & PAN Card.
7. The bidder should not got black listed by any government organization (Central/State/PSU), bidder should submit affidavit signed by Director of the company.

Note to eligibility criteria:-

I. The bidder should necessarily submit completion certificate of the Qualifying works from the client/user/ duly signed by an officer not below the rank of Executive Engineer or equivalent of the concerned organization.
II. The Bidder shall submit the audited balance sheets / CA certified turnover for last 3 years (2016-17, 2017-18, and 2018-19).
III. For the purpose of determination of turnover of the bidder, only turnover from engineering projects shall be considered. This shall be backed by a certificate from the Statutory Auditors of the company/Chartered Accountant. Such certificate issued by Chartered Accountant should have Unique Document Identification Number (UDIN). Turnover from real estate development, sale of RMC, trading or sale of flats or offices shall not be considered for evaluation.
IV. For the purpose of determining the relationship of the Bidder with their group companies, only the following documents such as the Annual Report, Balance Sheet or the Auditor Certificate, shall be considered.
V. Net worth shall be calculated as the sum of share capital and free reserves and surplus.
VI. Accumulated losses if not adjusted in reserves and surplus and shown separate in the balance sheet shall be deducted from the sum of share capital and free reserves and surplus. Reserves on account of revaluation of fixed assets shall be excluded.
VII. BSCDCL shall have the authority to make enquiries with the bidder's bankers and auditors.
VIII. The bidders shall indicate information regarding any litigation or arbitration resulting from contracts executed by the bidder in the last five years. The

information shall include the name of the parties concerned, disputed amount, cause of litigation & matter in dispute.

DOCUMENTS COMRISING THE BID :

TheBiddersshouldadditionallysubmitthefollowingdetailsintheirBid along with documents mentioned in instruction to bidder and eligibility criteria for bidderbutnotlimitedtothe same:

1. An Organization Chart of administration and execution of the contract showing thedeploymentofkey personnelatSitewithindividualtasks.
2. Copiesoforiginaldocumentsdefiningtheconstitutionorlegalstatus,placeof registration and principal place ofbusiness;written PowerofAttorney authorizing the signatory ofthebid tocommitandbind theBidder,detailsof arbitrationsand litigations.
3. Aletterofauthoritytoseekreferencesfromthebidders'bankersand previous /existing Employer's.
4. Proposedgeneralprogramme(ProposedScheduleandcashflowestimatein percentage formonly)/methodstatements/Quality Plan/SiteManagement Planinsufficientdetail todemonstrate theadequacy ofthebidder'sproposals tomeetthetechnicalspecificationsandthecompletiontimereferredtoin bid document.
5. All the document in support for meeting the Qualification Criteria
6. Signed copy of Pre-Bid Meeting held, if any.
7. Copies of all schedules, Technical Specifications and Deviations, if any, drawings, literature, brochures.
8. Proposed Safety plan and procedures that shall be followed during the execution oftheWorks
9. List of equipment / plant and machinery proposed to be deployed for executing the Contractin linewith proposed general program/method statement. Availability (eitherownedorleasedorbyprocurement)ofkey andcritical equipmentforthe Workslistofequipmenttobeenclosedwiththebid.
10. ExperienceinhandlingSimilarProjectstobesupportedbyWO/POCopies, ProjectCompletioncertificate,ProjectStatusReport(duly certifiedby respective authority) and Performance Certificates from clients.

Even though the bidders meet the above qualifying criteria, they are liable to be disqualified if they have;

(a) Made misleading or false representations in the forms, statements and attachments submitted by them which comes to the knowledge of Employer; and/ or;

(b) Record of poor performance such as abandoning the works, not properly completing the contract, inordinate delays in completion, financial failures, etc.

Evaluation Criteria:

The lowest evaluated rates including O&M for five years will be considered at the time of evaluation.

Annexure-I

MEMORANDUM

Sl. No.	Description	Cl. No. of NIT/ITT/Clauses of Contract (CC)	Values/Description to be Applicable for Relevant Clause (S)
1)	Name of Work		**DESIGN, SUPPLY, CONSTRUCTION, ERECTION ANDTESTINGCOMMISSIONING OF AUTOMATED SOLID WASTE COLLECTION, SEGREGATION AND TRANSPORTATION SYSTEM INCLUDING 5 YEARS O & M FOR AREA BASED DEVELOPMENT UNDER BHOPAL SMART CITY ON EPC BASIS.**
2)	Client/Owner		Bhopal Smart City Development Corporation Ltd.
3)	Type of Tender		EPC/Design Build Operate tender
4)	Earnest Money Deposit		Rs. 29,00,000/- (TwentyNine lakhs rupees only)
5)	Estimated Cost		Rs. 58Cr. (Fifty EightCrore only)
6)	Time allowed for Completion of Work		(18Months including raining season for construction) and (60 Months for O&M After commissioning of building)
7)	Mobilization Advance		**10%** of contract value
8)	Interest Rate of Mobilization Advance		Simple Interest Rate of 10 % Percent only) (Per Annum)
9)	Schedule of rates applicable		NON SOR Items

10)	Validity of Tender		180 days from the date of Submission of price bid
11)	Performance Guarantee		5.00 % (Five Percent Only) of contract value/Bid Value within 30 days from the issue of Letter of Intent.
12)	Security Deposit/Retention Money		5.00% (Five Percent Only) of the gross value of each running bill.
13)	Time allowed for starting the work		The date of start of contract shall be reckoned from 10 days after the date of work order.
14)	Escalation		All rates as per Bill of Quantities (BOQ) quoted by contractor shall be firm and fixed for entire contract period as well as extended period for completion of the works. **No escalation shall be applicable on this**
15	Operation and Maintenance Period		**Five (5) years after successful commissioning of all Tendered works**
16)	Defects Liability Period		**Five (5) years after successful commissioning of all works i.e upto completion of Operation and Maintenance period**

The intending tenderer must read the terms and conditions of BSCDCL carefully. He should only submit his tender if he considers himself eligible and he is in possession of all the documents required.

Information and Instructions for Tenderers posted on Website(s) shall form part of tender Document.

The Tender Document as uploaded can be viewed and downloaded free of cost by anyone including intending tenderer. But the tender can only be submitted after uploading the mandatory scanned documents.

The Bidder shall submit the Technical BID & Financial Bid online through e-procurement portal www.mptenders.gov.in in comprising of the following documents along with supporting documents as appropriate:

Checklist for Online Submission: Envelope (A, B and C)

(a) Envelope-A will contain: (Hardcopy and online submission is necessary)

1. Proof of e-payment towards cost of tender document/Acknowledgement towards cost of tender fee submission

2. Proofof onlinepaymentthroughe-portalwww.mptenders.gov.in/ o r Bank GuaranteeofanyNationalizedorCommercialScheduledBankagainst EMDinfavor CEO,BSCDCL shallbeasperNoticeInviting e- tender.

(b) Envelope-B will contain: (Hardcopy and online submission is necessary)

1. Scanned copy of all approved/authenticated"Eligibility Criteria for Bidder" documents as per Para of this RFP.
2. Letter of Acceptance of tender condition unconditional as per format enclosed
3. Certificate of Financial Turnover duly certified by CA as indicated above.
4. GST registration number, EPF registration, PAN No.
5. All pages of the entire Corrigendum (if any) duly signed by the authorized person.
6. Affidavit as per "Appendix-O" of tender document.
7. Acceptance letter and Affidavit/Undertaking for Blacklisting/ Debar.
8. Should submit the list of tools plant and machinery.
9. Any other documents as asked in RFP document.

(c) Envelope-C will contain:(Only online submission is necessary)

The Financial Bids shall be uploaded online only strictly in the prescribed format.

If any condition or conditional rebate is offered by the tenderer, their tender shall summarily be rejected.

Thetenderers arerequired toquotestrictlyaspertermsandconditions, specifications, standardsgiveninthetenderdocuments andnottostipulate anydeviations.

Aftersubmission ofthetenderthetenderercanre-submit revisedtenderany numberoftimesbutbeforelasttimeanddateofsubmission oftenderas notified.

WhenitisdesiredbyBSCDCLtosubmitrevisedfinancialtenderthenitshall bemandatorytosubmitrevisedfinancialtender.Ifnotsubmitted thenthe tendersubmittedearliershallbecomeinvalid. Onopeningdate,thetenderercan loginandseethetenderopeningprocess. Contractorcan uploaddocumentsintheformofJPGformatandPDFformat.

Ifthecontractor isfoundineligible afteropeningoftenders, histendershall becomeinvalidandcostoftenderdocumentandprocessing feeshallnotbe refunded.

Ifanydiscrepancyisnoticedbetweenthedocuments asuploadedatthetime of submissionof tenderandhard copiesas submittedphysicallyby the contractor thetendershallbecomeinvalidandcostoftenderdocumentand processingfeeshallnotbe refunded.

Notwithstanding anythingstatedabove,BSCDCLreservestherighttoassess thecapabilitiesand capacity of the tenderer to perform the contract, in the overall interest of BSCDCL. In case, tenderer's capabilities and capacities are not found satisfactory, BSCDCL reserves the right to reject the tender.

Examination of Technical Bids and Determination of Responsiveness:

1. PriortodetailedevaluationofTechnicalBids,theEmployerwilldeterminewhethereachBid
   (a) Meetstheeligibilitycriteriadefinedin Clause
   (b) Hasbeenproperlysignedbyanauthorizedsignatory(accreditedrepresentative)holdingpowerofAttorneyinhisfavor.
   (c) Isaccompaniedbytherequired Bidsecurityand;
   (d) IsresponsivetotherequirementsoftheBiddingdocuments.

2. A substantially responsive Technical Bid is one which conforms to all the terms, conditions and specification of the Bidding documents, without material deviation or reservation. A material deviation or reservation is one
   (a) Whichaffectsinanysubstantialwaythescope,qualityorperformanceofthework s;
   (b) Whichlimitsin anysubstantialway, theEmployer'srightsor theBidder'sobligationsundertheContract;or
3. IfaTechnicalBidisnotsubstantiallyresponsive,itwillberejectedbytheEmployer,and maynotsubsequentlybemaderesponsivebycorrectionorwithdrawalofthenon-conformingdeviationorreservation.

Instructions for financial bid submission-

In case of Percentage Rate Tender, Contractor must ensure to quote single percentage rate in attached financial bid format.Quote should be in percentage higher or below on the SOR Rates the same is to quoted in the form of decimal only. For example if contractor wants to quote 5 percent higher then he have to quote 1.05 and if he wants to quote 5 [percent below he have to quote 0.95 in given column of financial bid sheet.

In case of Item Rate Tender, price shall be entered against each item in the Bill of Quantities / Schedule of Quantities. The cost of item against which the contractor has failed to enter a rate or price shall be deemed to be covered by rates and prices of other items in Bill of Quantities / Schedule of Quantities and no payment shall be made for the quantities executed for items against which rate has not been quoted by the contractor.

In addition to this, while selecting any of the cells a warning appears that if any cell is left blank the same shall be treated as "0". Therefore, if any cell is left blank and no rate is quoted by the tenderer, rate of such item shall be treated as "0" (ZERO).

i. Financial Bid format is uploaded in Excel Format in www.mptenders.gov.in. At the time of financial bidding, bidder is requested to download the file, and update the same.

ii. For SOR items bidder need to quote 1 plus percentage higher of below the quoted ratefor example if bidder wants to quote 5% higher the SOR price then he have to quote1.05 and similarly if he wants to quote 5% below the SOR price then he have to quote0.95.
iii. For Non SOR items bidder can quote for individual item rates in respective financial bid sheet.
iv. Bidders are requested to check final figure in all the totals of all sheets. BSCDCL is not responsible for errors in the financial bid document.
v. Bidders are required to upload the updated financial bid in the prescribed excel format in the www.mptenders.gov.in at the time of final financial bid submission.

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SECTION-2

INSTRUCTIONSTO BIDDER

InstructiontoTenderer(ITT)

A.GENERALINSTRUCTIONS:

2.1. Generaltermsof Bidding

2.1.1 NoBiddershallsubmitmorethanoneBIDfortheProject.

2.1.2 TheFeasibilityReport/PreliminaryProjectReportof theProject hasbeen assessed howevertheBidders areexpected tocarry outtheirownsurveys, investigations andotherPreliminary examinationoftheProjectbeforesubmittingtheirBids.Nothing containedintheattacheddrawings/BOQ shallbebindingontheBSCDCLnorconferany rightontheBidders,andtheBSCDCLshallhavenoliabilitywhatsoever inrelationtoor arisingoutofanyorallcontentsofTENDER.

2.1.3Notwithstandinganything tothecontrarycontainedinthisRFP,thePreliminaryterms specifiedinthedraftAgreement shallhaveoverridingeffect;provided,however,thatany conditionsorobligations imposedontheBidderhereunder shallcontinuetohaveeffectin additiontoitsobligationsundertheAgreement.

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2.1.4The BID shall be furnished in the financial bid format attached separately in the Excel format

2.1.5The Bidder shall deposit a BID Security (EMD) of (Rs. 29,00,000/- (TwentyNinelakhs rupees only) in accordance with the provisions of this RFP. The Bidder has to provide the BID Security (EMD) through online payment or in the form of a Bank Guarantee acceptable to the BSCDCL, as per format.

Company Name: Bhopal Smart City Development Corporation Ltd.
Bank Name: Allahabad Bank.

Branch Address: Arera Colony, Bhopal

A/C no. : 50327343809

IFSC Code: ALLA0210197

PAN No. : AAGCB6537N

TIN No. : 23889236926

Service Tax No. : AAGCB6537NSD001

GST no: 23AAGCB6537N1ZE.

2.1.6ThevalidityperiodoftheBankGuarantee,shallnotbelessthan180(onehundred andeighty) daysfromtheBIDDueDate,inclusive ofaclaimperiodof60(Sixty)days,and maybeextendedasmaybemutuallyagreedbetweenthe BSCDCLandtheBidder.

2.1.7 TheBIDshallbesummarilyrejectedifitisnotaccompaniedbytheBIDSecurity.The BIDSecurity shallberefundable nolaterthan150(onehundredandfifty)daysfromthe BID DueDateexceptinthecaseoftheSelectedBidderwhoseBIDSecurity shallbe retained tillit

hasprovidedaPerformanceSecurityundertheAgreement.

2.1.8TheBidder should submitaPower ofAttorney aspertheformat,authorizingthesignatoryoftheBIDtocommittheBidder.

2.1.9 Anyconditionor qualificationor anyother stipulationcontainedinthe BIDshall render theBIDliabletorejectionasanon-responsiveBID.

2.1.10TheBIDandallcommunicationsinrelationtoorconcerningtheBiddingDocuments andtheBIDshallbeinEnglishlanguage.

2.1.11Thedocuments includingthisRFPandallattacheddocuments, providedbythe BSCDCLareandshallremainorbecomethepropertyoftheBSCDCLandareTransmitted totheBidderssolelyforthepurposeofpreparation andthesubmission ofa BIDin accordanceherewith.Biddersaretotreatall informationas strictlyconfidentialand shallnot use it for any purpose other than for preparation andsubmission of their BID.

2.1.12The provisionsofthis Clause shallalsoapplymutatismutandistoBIDsandallotherdocuments submittedbythe Bidders, and the BSCDCL will not return to the Bidders any BID, documentor any informationprovidedalongtherewith.

2.1.13ThisRFPis nottransferable.

2.1.14AnyawardofProjectpursuanttothisRFPshallbesubjecttothetermsofBidding Documentsandalsofulfillingthecriterionasmentionedintender document.

2.1.15While bidding is open to persons from any country, the following provisions shall apply then the Eligibility of such Bidder shall be subject to approval of the BSCDCL from national security and public interest perspective. The decision of the BSCDCL in this behalf shall be final and conclusive and binding on the Bidder. The holding or acquisition of equity or control, as above, shall include direct or indirect holding/ acquisition, including by transfer, of the direct or indirect legal or beneficial ownership or control, by persons acting for themselves or in concert and in determining such holding or acquisition, the BSCDCL shall be guided by the principles, precedents and definitions contained in the Securities and Exchange Board of India (Substantial Acquisition of Shares and Takeovers) Regulations,1997, or any substitute thereof, as inforce on the date of such acquisition. The Bidder shall promptly inform the BSCDCL of any change in the shareholding, as above, and failure to do so shall render the Bidder liable for disqualification from the Bidding Process.

2.1.17Notwithstanding anything to the contrary contained herein, in the event that the Bid Due Date falls within three months of the closing of the latest financial year of a Bidder, it shall ignore such financial year for the purposes of its Bid and furnish all its information and certification with reference to the 5 (five) years or 1 (one) year, as the case may be, preceding its latest financial year. For the avoidance of doubt, financial year shall, for the Purposes of a Bid hereunder, mean the accounting year followed by the Bidder in the course of its normal business.Latest Financial Year will be (2018-2019)

2.1.18AnyentitywhichhasbeenbarredbyGOIorGovt.ofMadhya Pradesh fortheworksofexpressways,Nationalhighways,andthebarsubsists

asontheBidDueDate,wouldnotbeeligibletosubmittheBID, bidder need to submit Affidavit regarding the same.

2.1.19TheBSCDCL reservestherighttorejectanotherwiseeligiblebidderonthebasisof theinformationprovidedin tender document.ThedecisionoftheBSCDCLinthiscase shallbefinal.

2.2 Eligibilityandqualificationrequirementsof Bidder

2.2.1Fordeterminingtheeligibilityof Bidderthefollowingshallapply:

(a)ABiddershallnothaveaconflictofinterest(the"ConflictofInterest")thataffects theBiddingProcess.AnyBidderfoundtohaveaConflictofInterestshallbedisqualified andliableforforfeitureoftheBIDSecurityorPerformanceSecurityasthecasemaybe.A BiddershallbedeemedtohaveaConflictofInterestaffectingtheBiddingProcess,if:

(b)ABiddershallbeliablefordisqualification andforfeitureofBIDSecurity,ifanylegal, financialortechnicaladviseroftheBSCDCL inrelationtotheProjectisengagedbythe Bidder,itsMemberoranyAssociatethereof,asthe casemaybe, inanymannerformatters relatedtoorincidental tosuchProjectduringtheBiddingProcessorsubsequent tothe(i) issueoftheLOAor(ii)executionoftheAgreement. Intheeventhoughsuchadviseris engagedbytheselectedBidderorContractor,asthecasemaybe,afterissueoftheLOA orexecutionoftheAgreement formattersrelatedorincidentaltotheproject,then notwithstandinganythingtothecontrarycontainedherein orinthe LOAortheAgreement andwithoutPrejudice toanyotherrightorremedyortheBSCDCL, includingtheforfeiture andappropriation oftheBIDSecurityorPerformance Security,asthecasemaybe,which theBSCDCLmayhavethereunderorotherwise,theLOAortheAgreement, asthecase maybe,shallbeliabletobeterminated withouttheBSCDCLbeingliableinanymanner whatsoevertotheSelectedBidderorContractor forthesame.Fortheavoidanceordoubt, thisdisqualification shallnotapplywheresuchadviserwasengagedbytheBidder,its MemberorAssociateinthepastbutitsassignmentexpiredorwasterminated6(six) monthspriortothedateofissueofthisRFP.Norwillthisdisqualificationapplywheresuch adviserisengagedafteraperiodof3(three)yearsfromthedateofcommercialoperation oftheProject.

Other Instructions-

On line tenders on behalf of Owner/Client are invited for the work. The pre-qualification / enlistment of the contractors should be valid on the last date of submission of tenders. In case the last date of submission of tender is extended, the pre-qualification of contractor should be valid on the original date of submission of tenders.
The work is estimated to _____ however, is given merely as a rough guide.
The tender document as uploaded can be seen on website www.mptenders.gov.in and can be downloaded free of cost.

Mode of Submission: **Earnest Money Deposit** Earnest Money Deposit of amount as mentioned in "NIT/ Memorandum (Annexure-I)" required to be submitted along with the tender shall be payable online through E-tendering portal www.mptenders.gov.in through NEFT/RTGS. The EMD shall be valid for minimum period of 180 (One Hundred Eighty) days from last day of submission of Tender.
The EMD of all unsuccessful tenderers will be returned within thirty (30) days of the Award of the contract to successful tenderer through online portal.
Financial Bidding can be done through the excel sheet uploaded on www.mptenders.gov.in, *Rates can be quoted in the yellow highlighted cell of the financial bid * Bidder should fill there company/organization name in the space provided (yellow section)
Interested Bidder who wish to participate in the tender has also to make following payments through online payment e-proc portal only. Cost of Tender Document –Rs. 50,000/- To be submit online only/- e-Tender Processing Fee – As applicable for MPEPROC portal, Cost of Tender Document and, e-Tender Processing Fee online payment shall be payee online Copy of pre-qualification/enlistment letter and certificate of work experience (if required) and other documents as specified in the tender shall be scanned and uploaded to the e-Tendering website within the period of tender submission.
Online technical tender documents submitted by intending tenderers shall be opened only of those tenderers, whose Earnest Money Deposit, Cost of Tender Document and e-Tender Processing Fee and other.
The tender submitted shall become invalid if: the tenderer is found ineligible. The tenderer does not upload all the documents (including GST registration) as stipulated in the tender document. If any discrepancy is noticed between the documents as uploaded at the time of submission of tender and hard copies as submitted physically in the office of tender opening authority.

VALIDITY OF TENDER

The tender for the works shall remain open for acceptance for a period of One Eighty (180) days from the date of bid submission date. If any tenderer withdraws his tender before the said period or issue of letter of acceptance, whichever is earlier, or makes any modifications in the terms and conditions of the tender which are not acceptable to the BSCDCL, then the BSCDCL shall, without prejudice to any other right or remedy, be at liberty to forfeit the said earnest money as aforesaid. Further the tenderers shall not be allowed to participate in the retendering process of work.

ACCEPTANCE OF TENDER

BSCDCL reserves the right to reject any or all the tenders in part or full without assigning any reason whatsoever. BSCDCL does not bind itself to accept the lowest tender.

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

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

The acceptance of tender will rest with the BSCDCL who does not bind itself to accept the lowest tender and reserves to itself the right to reject any or all the tenders received without assigning any reason thereof. Tenders in which, any of the prescribed conditions are not fulfilled or found incomplete in any respect are liable to be rejected.

On acceptance of tender, the name of the accredited representative(s) of the contractor who would be responsible for taking instructions from Engineer-in-Charge or its authorized representative shall be intimated by the contractor within 07 days of issue date of Letter of Intents by BSCDCL.

The tenderer shall not be permitted to tender for works if his near relative is posted in the project office or concerned Office of the BSCDCL. The contractor shall also intimate the names of persons who are working with him in any capacity or are subsequently employed by him and who are near relatives to any of the officers in BSCDCL. Any breach of this condition by the tenderer would render him liable to the withdrawal of the work awarded to him and forfeiture of Earnest Money and Security Deposit. This may also debar the contractor from tendering for future works under BSCDCL.

For the purpose of operation of this clause a near relative shall mean wife, husband, parents, grandparents, children, grandchildren, brothers, sisters, uncles, aunts, cousins and their corresponding in-laws.

The time of completion of the entire work, as contained in contract shall be as mentioned in “Memorandum - Annexure-I”, which shall be reckoned from the 10th day after issue of the Letter of Intent by the BSCDCL.

Canvassing whether directly or indirectly, in connection with tenderers is strictly prohibited

and the tenders submitted by the contractors who resort to canvassing will be liable for rejection.

The tender award, execution and completion of work shall be governed by tender documents consisting of (but not limited to) Letter of Intent/Letter of work order, Bill of Quantities, Special Conditions of Contract, General Conditions of Contract, Specifications, Drawings. The tenderers shall be deemed to have gone through the various conditions including sub-soil water conditions, topography of the land, drainage and accessibility etc. or any other condition which in the opinion of contractor will affect his price/rates before quoting their rates. No claim whatsoever against the foregoing shall be entertained.

The drawings with the tender documents are Tender Drawing and are indicative only.

ADDENDA/CORRIGENDA

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

SITE VISIT AND COLLECTING LOCAL INFORMATION

Before tendering, the tenderers are advised to visit the site, its surroundings to assess and satisfy themselves about the local conditions such as the working and other constraints at site, approach roads to the site, availability of water & power supply, application of taxes, duties and levies as applicable & any other relevant information required by them to execute complete scope of work. The tenderer may obtain all necessary information as to risks, weather conditions, contingencies & other circumstances (insurgencies etc.) which may influence or affect their tender prices. Tenderer shall be deemed to have considered site conditions whether he has inspected it or not and to have satisfied himself in all respect before quoting his rates and no claim or extra charges whatsoever in this regard shall be entertained / payable by the BSCDCL at a later date.

ACCESS BY ROAD

Contractor, if necessary, shall build temporary access roads to the actual site of construction for the works at his own cost to make the site accessible. The Contractor shall maintain the same in motorable condition at all the times as directed by Engineer-in-Charge at his own cost. The contractor shall be required to permit the use of any roads so constructed by him for vehicles of BSCDCL or any other agencies/ contractors who may be engaged on the project site, free of cost.
Non-availability of access roads or approach to site, for the use of the contractor shall in no case condone any delay in the execution of work nor be the cause for any claim for compensation.

HANDING OVER & CLEARING OF SITE

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

The efforts will be made by the BSCDCL to handover the site to the Contractor free of encumbrances. However, in case of any delay in handing over of the site to the Contractor, the BSCDCL shall only consider suitable extension of time for the execution of the work. It should be clearly understood that the BSCDCL shall not consider any revision in contract price or any other compensation whatsoever viz. towards idleness of contractor's labour, equipment etc. Old structures on the proposed site, if required, shall be demolished by the contractor properly at his own cost unless and otherwise mentioned elsewhere in the tender document. The useful material obtained from demolition of structures & services shall be the property of the owner/BSCDCL and these materials shall be stacked in workmanship like at the place specified by the Engineer-in-charge.

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

The information about the public utilities (whether over ground or underground) like electrical/ telephone/ water supply lines, OFC Cables, open drain etc. is the responsibility of contractor to ascertain the utilities that are to be affected by the works through the site investigation.

The contractor shall be responsible to obtain necessary approval from the respective authorities for shifting/ re-alignment of existing public utilities. BSCDCL shall only assist the contractor for visioning in obtaining the approval from the concerned authorities.

Any services affected by the works must be temporarily supported by the contractor who must also take all measures reasonably required by the various bodies to protect their services and property during the progress of works. It shall be deemed to be the part of the contract and no extra payment shall be made to the contractor for the same.

SCOPE OF WORK

The scope of work covered in this tender shall be as per the Bill of Quantities, specifications, drawings, instructions, orders issued to the contractor from time to time during the pendency of work. The drawings for this work, which may be referred for tendering, provide general idea only about the work to be performed under the scope of this contract. Drawings given in Tender document is for information purpose only and successful bidder shall undertake confirmatory survey for accuracy and completeness of data. It is in scope of successful Bidder to undertake all Site surveys, Geotechnical investigations, obtaining all required approvals from the relevant authorities, Further detailing of for all Architectural, Structural works, MEP works,Piping,Instrumentation …etc as per Employers requirement and submit the same to client for review and approval, Prepare Good for Construction Drawings, submit maintenance manual to client for approval before start of Maintenance period. The successful bidder shall have to prepare and submit 'As Built Drawings' depicting the exact construction carried out on site, in soft and hard copy format.

Statutory and other charges for getting various required approvals shall be in scope of Successful bidder

The quantities of various items as entered in the "BILL OF QUANTITIES" are indicative only and may vary depending upon the actual requirement. The contractor shall be bound to carry out and complete the stipulated work irrespective of the variation in individual items specified in the bill of quantities..Also refer section 7 for detailed Scope of work.

APPROVAL OF TEMPORARY / ENABLING WORKS

The setting and nature of all offices, huts, access road to the work areas and all other temporary works as may be required for the proper execution of the works shall be subject to the approval of the Engineer- in-charge. All the equipment's, labour, material including cement, reinforcement and the structural steel required for the enabling/ temporary works associated with the entire Contract-shall have to be arranged by the Contractor only. Nothing extra shall be paid to the Contractor on this account.

CLARIFICATION AFTER TENDER SUBMISSION

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

ORDER OF PRECEDENCE OF DOCUMENTS

In case of difference, contradiction, discrepancy, with regard to conditions of contract, Specifications, Drawings, Bill of quantities etc. forming part of the contract, the following shall prevail in order of precedence.

Letter of Intent, along with statement of agreed variations and its enclosures, if any.

Description of Bill of Quantity / Schedule of Quantities.

Special Condition of Contract.

Technical specifications (General, Additional and Technical Specification) as given in Tender documents.

General Conditions of Contract.

Drawings

CPWD/ UADD specifications (as specified in Technical

Specification of the Tender) update with correction slips issued up to last date of receipt of tenders.

Relevant B.I.S. Codes

Financial Bid

Online tender filled in either percentage plus or minus Bid to be quoted 1 plus % above or below(for example: If want to quote 5% above the write 1.05 and if want to quote 5% belowthen write 0.95) in the given uploaded Excel Sheet format

For NON SOR item sheet individual rates has to be quoted for each item in the given uploaded excel sheet

(If entered '0' it will be treated as 'at par'. By default the value is zero only).

Note:Incaseofrebate/premiumof15%andaboveasquotedbytheBidder,therate analysis of major items shall be submitted by L1 and L2 bidder after demand notificationbye-mailtobiddersbyconcernedEIC.

BIDSECURITYOREMD

TheBiddershallfurnish,aspartof theBid,BidSecurity/EMD,in theamountspecifiedin the BidData Sheet.Thisbidsecurityshallbeinfavorof theauthoritymentionedintheBidData Sheetandshallbevalidtillthevalidityofthebid.

Anybidnotaccompaniedby anacceptableBidSecurityandnotsecuredasindicatedinsub-clausementionedabove,shallberejectedbytheEmployerasnon-responsive.

TheBidSecurityofthesuccessfulBidderwillbedischargedwhentheBidderhassignedthe

AgreementandfurnishedtherequiredSecurityDeposits.

TheBidSecuritymay beforfeited:

a)IftheBidderwithdrawstheBidafterbidopening(openingoftechnicalqualificationpart ofthebidduringtheperiodofBidvalidity;

b)Inthecase ofasuccessfulBidder,iftheBidderfailswithinthespecifiedtimelimitto:

i.signtheAgreement;and/or

ii.FurnishtherequiredSecurityDeposits.

Norejectionsandforfeitureshallbedoneincaseofcurabledefects,.Fornon-curabledefects the10%ofEMDshallbeforfeitedandbidwillbeliableforrejection.

Failure of the bidder to submit the documents to Employer will lead to rejection of Bid.

ACCEPTANCE OF TENDER CONDITIONS

From: (On the letter head of the company by the authorized officer having power of attorney)

BSCDCL Limited,_____

Sub: Name of the work & NIT No.:

Sir,

This has reference to above referred tender. I/We are pleased to submit our tender for the above work and I/We hereby unconditionally accept the tender conditions and tender documents in its entirety for the above work. I/we are eligible to submit the tender for the subject tender and I/We are in possession of all the documents required. I/We have viewed and read the terms and conditions of this GCC/SCC carefully. I/We have downloaded the following documents forming part of the tender document:

a) Notice Inviting e-Tender. (pg- to pg-)
b) Quoting Sheet for Tenderer (pg- to pg-)

c) Instructions to Tenderers & General Conditions of Contract (Vol- I/2013) :(pg- to pg)

d) Technical Specifications (Vol-II) (pg- to pg-)

e) Bill of Quantities (Vol-III) (pg- to pg-)

f) Tender Drawing (pg- to pg-)

Acceptance of Tender Conditions (Annexure II)

g)Corrigendum, if any (pg- to pg-)

I/we have uploaded the mandatory scanned documents such as cost of tender document, EMD, e-Tender Processing Fee and other documents as per Notice Inviting e-tender AND I/We agree to pay the cost of tender document, EMD, e-Tender Processing Fee (only receipt/proof of online payment) and other documents in the form and manner as described in NIT/ITT .Should this tender be accepted, I/We agree to abide by and fulfill all terms and conditions referred to above and as contained in tender documents elsewhere and in default thereof, to forfeit and pay BSCDCL, or its successors or its authorized nominees such sums of money as are stipulated in the notice inviting tenders and tender documents. If I/we fail to commence the work within 10 days of the date of issue of Letter of Intent and/or I/we fail to sign the agreement as per Clauses of Contract and/or I/we fail to submit performance guarantee as per Clauses of Contract, I/we agree that BSCDCL shall, without prejudice to any other right or remedy, be at liberty to cancel the Letter of Intent and to forfeit the said earnest money as specified above.

Dated:_____ Yours faithfully,

(Signature of the tenderer with rubber stamp)

SECTION-3

GENERAL CONDITIONS OF CONTRACT (GCC)

CLAUSES OF CONTRACT (CC)

DEFINITIONS

The Contract means the documents forming the tender and acceptance thereof and the formal agreement executed between the competent authority on behalf of BSCDCL and the contractor, together with the documents referred to therein including these conditions, the specifications, Designs, drawings and instructions issued from time to time by the Engineer-in-Charge and all these documents taken together, shall be deemed to form one contract and shall be complementary to one another. Bhopal Smart City Development Corporation Limited, hereinafter called 'BSCDCL' proposes to get the works executed as mentioned in the Contract on behalf of Owner/ Client as Implementing agency/Executing Agency.

3.1 In the contract, the following expressions shall, unless the context otherwise requires, have the meanings, hereby respectively assigned to them:-

APPROVAL means approved in writing including subsequent written confirmation of previous verbal approval.

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

CONTRACTOR shall mean the individual, firm**,** LLP or company, whether in corporate or not, undertaking the works and shall include the legal personal representative of such individual or the persons composing such firm or LLP or company, or the successors of such firm or company and the permitted assignees of such individual, firm or company.

CONTRACT VALUE means the sum for which the tender is accepted as per the Letter of Intent.

DRAWINGS mean the drawings referred to in the contract document including modifications if any and such other drawings as may from time to time be furnished and/ or approved by BSCDCL.

DATE OF COMMENCEMENT OF WORK: The date of start of contract shall be reckoned from 10 days after the date of issue of Letter of Intent.

ENGINEER-IN-CHARGE means the Engineer of BSCDCL who shall supervise and be in-charge of the work.

LANGUAGE: All documents and correspondence in respect of this contract shall be in English Language.

"LETTER OF INTENT" shall mean BSCDCL's letter or notification conveying its acceptance of the tender subject to such conditions as may have been stated There in.

MONTHmeans English Calendar month 'Day' means a Calendar day of 24 Hr **BSCDCL** shall means Bhopal Smart City Development Corporation Limited, a company registered under the Indian Company Act, with its registered office at Near Tatpar Petrol Pump, Sector A, Berkheda, Bhopal, Madhya Pradesh 462023 or its Administrative officers or its engineer or other employees authorized to deal with any matter with which these persons are concerned on its behalf.

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

SCHEDULE(s) referred to in these conditions shall mean the standard schedule of rates of the government mentioned in the Memorandum (Annexure-I) with the amendments thereto issued up to the date of receipt of the tender.

SITE means the lands and other places on, under, in or through Which the works are to be executed or carried out and any other lands or places provided by BSCDCL/client/owner or used for the purpose of the contract.

TENDER means the Contractor's priced offer to BSCDCL for the execution and completion of the work and the remedying of any defects therein in accordance with the provisions of the Contract, as accepted by the Letter of Intent or Award letter. The word TENDER is synonymous with Tender and the Word TENDER DOCUMENTS with "Tendering Documents" or "offer documents".

WRITING means any manuscript typed written or printed statement under or over signature and/or seal as the case may be.

Works or Work shall unless there be something either in the subject or context repugnant to such construction, be construed and taken to mean the works by or by virtue of the contract contracted to be executed whether temporary or permanent, and whether original, altered, substituted or additional.

The headings in the clauses/ conditions of tender documents are for convenience only and shall not be used for interpretation of the clause/ condition.

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

Excepted Risk are risks due to riots (other than those on account of contractor's employees), war (whether declared or not) invasion, act of foreign enemies, hostilities, civil war, rebellion revolution, insurrection, military or usurped power, any acts of Government, damages from aircraft, acts of God, such as earthquake, lightening and unprecedented floods, and other causes over which the contractor has no control and accepted as such by the BSCDCL or causes solely due to use or occupation by Government of the part of the works in respect of which a certificate

of completion has been issued or a cause solely due to BSCDCL's faulty design of works.

Market Rate shall be the rate as decided by the Engineer-in-Charge on the basis of the prevailing cost of materials and labour at the site where the work is to be executed plus the percentage mentionedelsewhere in the tender document to cover, all overheads and profits.

PERFORMANCE GUARANTEE:

"Within 30 (Thirty) days from the date of issue of Letter of Intent or within such extended time as may be granted by BSCDCL in writing, the contractor shall submit to BSCDCL an irrevocable performance bank guarantee in the form appended, from any Nationalized Bank or all Commercial schedule bank equivalent to 5% (five per cent only) of the contract value for the due and proper execution of the Contract. The Performance Guarantee shall be initially valid up to the stipulated date of completion plus 60 days beyond that. In case the time for completion of works gets extended, the contractor shall get the validity of Performance Guarantee extended to cover such extended time for completion of work.

BSCDCL reserve the right of forfeiture of the performance guarantee in the event of the contractor's failure to fulfill any of the contractual obligations or in the event of termination of contract as per terms and conditions of contract.

Performance guarantee shall be returned after successful completion / testing / commissioning and handing over the project to the client up to the entire satisfaction of BSCDCL / Client.

In case the contractor fails to submit the performance guarantee of the requisite amount within the stipulated period or extended period, Letter of Intent automatically will stand withdrawn and EMD of the contractor shall be forfeited.

SECURITY DEPOSIT/ RETENTION MONEY

The Security deposit or the retention money shall be deducted from each running bill of the contractor @ 5% (five per cent only) of the gross value of the Running Account bill. Earnest money shall be adjusted first in the security deposit and further recovery of security deposit shall commence only when the upto date amount of security deposit exceeds the earnest money deductible under this clause. No Interest shall be paid on amount so deducted.

Security deposit will be released after completion of defect liability period.

In lieu of security deposit /retention money BG can be submitted which shall bereleased after completion of defect liability period.

The release/refund of security deposit of the contractor shall be subject to the observance/compliance of the conditions as under and whichever is later:

a) Expiry of the defect liability period in conformity with provisions contained in clause (Defect liability clause). The expiry of defect liability period shall be extended from time to time depending upon extension of time granted by BSCDCL.

The contractor produces a clearance certificate from the labour office. As soon as the work is virtually completed, the contractor shall apply for the labour clearance

certificate to the Labour Officer under intimation to the Engineer-in-Charge. The Engineer-in-Charge, on receipt of the said communication, shall write to the Labour Officer to intimate if any complaint is pending against the contractor in respect of the work. If no complaint is pending, on record till after 3 months after completion of the work and/or no communication is received from the Labour Officer to this effect till six months after the date of completion, it will be deemed to have received the clearance certificate.

3.2 BSCDCL reserves the right of part or full forfeiture of security deposit in addition to other claims in the event of contractor's failure to fulfill any of the contractual obligations or in the event of termination of contract as per terms and conditions of contract.

MOBILIZATION ADVANCE

Mobilization advance up to maximum of amount as mentioned in the

"Memorandum (Annexure-I)" shall be paid to the contractor, if requested by him, on submission of irrevocable Bank Guarantee valid for contract period of an amount 1.2 times of the mobilization advance to take care of advance and interest at prescribed rate from a nationalized bank or all Commercial scheduled bank in the enclosed Performa. The Mobilization advance shall be interest bearing @ as mentioned in the "Memorandum (Annexure-I)".

This advance shall be paid in three installments as follows:

First Installment of fifty percent of total mobilization advance shall be paid after the agreement is signed and upon submission of performance guarantee for full amount as specified.

2nd installment of twenty five percent of total mobilization advance will be paid after the setting up of site office and site laboratory, complete mobilization of plant and machinery, scaffolding & shuttering materials etc.

The Balance twenty five percent of total mobilization advance shall be paid on completion of 10% of work in terms of cost and after the contractor has fully mobilized the work at site.

The mobilization advance bear simple interest at the rate as mentioned in the Memorandum (Annexure-I) and shall be calculated from the date of payment to the date of recovery (365 days in a year) both days inclusive, on the outstanding amount of advance. Recovery of such mobilization advanced including interest shall be made by the deduction from the contractor's bills commencing after first ten percent of the gross value of the work is executed and paid, on pro-rata percentage basis to the gross value of the work billed beyond 10% in such a way that the entire advance is recovered either by the time eighty percent of the gross value of the contract is executed and paid, together with interest due on the entire outstanding amount up to the date of recovery of the installment or on expiry of eighty percent of contract period (i.e. time allowed for completion of work in terms of Memorandum-Annexure-I) whichever is earlier.
The bank guarantee submitted by contractor against mobilization advance shall initially be made for the full amount as mentioned in para 4.1 above

and valid for the contract period, and be kept renewed from time to time to cover the balance amount and likely period of completion of recovery together with interest. However, the contractor can submit part bank guarantees against the mobilization advance in as many numbers as per proposed number of recovery installments equivalent to the amount of each installment.

Notwithstanding what is contained above, no mobilization advance whatsoever shall be payable, if payment of mobilization advance is not mentioned in the Memorandum (Annexure-I).

SECURED ADVANCE AGAINST NON-PERISHABLE MATERIALS

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

DEVIATIONS / VARIATIONS EXTENT AND PRICING

The Engineer-in-Charge shall have power (i) to make any alterations in, omissions from, additions to or substitutions for, the original specifications, drawings, designs and instructions that may appear to him to be necessary during the progress of the work, (ii) to omit part of the works in case of non-availability of a portion of the site or for any other reasons and the contractor shall be bound to carry out the works in accordance with any instructions given to him in writing signed by the Engineer-in-Charge and such alterations, omissions, additions, or substitutions shall form part of the contract as if originally provided therein and any altered, additions or substituted works which the contractor may be directed to do in the manner specified above as part of the work, shall be carried out by the contractor on the same conditions in all respects including price on which he agreed to do the main work except as hereunder provided:
The time for the completion of the work shall, in the event of any deviations resulting in additional cost over the tendered value sum being ordered be extended, if requested by the contractor, as follows:

in the proportion which the additional cost of the altered, additional or substituted work bears to the original tendered value plus25% of the time calculated in (i) above or such further additional time as may be considered reasonable by the Engineer-in-Charge.

If the extra items includes any work for which no rate is specified in the contract, then such work shall be carried out at the rates entered in theschedule of rates (as mentioned in Memorandum (Annexure-I)) for Civil Works minus/plus the percentage which the tendered amount of scheduled items bears with the estimated amount of schedule items based on the Schedule of Rates (as mentioned in Memorandum (Annexure-I) for Civil/ Sanitary Works). The scheduled item means the items appearing in the Schedule of Rates (as mentioned in Memorandum (Annexure-I)for Civil/ Sanitary Works) which shall be applicable in this clause. This clause will apply mutates mutandis to electrical work except that Electrical Schedule of Rates as mentioned in Memorandum (Annexure-I) will be considered in place of Civil works Schedule of rates as mentioned in Memorandum (Annexure-I)

However, In the case of extra item(s), (items that are completely new, and are in addition to the items contained in the contract, and not included in the schedule of rates (as mentioned in Memorandum (Annexure-I)), the contractor may within fifteen days of receipt of order or occurrence of the item(s) claim rates, supported by proper analysis, for the work and the engineer-in-charge shall within one month of the receipt of the claims supported by analysis, after giving consideration to the analysis of the rates submitted by the contractor, determine the rates on the basis of the market rates and the contractor shall be paid in accordance with the rates so determined.

In the case of substituted items (items that are taken up with partial substitution or in lieu of items of work in the contract), the rate for the agreement item (to be substituted) and substituted item shall also be determined in the manner as mentioned in the following para:

If the market rate for the substituted item so determined is more than the market rate of agreement item (to be substituted), the rate payable to the contractor for the substituted item shall be the rate for the agreement item (to be substituted) so increased to the extent of the difference between the market rates of substituted item and the agreement item (to be substituted).

If the market rate for the substituted item so determined is less than the market rate of the agreement (to be substituted), the rate payable to the contractor for the substituted item shall be the rate for the agreement item (to be substituted) so decreased to the extent of the difference between the market rates of substituted item and the agreement item (to be substituted)

Any operation incidental to or necessarily has to be in contemplation of tenderer while filling, tender or necessary for proper execution of the item

included in the Schedule of quantities or in the schedule of rates mentioned above, whether or not specifically indicated in the description of the item and the relevant specifications shall be deemed to be included in the rates quoted by the tenderer or the rate given in the said schedule or rates as the case may be Nothing extra shall be admissible for such operations.

Market Rates to be determined as per various sub-clauses given in tender document shall be on the basis of Prevailing rates of Material (unless mentioned otherwise), Relevant Labour authority rate for Labour, market rates of T&P etc. plus 15% towards Contractors' Profits and Overheads.
The following factors may be considered in the justification of rates on which Contractor's overhead & profit shall not be applicable:
Buildings and Other Construction Worker Cess as applicable in the state of work place
EPF (Employer Contribution) component, as per EPF act on the portion of labour's wages, on works contract / WCT, as per composite scheme in the State of work place, if applicable GST

ESCALATION

No claim on account of any escalation on whatsoever ground shall be entertained at any stage of works. All rates as per Bill of Quantities (BOQ) quoted by contractor shall be firm and fixed for entire contract period as well as extended period for completion of the works. No escalation shall be applicable on this contract.

COMPENSATION FOR DELAY

If the contractor fails to maintain the required progress in terms of clause
or relevant clause of GCC & Special Conditions of Contract, to complete the work and clear the site on or before the contract or extended date of completion, he shall, without prejudice to any other right or remedy available under the law to the BSCDCL on account of such breach, pay as agreed compensation the amount calculated at the rates stipulated below as the Engineer in charge (whose decision in writing shall be final and binding) may decide on the amount of tendered value of the work for every completed day / week (as applicable) that the progress remains below that specified in Clause
or the relevant clause in GCC & Special Conditions of Contract or that the work remains incomplete.

This will also apply to items or group of items for which a separate period of completion has been specified

i) Compensation for delay of work @ 1.5% per month delay to be computed on daily basis.
Provided always that the total amount of compensation for delay to be paid under this Condition shall not exceed 10% of the Tendered Value of work or of the Tendered Value of the item or group of items of work for which a separate period of completion is originally given. The amount of compensation may be adjusted or set-off against any sum payable to the Contractor under this or any other contract with BSCDCL.

In case, the contractor does not achieve a particular milestone mentioned elsewhere in the tender document, or the re-scheduled milestone(s) the amount shown against that milestone shall be withheld, to be adjusted against the compensation levied at the final grant of Extension of Time. With-holding of this amount or failure to achieve a milestone, shall be automatic without any notice to the Contractor. However, if the contractor catches up with the progress of work on the subsequent milestone(s), the withheld amount shall be released. In case the contractor fails to make up for the delay in subsequent milestone(s), amount mentioned against each milestone missed subsequently also shall be withheld. However, no interest, whatsoever, shall be payable on such withheld amount.

ACTION IN CASE WORK NOT DONE AS PER SPECIFICATIONS

All works under or in course of execution or executed in pursuance of the contract, shall at all times be open and accessible to the inspection and supervision of the Engineer-in-charge, his authorized subordinates in charge of the work and all the superior officers, officer of the Quality Assurance Unit of the BSCDCL or any organization engaged by the BSCDCL for Quality Assurance and the contractor shall, at all times, during the usual working hours and at all other times at which reasonable notice of the visit of such officers has been given to the contractor, either himself be present to receive orders and instructions or have a responsible agent duly accredited in writing, present for that purpose. Orders given to the Contractor's agent shall be considered to have the same force as if they had been given to the contractor himself. If it shall appear to the Engineer-in-charge or his authorized subordinates in-charge of the work or to the officer of Quality Assurance or his subordinate officers or the officers of the organization engaged by the BSCDCL for Quality Assurance or his subordinate officers, that any work has been executed with unsound, imperfect, or unskillful workmanship, or with materials or articles provided by him for the execution of the work which are unsound or of a quality inferior to that contracted or otherwise not in accordance with the contract, the contractor shall, on demand in writing which shall be made within twelve months of the completion of the work from the Engineer-in-Charge specifying the work, materials or articles complained of notwithstanding that the same may have been passed, certified and paid for forthwith rectify, or remove and reconstruct the work so specified in whole or in part, as the case may require or as the case may be, remove the materials or articles so specified and provide other proper and suitable materials or articles at his own charge and cost. In the event of the failing to do so within a period specified by the Engineer-in-Charge in his demand aforesaid, then the contractor shall be liable to pay compensation at the same rate as per conditions of contract (for non-completion of the work in time) for this default. In such case the Engineer-in-Charge may not accept the item of work at the rates applicable under the contract but may accept such items at reduced rates as the Engineer in charge may consider reasonable during the preparation of on account bills or final bill if the item is so acceptable without detriment to the safety and utility of the item and the structure or he may reject the work outright without any payment and/or get it and other connected and incidental items rectified, or removed and re-executed at the risk and cost of the contractor. Decision of the Engineer-in-Charge to be conveyed in writing in respect of the same will be final and binding on the contractor.

ACTION IN CASE OF BAD WORK

If it shall appear to the Engineer-in-Charge or his authorized representative in charge of the work or to the Chief Technical Examiner or to any other inspecting agency of Government/ State Government/ Owner where the work is being executed, that any work has been executed with unsound, imperfect, or unskillful workmanship or with materials of any inferior description, or that any materials or articles provided by him for the execution of the work are unsound or of a quality inferior to that contracted for or otherwise not in accordance with the contract, the contractor shall on demand in writing which shall be made within twelve months of the completion of the work from the Engineer-in-Charge specifying the work, materials or articles complained of notwithstanding that the same may have been passed, Certified and paid for forthwith rectify, or remove and reconstruct the work so specified in whole or in part

as the case may require or as the case may be, remove the materials or articles so specified and provide other proper and suitable materials or articles at his own proper charge and cost, and in the event of his failing to do so within a period to be specified by the Engineer-in-Charge in his demand aforesaid while the contractor failure to do so shall continue, the Engineer-in-Charge may rectify or remove and re-execute the work or remove and replace with others, the material or articles complained of as the case may be at the risk and expense in all respects of the contractor.

CANCELLATION/DETERMINATION OF CONTRACT IN FULL OR PART

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

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

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

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

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

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

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

If the contractor shall obtain a contract with BSCDCL as a result of wrong tendering or other non-bona-fide methods of competitive tendering or commits breach of Integrity Pact; or If the contractor being an individual, or if a firm, any partner thereof shall at any time be adjudged insolvent or have a receiving order or order for administration of his estate made against him or shall take any proceedings

for liquidation or composition (other than a voluntary liquidation for the purpose of amalgamation or reconstruction) under any Insolvency Act for the time being in force or make any conveyance or assignment of his effects or composition or arrangement for the benefit of his creditors or purport so to do, or if any application be made under any Insolvency Act for the time being in force for the sequestration of his estate or if a trust deed be executed by him for benefit of his creditors; or If the contractor being a company, shall pass a resolution or the Court shall make an order for the winding up of the company, or a receiver or manager on behalf of the debenture holders or otherwise shall be appointed or circumstances shall arise which entitle the Court or debenture holders to appoint a receiver or manager; or If the contractor shall suffer an execution being levied on his goods and allow it to be continued for a period of 21 days, or. If the contractor assigns, transfers, sublets (engagement of labour on a piece-work basis or of the labour with materials not to be incorporated in the work, shall not be deemed to be subletting) or otherwise parts with or attempts to assign, transfer sublet or otherwise parts with the entire works or any portion thereof without and prior written approval of the Engineer-in-Charge.

When the contractor has made himself liable for action under any of the cases aforesaid, the Engineer-in-Charge may without prejudice to any other right or remedy which shall have accrued or shall accrue hereafter to BSCDCL, by a notice in writing to cancel the contract as whole or only such items of work in default from the Contract, the Engineer-in-charge shall have powers:
Take possession of site and any materials, constructional plant, implements, stores, etc. thereon; and/ or Carry out the incomplete work by any means at the risk and cost of the contractor; and/ or

The Engineer-in-charge shall determine the amount, if any, is recoverable from the contractor for completion of the part work/part incomplete work of any item(s) taken out of his hands and execute at the risk and cost of the contractor, the liability of contractor on account of loss or
damage suffered by BSCDCL because of action under this clause shall not exceed 10% of the tendered value of the work.

To determine or rescind the contract as aforesaid (of which termination or rescission notice in writing to the contractor under the hand of the Engineer-in-Charge shall be conclusive evidence). Upon such determination or rescission the full security deposit recoverable under the contract and performance guarantee shall be liable to be forfeited and un-used materials, construction plants, implements, temporary buildings, etc. shall be taken over and shall be absolutely at the disposal of the BSCDCL. If any portion of the Security Deposit has not been paid or received it would be called for and forfeited; and/ or

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

After giving notice to the contractor to measure up the work of the contractor and to take such whole, or the balance or part thereof as shall be un-executed or delayed with reference to the General Conditions of Contract / or relevant clause of Condition Special of Contract, out of his hands and to give it to another contractor to complete in which case any expenses which may be incurred in excess of the sum which would have been paid to the original contractor if the whole work had been executed by him (of the amount of which excess the certificate in writing of the Engineer-in-Charge shall be final and conclusive) shall be borne and paid by the original contractor and may be deducted from any money due to him by BSCDCL under his contract or on any other account whatsoever or from his security deposit or the proceeds of sales of unused materials, construction plants, implements temporary buildings etc. thereof or a sufficient part thereof as the case may be. If the expenses incurred by the BSCDCL are less than the amount payable to the contractor at his agreement rates, the difference shall not be paid to the contractor; and/or

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

Any excess expenditure incurred or to be incurred by BSCDCL in completing the works or part of the works or the excess loss or damages suffered or

may be suffered by BSCDCL as aforesaid after allowing such credit shall without prejudice to any other right or remedy available to BSCDCL in law be recovered from any moneys due to the contractor on any account, and if such moneys are not sufficient the contractor shall be called upon in writing and shall be liable to pay the same within 30 days.

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

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

In the event of anyone or more of the above courses being adopted by the Engineer-in-Charge the contractor shall have no claim to compensation for any loss sustained by him by reasons of his having purchased or procured any materials or entered into any engagements or made any advances on account or with a view to the execution of the work or the performance of the contract. And in case action is taken under any of the provision aforesaid the contractor shall not be entitled to recover or be paid any sum for any work thereof or actually performed under this contract unless and until the Engineer-in-Charge has certified in writing the performance of such work and the

value payable in respect thereof and he shall only be entitled to be paid the value so certified.

Provided further that if any of the recoveries to be made, while taking action as above, are in excess of the security deposit forfeited, these shall be

Limited to the amount by which the excess cost incurred by the BSCDCL exceeds the security deposit so forfeited.

CONTRACTOR LIABLE TO PAY COMPENSATION EVEN IF ACTION NOT TAKEN

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

CARRYING OUT PART WORK AT RISK & COST OF CONTRACTOR

If contractor:

At any time makes default during currency of work or does not execute any part of the work with due diligence and continues to do so even after a notice in writing of 7 days in this respect from the Engineer-in-Charge;

or

Commits default in complying with any of the terms and conditions of the contract and does not remedy it or takes effective steps to remedy it within 7 days even after a notice in writing is given in that behalf by the Engineer-in-Charge;

or

Fails to complete the work(s) or items of work with individual dates of completion, on or before the date(s) so determined, and does not complete them within the period specified in the notice given in writing in that behalf by the Engineer-in-Charge.

The Engineer-in-Charge without invoking action under conditions of contract may, without prejudice to any other right or remedy against the contractor which have

either accrued or accrue thereafter to BSCDCL, by a notice in writing to take the part work/part incomplete work of any item(s) out of his hands and shall have powers to:

Take possession of the site and any materials, constructional plant, implements, stores, etc., thereon; and/orCarry out the part work / part incomplete work of any item(s) by any means at the risk and cost of the contractor.

The Engineer-in-Charge shall determine the amount, if any, is recoverable from the contractor for completion of the part work/ part incomplete work of any item(s) taken out of his hands and execute at the risk and cost of the contractor, the liability of contractor on account of loss or damage suffered by BSCDCL because of action under this clause shall not exceed 10% of the tendered value of the work.

In determining the amount, credit shall be given to the contractor with the value of work done in all respect in the same manner and at the same rate as if it had been carried out by the original contractor under the terms of his contract, the value of contractor's materials taken over and incorporated in the work and use of plant and machinery belonging to the contractor. The certificate of the Engineer-in-Charge as to the value of work done shall be final and conclusive against the contractor provided always that action under this clause shall only be taken after giving notice in writing to the contractor. Provided also that if the expenses incurred by the department are less than the amount payable to the contractor at his agreement rates, the difference shall not be payable to the contractor.

Any excess expenditure incurred or to be incurred by BSCDCL in completing the part work/ part incomplete work of any item(s) or the excess loss of damages suffered or may be suffered by BSCDCL as aforesaid after allowing such credit shall without prejudice to any other right or remedy available to BSCDCL in law or per as agreement be recovered from any money due to the contractor on any account, and if such money is insufficient, the contractor shall be called upon in writing and shall be liable to pay the same within 30 days.

If the contractor fails to pay the required sum within the aforesaid period of 30 days, the Engineer-in-Charge shall have the right to sell any or all of the contractors' unused materials, constructional plant, implements, temporary building at site etc. and adjust the proceeds of sale thereof towards the dues recoverable from the contractor under the contract and if thereafter there remains any balance outstanding, it shall be recovered in accordance with the provisions of the contract.

In the event of above course being adopted by the Engineer-in-Charge, the contractor shall have no claim to compensation for any loss sustained by him by reason of his having purchased or procured any materials or entered into any engagements or made any advance on any account or with a view to the execution of the work or the performance of the contract.

SUSPENSION OF WORKS

The contractor shall, on receipt of the order in writing of the Engineer-in-charge, suspend the progress of the works or any part thereof for such time and in such manner as the Engineer-in-charge may consider necessary for any of the following reasons:

On account of any default on part of the contractor, or For proper execution of the works or part thereof for reason other than the default of the contractor, or For safety of the works or part thereof.

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

(b) If the suspension is ordered for reasons (ii) and (iii) in sub-para (a) above.

i) The contractor shall be entitled to an extension of the time equal to the period of every such suspension plus 25% for completion period. No adjustment in contract price will be allowed for reasons of such suspension.

ii) In the event of the Contractor treating the suspension as an abandonment of the Contract by BSCDCL, he shall have no claim to payment of any compensation on account of any profit or advantage which he may have derived from the execution of the work in full.

TERMINATION OF CONTRACT ON DEATH OF CONTRACTOR

Without prejudice to any of the right or remedies under this contract if the contractor dies, the Engineer in-charge shall have the option of terminating the contract without compensation to the contractor.

TIME ESSENCE OF CONTRACT & EXTENSION FOR DELAY

The time allowed for execution of the Works as specified in the Memorandum (Annexure-I) or the extended time in accordance with these conditions shall be the essence of the contract. The execution of the works shall commence from such time period as mentioned in MEMORANDUM (ANNEXURE – I) or the date on which the Engineer-in-Charge issues written orders to commence the work. If the Contractor commits default in commencing the execution of the work as aforesaid, the BSCDCL shall without prejudice to any other right or remedy available in law, be at liberty to forfeit the earnest money & performance guarantee absolutely.

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

If the work(s) be delayed by:

1. force-majeure or

2. Abnormally bad weather, or

3. Serious loss or damage by fire, or

4. Civil commotion, local commotion of workmen, strike or lockout, affecting any or the trades

employed on the work, or
5. Delay on the part of other contractors or tradesmen engaged by Engineer-in-Charge in

Executing work not forming part of the Contract, or

6. Non-availability of stores, which are responsibility of the BSCDCL or,

7. Non-availability or break down of tools and plant to be supplied or supplied by BSCDCL or,

8. Any other cause which, in the absolute discretion of the BSCDCL, is beyond the

Contractor's control, then upon the happening of any such event causing delay, the

Contractor shall immediately give notice thereof in writing to the Engineer-in-Charge within 07 days but shall nevertheless use constantly his best endeavor to prevent or make good the delay and shall do all that may be reasonably required to the satisfaction of the Engineer-in-Charge to proceed with the works.

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

TIME SCHEDULE & PROGRESS

3.6 Time allowed for carrying out all the works as entered in the tender shall be as mentioned in the "Memorandum (Annexure-I)" which shall be reckoned from the 10th day from the date on which the Letter of Intent is issued to the Contractor. Time shall be the essence of the contract and contractor shall ensure the completion of the entire work within the stipulated time of completion.

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

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

During the currency of the work the contractor is expected to adhere to the time schedule on mile stone and total completion and this adherence will be a part of Contractor's performance under the contract. During the time schedule on mile stone and total completion and this adherence will be a part of Contractor's performance under the contract. During the execution of the work contractor is expected to participate in the review and updating of the Network/BAR CHART undertaken by the BSCDCL. These reviews may be undertaken at the discretion of Engineer-in-charge either as a periodical appraisal measure or when the quantum of work order on the contractor is substantially changed through deviation orders or amendments. The review shall be held at site or any of the offices of BSCDCL/owner /consultant at the sole discretion of BSCDCL. The contractor will adhere to the revised schedule thereafter. The approval to the revised schedule resulting in a completion date beyond the stipulated date of completion shall not automatically amount to a grant of extension of time to the contractor.

Contractor shall submit (as directed by Engineer-in-Charge) progress reports on a computer based program (program and software to be approved by Engineer-in-Charge) highlighting status of various activities and physical completion of work. The contractor shall send completion report with as built drawings to the office of Engineer-in-Charge, of BSCDCL in writing within a period of 30 days of completion of work.

The photographs of the project taken on last day of every month indicating progress of work (in soft copies) shall be attached along with the physical progress reports to be submitted to Engineer-in-charge.

TAXES AND DUTIES

3.7 Except as otherwise specifically provided in the contract, the contract or shall be liable and responsible for the payment, of all taxes, such as GST (State and Central) & any other applicable tax(es), duty(ies), levy, cess if any, in the state concerned which may be specified by local/state/ central government from time to time on all material articles which may be used for this work. The rates quoted by him in the tender in bill of quantities shall be inclusive of all taxes and GST.

In the event of nonpayment/default in payment of any of the above taxes, BSCDCL reserves the right to with-hold the dues/payments of contractor and make payment to local/state/Central Government authorities or to labourers as may be applicable.

The imposition of any new and/or increase in the aforesaid taxes, duties levies (including fresh imposition of any other Tax) is imposed by Statute, after the last stipulated date for the receipt of tender including extensions if any and the contractor thereupon necessarily and properly pays such taxes/levies/cess, the contractor shall be reimbursed the amount so paid, provided such payments, if any, is not, in the opinion of Engineering-in charge attributable to delay in execution of work within the control of contractor. The contractor shall, within a period of 30 days of the imposition of any such further tax or levy or cess, give a written notice thereof to the Engineering-in-charge that the same is given pursuant to this condition, together with all necessary information relating thereto.

The rate quoted by the contractor shall be deemed to be inclusive of all taxes and GST as given in tender document Tax deductions at source shall be made as per laws prevalent in the State as applicable for the work.

The stamp duty and registration charges, if any, on the contract agreement levied by the Government or any other statutory body, shall be paid by the contractor as applicable in the state of work.

It will be incumbent upon the Contractor to obtain a registration certificate as a dealer under the GST Act and necessary evidence to this effect shall be furnished by the Contractor to BSCDCL.

The Bidder shall quote his rates inclusive of GST in conjunction with other terms and conditions. In case, the GST on Works contract on execution of works is waived off by the State Govt. at later stage for this project, the equivalent amount from the date of waiver of such tax (as per prevailing rate as on the date of waiver of all type of Taxes and GST Works Contract) shall be deducted from the amount payable to the contractor from subsequent RA bills.

In the event of decrease / relaxation and / or waiver of any of the existing / prevailing tax(es), duties, levies, cess by Central / state Govt. Or any other statutory body (ies), after the last stipulated date for the receipt of tender including extension (if any), and the contractor thereupon has been paid or has raised claims of such tax(es), duties, levies, cess; such sums shall be recovered / deducted (from claims raised but which has not been paid) effective from the date as reckoned in the relevant statutory order / law / ordnance etc. The contractor, shall, within a period of 30 days of any such waiver/relaxation/decrease in tax(es), duties, levies, cess, give a written notice thereof to Engineer-in-charge stating the statutory change with Documentary proof thereto. Provided always that Engineer-in-charge shall have full powers to effect recovery/deduction on account of any such statutory change even if contractor has not intimated in the event when any such statutory action comes to his notice.

INCOME TAX DEDUCTION (TDS)

Income tax deductions shall be made from all payments made to the contractor including advances against work done, as per the rules and regulations in force, in accordance with the Income Tax act prevailing from time to time.

GOODS AND SERVICES TAX (GST)

The Bidder shall quote rates **inclusive of all type of tax and GST nothing extra shall be paid.** The contractor must have **GST registration number** and will provide copy of Registration to BSCDCL before release of any payment by the Corporation. The contractor will submit regular Invoice / Bill fulfilling `all conditions of Goods and Service Tax(GST) Rules.

ROYALTY ON MATERIALS:

The contractor shall deposit royalty and obtain necessary permit for supply of bajri, stone, kankar, sand and other materials etc. from the local authorities and quoted rates shall be inclusive of royalty.
The contractor shall be deemed to have inspected the site, its surrounding and acquainted itself with the nature of the ground, accessibility of the site and full extent

and nature of all operations necessary for the full and proper execution of the contract, space for storage of materials, constructional plant, temporary works, restrictions on the plying of heavy vehicles in area, supply and use of labour materials, plant, equipment and laws, rules and regulations, if any, imposed by the local authorities.

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

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

INSURANCE OF WORKS ETC

Contractor is required to take contractor's all risk policy or erection all risk policy (as the case may be) from an approved insurance company in the joint name with BSCDCL and bear all costs towards the same for the full period of execution of works including the defect liability period for the full amount of contract against all loss of damage from whatever cause arising other than **excepted risks** for which he is responsible under the terms of the contract and in such manner that the BSCDCL and the contractor are covered during the period of construction of works and/or also covered during the period of defect liability for loss or damage. The work and the temporary works to the full value of such works.

The materials, constructional plant, centering, shuttering and scaffolding materials and other things brought to the site for their full value.Whenever required by BSCDCL, the contractor shall produce the policy or the policies of insurance and the receipts for payment of the current premium.

INSURANCE UNDER WORKMEN COMPENSATION ACT

Contractor is required to take insurance cover under the Workman Compensation Act, 1923 amended from time to time from an approved insurance company and pay premium charges thereof. Wherever required by BSCDCL the contractor shall produce the policy or the policies of Insurance and the receipt of payment of the current premiums.

THIRD PARTY INSURANCE

Contractor is required to take third party insurance cover for an amount of 5%(five percent) of contract value from an approved insurance company for insurance against any damage, injury or loss which may occur to any person or property including that of BSCDCL / owner / client, arising out of the execution of the works or temporary works.

Wherever required by BSCDCL the contractor shall produce the policy or the policies of Insurance and the receipt of payment of the current premiums.

In case of failure of the contractor to obtain contractors all risk policy, insurance under workman compensation act and third party insurance as described above within one month from the date of commencement of work, running account payments of the contractor shall be withheld till such time the aforesaid insurance covers are obtained by the contractor.

If the Contractor could not effect a comprehensive insurance cover against risks which he may be required to effect under the terms of the contract, then he shall give his attention to get the best insurance cover available and even in case of effecting a wider insurance cover than the one which the subsidiary of the General Insurance Company could offer, such an insurance is ought to be done after the BSCDCL's approval, by or through the subsidiary of the General Insurance Company.

The contractor shall at all times indemnify BSCDCL and Owner against all claims, damages or compensation under the provision of Payment of wages act-1936, Minimum Wages Act-1948, Employer's liability Act-1938, the workmen's compensation Act-1947, Industrial Disputes Act-1947 and Maternity Benefit Act-1961 or any modifications thereof or any other law in force or as consequence of any accident or injury to any workman or other persons in or about the works, whether in the employment of the contractor or not, against all costs, charges and expenses of any suit, action or proceedings arising out of such incident or injury and against all sum or sums which may with the consent of the contractor be paid to compromise or compound any such claim. Without limiting his obligations and liabilities as above provided, the contractor shall insure against all claims, damages or compensation payable under the Workmen's Compensation Act 1923 or any modification thereof or any other law relating thereto.

PAYMENTS

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

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

All payments shall be released by way of e-transfer through RTGS/NEFT in India directly at their Bank account by BSCDCL.

MEASUREMENTS OF WORKS

Engineer-in-charge shall, except as otherwise provided, ascertain and determine by measurement, the value of work done in accordance with the contract.
Except where any general or detailed description of the work expressly shows to the contrary, measurement shall be taken in accordance with the

Procedure set forth in the UADD Specification. In the case of items which are not covered by specifications, mode of measurement as specified in the Technical Specifications of the contract and if for any item no such technical specification is available, then a relevant standard method of measurement issued by the Bureau of Indian Standard shall be followed.

Provided further that, In case of Cancellation/Determination of Contract in Full or in Part in accordance with clause of tender document (and its sub-clauses), following methodology shall be adopted in respect of measurements in addition to what has been mentioned in foregoing:-

All measurements and levels shall be taken jointly by the Engineer-in-Charge or his authorized representative and by the contractor or his authorized representative from time to time during the progress of the work and such measurements shall be signed and dated by the Engineer-in-Charge and the contractor or their representatives in token of their acceptance. If the contractor objects to any of the measurements recorded, a note shall be made to that effect with reason and signed by both the parties.

If for any reason the contractor or his authorized representative is not available and the work of recording measurements is suspended by the Engineer-in-Charge or his representative, the Engineer-in-Charge and BSCDCL shall not entertain any claim from contractor for any loss or damages on this account. If the contractor or his authorized representative does not remain present at the time of such measurements after the contractor or his authorized representative has been given a notice in writing three (3) days in advance or fails to countersign or to record objection within a week from the date of the measurement, then such measurements recorded in his absence by the Engineer-in-Charge or his representative shall be deemed to be accepted by the Contractor. The contractor shall, without extra charge, provide all assistance with every appliance, labour and other things necessary for measurements and recording levels.

COMPUTERISED MEASUREMENT BOOKS

Engineer-in-Charge shall, except as otherwise provided, ascertain and determine by measurement the value of work done in accordance with the contract. All measurements of all items having financial value shall be entered by the contractor and compiled in the shape of the Computerized Measurement Book as per the format of BSCDCL so that a complete record is obtained of all the items of works performed under the contract. All such measurements and levels recorded by the contractor or his authorized representative from time to time, during the progress of the work, shall be got checked by the contractor from the Engineer-in-Charge or his authorized representative as per interval or program fixed in consultation with Engineer-in-Charge or his authorized representative.

After the necessary corrections made by the Engineer-in-Charge, the measurement sheets shall be returned to the contractor for incorporating the corrections and for resubmission to the Engineer-in- Charge for the dated signatures by the Engineer-in-Charge and the contractor or their representatives in token of their acceptance.

Whenever bill is due for payment, the contractor would initially submit draft computerized measurement sheets and these measurements would be got checked/test checked from the Engineer-in-Charge and/or his authorized representative. The contractor will, thereafter, incorporate such changes as may be done during these checks/test checks in his draft computerized measurements, and submit to BSCDCL a computerized measurement book, duly bound, and with its pages machine numbered. The Engineer-in-Charge and/or his authorized representative would thereafter check this MB, and record the necessary certificates for their checks/test checks.

The final, fair, computerized measurement book given by the contractor, duly bound, with its pages numbered, should be 100% correct, and no cutting or over-writing in the measurements would thereafter be allowed. If at all any error is noticed, the contractor shall have to submit a fresh computerized MB with its pages duly numbered and bound, after getting the earlier MB cancelled by the BSCDCL. The contractor shall submit two spare copies of such computerized MB's for the purpose of reference and record by the various officers of the BSCDCL.

The contractor shall also submit to the department separately his computerized Abstract of Cost and the bill based on these measurements, duly bound, and its pages numbered along with two spare copies of the "bill.

The contractor shall, without extra charge, provide all assistance with every appliance, labour and other things necessary for checking of measurements /levels by the Engineer-in-Charge or his representative.

The contractor shall give not less than seven days' notice to the Engineer-in-Charge or his authorized representative in charge of the work before covering up or otherwise placing beyond the reach of checking and/or test checking the measurement of any work in order that the same may be checked and/or test checked and correct dimensions thereof be taken before the same is covered up or placed beyond the reach of checking and/or test checking measurement and shall not cover up and place beyond reach of measurement any work without consent in writing of the Engineer-in-Charge or his authorized representative in charge of the work who shall within the aforesaid period of seven days inspect the work, and if any work shall be covered up or placed beyond the reach of checking and/or test checking measurements without such notice having been given or the Engineer-in-Charge's consent being obtained in writing the same shall be

uncovered at the Contractor's expense, or in default thereof no payment or allowance shall be made for such work or the materials with which the same was executed.

Engineer-in-Charge or his authorized representative may cause either themselves or through another officer of the BSCDCL to check the measurements recorded by contractor and all provisions stipulated herein above or anywhere in the tender document shall be applicable to such checking of measurements or levels.

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

WITHHOLDING AND LIEN IN RESPECT OF SUMS DUE FROM CONTRACTOR

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

It is an agreed term of the contract that the sum of money or moneys so withheld or retained under the lien referred to above by the Engineer-in-Charge or BSCDCL will be kept withheld or retained as such by the Engineer-in-Charge or BSCDCL till the claim arising out of or under the contract isdetermined by the competent court and that the contractor will have no claim for interest or damages whatsoever on any account in respect of such withholding or retention under the lien referred to above and duly notified as such to the contractor. For the purpose of this clause, where the contractor is a partnership firm or a limited company, the Engineer-in-Charge or the BSCDCL shall be entitled to withhold and also have a lien to retain towards such claimed amount or amounts in whole or in part from any sum found payable to any partner/limited company, as the case may whether in his individual capacity or otherwise. BSCDCL shall have the right to cause an audit and technical examination of the works and the final bills of the contractor including all supporting vouchers, abstract, etc, to be made after payment of the final bill and if as a result of such audit and technical examination any sum is found to have been overpaid in respect of any work done by the contractor under the contract or any work claimed to have been done by him under the contract and found not to have been executed, the contractor shall be liable to refund the amount of over-payment and it shall be lawful for BSCDCL to recover the same from him in the manner prescribed in tender document of this clause or in any other manner legally permissible; and if it is found that the contractor was paid less than what was due to him under the contract in respect of any work executed by him under it, the amount of such under payment shall be duly paid by BSCDCL to the contractor, without any interest thereon whatsoever.

LIEN IN RESPECT OF CLAIMS IN OTHER CONTRACTS

Any sum of money due and payable to the contractor (including the security deposit returnable to him) under the contract may be withheld or retained by way of lien by the Engineer-in-Charge or by BSCDCL against any claim of the Engineer-in-Charge or BSCDCL in respect of payment of a sum of money arising out of or under any other contract made by the contractor with the Engineer-in-Charge or the BSCDCL. It is an agreed term of the contract that the sum of money so withheld or retained under this clause by the Engineer-in-Charge or the BSCDCL will be kept withheld or retained as such by the Engineer-in-Chargeor the BSCDCL or till his claim arising out of the same contract or any other contract is either mutually settled or determined by the competent court, as the case may be, and that the contractor shall have no claim for interest or damages whatsoever on this account or on any other ground in respect of any sum of money withheld or retained under this clause and duly notified as such to the contractor.

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

All items of work in the bill of quantities/ schedule of quantities shall be carried out as per the UADD (as the case may be) specifications, drawings and instructions of the Engineer-in-Charge of BSCDCL and the rates shall include for supply of required materials including proper storage, consumables, skilled & unskilled labour, supervision and tools, tackles, plant & machinery complete as called for in the detailed specifications and conditions of the contract. Latest updated UADD specification shall be followed for execution of work.

The contractor shall execute the whole and every part of the work in the most substantial and workman like manner both as regards materials and otherwise in every respect in strict accordance with the specifications.

The contractor shall also conform exactly, fully and faithfully to the design, drawings and instructions in writing in respect of the work assigned by the Engineer-in-Charge.

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

MATERIALS TO BE PROVIDED BY THE CONTRACTOR

The contractor shall, at his own expense, provide all materials, required including Cement & Steel for the works. The contractor shall at his own expense and without delay; supply to the Engineer-in-Charge samples of materials to be used on the work and shall get the same approved in advance. All such materials to be provided by the Contractor shall be in conformity with the specifications laid down or referred to in the contract.

The contractor shall, if requested by the Engineer-in-Charge furnish proof, to the satisfaction of the Engineer-in-Charge that the materials so comply.

The contractor shall at his risk and cost, submit the samples of materials to be tested or analyzed and bear all charges and cost of testing unless specifically provided for

otherwise elsewhere in the contract or specifications. The Engineer-in-Charge or his authorized representative shall at all times have access to the works and to all workshops and places where work is being prepared or from where materials, manufactured articles or machinery are being obtained for the works and the contractor shall afford every facility and every assistance and cost in obtaining the right and visit to such access. The Engineer-in-Charge shall have full powers to require the removal from the premises of all materials which in his opinion are not in accordance with the specifications and in case of default, the Engineer-in-Charge shall be at liberty to employ at the expense of the contractor, other persons to remove the same without being answerable or accountable for any loss or damage that may happen or arise to such materials. The Engineer-in-Charge shall also have full power to require other proper materials to be substituted thereof and in case of default, the Engineer-in-Charge may cause the same to the supplies and all costs which may require such removal and substitution shall be borne by the contractor

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MATERIALS AND SAMPLES

The materials/products used on the works shall be one of the approved make/ brands out of list of manufacturers / brands /makes given in the tender documents. The contractor shall submit samples/ specimens out of approved makes of materials/ products to the Engineer-in-Charge for prior approval. In exceptional circumstances Engineer-in-Charge may allow alternate equivalent makes/brands of products/ materials at his sole discretion. The final choice of brand / make shall remain with the Engineer- in-Charge, whose decision in this matter shall be final and binding and nothing extra on this account shall be payable to the Contractor. In case single brand/ make are mentioned, other equivalent makes/ brands may be considered by the Engineer-in-Charge. In case of variance in UADD Specifications from approved products/makes specification, the specification of approved product/make shall prevail for which nothing shall be paid extra to the Contractor. In case no make or brand of any materials, articles, fittings and accessories etc. is specified, the same shall comply with the relevant Indian Standard Specifications and shall bear the ISI/BIS mark. The Engineer of BSCDCL and the owner shall have the discretion to check quality of materials and equipment's to be incorporated in the work, at source of supply or site of work and even after incorporation in the work. They shall also have the discretion to check the workmanship of various items of work to be executed in this work. The contractor shall provide the necessary facilities and assistance for this purpose.

The above provisions shall not absolve the contractor from the quality of final product and in getting the material and workmanship quality checked and approved from the Engineer-in-Charge of BSCDCL.

The contractor shall well in advance, produce samples of all materials, articles, fittings, accessories etc. that he proposes to use and get them approved in writing by BSCDCL. The materials articles etc. as approved shall be *LABELLED* assuch and shall be signed by BSCDCL and the Contractor's representative.

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

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

The contractor shall set up and maintain at his cost, a field testing laboratory for all day to day tests at his own cost to the satisfaction of the Engineer-in-Charge. This field testing laboratory shall be provided with equipment and facilities to carry out all mandatory field tests as per UADD (as the case may be) specifications. The laboratory building shall be constructed and installed with the appropriate facilities, Temperature and humidity controls shall be available wherever necessary during testing of samples. All equipment's shall be provided by the Contractor so as to be compatible with the testing requirements specified. The Contractor shall maintain all the equipment's in good working condition for the duration of the contract. The Contractor shall provide approved qualified personnel to run the laboratory for the duration of the Contract. The number of staff and equipment available must at all times be sufficient to keep pace with the sampling and testing programmer as required by the Engineer-in-charge. The Contractor shall fully service the site laboratory and shall supply everything necessary for its proper functioning, including all transport needed to move equipment and samples to and from sampling points on the site, etc. The Contractor shall re-calibrate all measuring devices whenever so required by the Engineer-in-charge and shall submit the results of such calibration without delay. All field test shall be carried out in the presence of BSCDCL's representative. All costs towards samples, materials, collection, transport, manpower, testing etc. shall be borne by the Contractor and are deemed to be included in the rates quoted by him in the bill of quantities.
The contractor(s) shall display the calibration certificate of each equipment at the location of equipment & shall get recalibrated at least one week before its expiry date.

MATERIALS PROCURED WITH THE ASSISTANCE OF BSCDCL

If any material for the execution of this contract is procured with the assistance of BSCDCL either by issue from its stores or purchase made under orders or permits or licenses obtained by BSCDCL, the contractor shall hold and use the said materials economically and solely for the purpose of this contract and shall not dispose them without the permission of Engineer-in-charge. The contractor, if required by the BSCDCL, shall return all such surplus or unserviceable materials that may be left with him after the completion of the contract or at its termination on whatsoever reason, on being paid or credited such price as the Engineer-in-charge shall determine having due regard to the conditions of materials. The price allowed to the contractor, however, shall not exceed the amount charged to him excluding the element of storage charges which shall be 10% of the cost charged to contractor. The decision of the Engineer-in-charge shall be final and conclusive.

Contractor(s) has / have to deploy security personnel for safeguarding of materials procured at site.

CONTRACTOR TO SUPPLY TOOLS & PLANTS

The contractor shall provide at his own cost all materials, machinery, tools & plants as require for completion of work. In addition to this, appliances, implements, other plants, ladders, cordage, tackle, scaffolding and temporary works required for the proper execution of the work, whether original, altered or substituted and whether included in the specifications or other documents forming part of the contract or referred to in these conditions or not, or which may be necessary for the purpose of satisfying or complying with the requirements of the Engineer-in-Charge as to any matter as to which under these conditions he is entitled to be satisfied, or which he is entitled to require together with carriage therefore to and from the work. The contractor shall also supply without charge the requisite number of persons with the means and materials, necessary for the

purpose of setting out works, and counting, weighing and assisting the measurement or examination at any time and from time to time of the work or materials. Failing his so doing, the same may be provided by the Engineer-in-Charge at the expense of the contractor and the expenses may be deducted, from any money due to the contractor, under this contract or otherwise and/or from his security deposit or the proceeds of sale thereof, or of a sufficient portions thereof.

MOBILIZATION OF MEN, MATERIALS AND MACHINERY:

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

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

It shall be the responsibility of the contractor to obtain the approval for any revision and/or modification desired by him from BSCDCL before implementation.

The procurement and supply in sequence and at the appropriate time of all materials and consumable shall be entirely the contractor's responsibilities and his rates for execution of work shall be inclusive of supply of all these items.

It is mandatory for the contractor to provide safety equipment's and gadgets to his all workers, supervisory and Technical staff engaged in the execution of the work while working. The minimum requirement (but not limited to) shall be gum boots, safety helmets, Rubber hand gloves, face masks, safety nets, safety belts, goggles etc. as per work requirements. Sufficient nos. of these equipment's and gadgets shall also be provided to BSCDCL by the contractor at his own cost for use of BSCDCL Officials and/ or workforce while working/supervision of work at site. No staff/ worker shall be allowed to enter the site without these equipment's/ gadgets.

The cost of the above equipment's/ gadgets are deemed to be included in the rates quoted by the contractor for the items & works as per Bill of Quantities and contractor shall not be entitled for any extra payment in these regard. The above norm is to be strictly complied with at site. In case the contractor is found to be deficient in providing Safety Equipment's/ Gadgets in the opinion of Engineer-in-charge, the Engineer-in-charge at his option can procure the same at the risk & cost of contractor and provide the same for the use of worksite and shall make the recoveries from the bills of the contractor for the same. The contractor shall abide by all rules & regulations pertaining to Health, Safety and Environment.

All designs, drawings, bill of quantities, etc., except Bar Bending Schedule, Shop & Fabrication drawings, for all works shall be supplied to the contractor for their scope of work all buildings services and development works by BSCDCL in phased manner as the works progress. However it shall be the duty and responsibility of the contractor to bring to the notice of the BSCDCL in writing as to any variation, discrepancy or any other

changes required and to obtain revised drawings and designs and / or approval of the BSCDCL in writing for the same.

One copy of contract documents including drawings furnished to the contractor shall be kept at the site and the same shall at all reasonable times be available for inspection.

All materials, construction plants and equipment's etc. once brought by the contractor within the project area, will not be allowed to be removed from the premises without the written permission of the Engineer-in-charge. Similarly all enabling works built by the contractor for the main construction undertaken by him, shall not be dismantled and removed without the written authority of the BSCDCL.

Contractor shall have to prepare the Bar Bending Schedule, shop and fabrication drawings free of cost, if required for any of the items of work.

Five copies of these drawings each including for revision will be submitted to BSCDCL for approval. Before executing the item, shop drawings and bar bending schedule should be approved by BSCDCL.

BSCDCL shall supply Work Force in the various categories to assist the contractor in execution of the works on recoverable basis as per provision mentioned elsewhere in the contract.

All contractors' plant, machinery and equipment shall be kept in perfect condition during currency of the contract.

QUALITY ASSURANCE PROGRAMME

To ensure that the services under the scope of this contract are in accordance with the specifications, the Contractor shall adopt Quality Assurance Programme to control such activities at the necessary points:
The contractor shall prepare and finalize such Quality Assurance Programme within 15 days from date of issue Letter of Intent. BSCDCL shall also carryout quality audit and quality surveillance of systems and procedures of Contractor's quality control activities. A Quality Assurance Programmer of Contractor shall generally cover the following:

His organization structure for the management and implementation of the proposed Quality Assurance Program.

- Documentation control system.
- The procedure for purpose of materials and source inspection.
- System for site controls including process controls.
- Control of non-conforming items and systems for corrective actions.
- Inspection and test procedure for site activities.
- System for indication and appraisal of inspection status.
- System for maintenance of records.
- System for handling, storage and delivery.

A quality plan detailing out quality practices and procedures, relevant standards and acceptance levels for all types of work under the scope of this contract.

All the quality reports shall be submitted by the Contractors in the formats appended hereto. Checklist enclosed here in this document shall be followed while carrying out

Construction activities (items). If any item is not covered by the Checklist/ Formats appended hereto, the Format for the same may be developed and submitted to Engineer-in-Charge for approval and the same shall be adopted. These filled in formats shall be prepared in two copies and duly signed by representatives of contractor and BSCDCL. All the costs associate with Printing of Formats and testing of materials required as per technical specifications or by Engineer-in-charge shall be included in the Contractor's quoted rates in the Schedule/ Bill of quantities.

CONTRACT COORDINATION PROCEDURES, COORDINATION

MEETINGS AND PROGRESS REPORTING

The Contractor shall prepare and finalize in consultation with BSCDCL, a detailed contract coordination procedure within 15 days from the date of issue of Letter of Intent for the purpose of execution of the Contract. The Contractor shall have to attend all the meetings at any place in India at his own cost with BSCDCL, Owners/ Clients or Consultants of BSCDCL/ Owner/ Client during the currency of the Contract, as and when required and fully cooperate with such personal and agencies involved during these discussions. The Contractor shall not deal in any way directly with the Clients/ Owners or Consultants of BSCDCL/Owner/ Clients and any dealing/correspondence if required at any time with Clients/ Owners/ Consultants shall be through BSCDCL only. During the execution of the work, Contractor shall submit at his own cost a detailed Monthly progress & programme report to the Engineer-in-charge of BSCDCL by 5th of every month. The format of monthly progress & programme report shall be as approved by Engineer-in-Charge of BSCDCL.

COMPLETION CERTIFICATE AND COMPLETION PLANS

Within ten days of the completion of the work, the contractor shall give notice of such completion to the Engineer-in-Charge and within thirty days of the receipt of such notice, the Engineer-in-Charge shall inspect the work and if there is no defect in the work, shall furnish the contractor with a final certificate of completion, otherwise a provisional certificate of physical completion indicating defects (a) to be rectified by the contractor and/or (b) for which payment will be made at reduced rates, shall be issued. But no final certificate of completion shall be issued, nor shall the work be considered to be complete until the contractor shall have removed from the premises on which the work shall be executed all scaffolding, surplus materials, rubbish and all huts and sanitary arrangements required for his/their work people on the site in connection with the execution of the works as shall have been erected or constructed by the contractor(s) and cleaned off the dirt from all wood work, doors, windows, walls, floor or other parts of the building, in, upon, or about which the work is to be executed or of which he may have had possession for the purpose of the execution; thereof, and not until the work shall have been measured by the Engineer-in-Charge. If the contractor shall fail to comply with the requirements of this Clause as to removal of scaffolding, surplus materials and rubbish and all huts and sanitary arrangements as aforesaid and cleaning off dirt on or before the date fixed for the completion of work, the Engineer-in-Charge may at the expense of the contractor remove such scaffolding, surplus materials and rubbish etc., and dispose of the same as he thinks fit and clean off such dirt as aforesaid, and the contractor shall have no claim in respect of scaffolding or surplus materials as aforesaid except for any sum actually realized by the sale thereof less actual cost incurred on removal of materials / debris / malba etc.

The contractor shall submit completion plan as required vide General Specifications for Electrical works as applicable within thirty days of the completion of the work. In case, the contractor fails to submit the completion plan as aforesaid, he shall be liable to pay a

sum equivalent to 2.5% of the value of the work subject to a ceiling of Rs.5,00,000 (Rs. Five Lakhs only) as may be fixed by the Engineer-in-charge concerned and in this respect the decision of the Engineer-in-charge shall be final and binding on the contractor.

PROHIBITION OF UNAUTHORISED CONSTRUCTION & OCCUPATION

No unauthorized buildings, construction of structures should be put up by the contractor anywhere on the project site, neither any building built by him shall be occupied in un-authorized manner by him or his staff.

It shall be the responsibility of the contractor to see that the building under construction is not occupied by anybody in un-authorized manner during construction, and is handed over to the Engineer-in-Charge with vacant possession of complete building. If such building though completed is occupied illegally, then the Engineer-in-Charge shall have the option to refuse to accept the said building/buildings in that position. Any delay in acceptance on this account will be treated as the delay in completion and for such delay, a levy of compensation upto 5% of tendered value of work may be imposed by the Engineer-in-Charge whose decision shall be final both with regard to the justification and quantum and shall be binding on the contractor.

However, the Engineer-in-Charge, through a notice, may require the contractor to remove the illegal occupation any time on or before construction and delivery.

FORECLOSURE OF CONTRACT BY BSCDCL/OWNER

If at any time after the commencement of the work the BSCDCL shall for any reason whatsoever is required to abandon the work or is not require the whole work thereof as specified in the tender to be carried out, the Engineer-in-Charge shall give notice in writing of the fact to the contractor, who shall have no claim to any payment of compensation whatsoever on account of any profit or advantage which he might have derived from the execution of the work in full, but which he did not derive in consequence of the foreclosure of the whole or part of the works.

DEFECTS LIABILITY PERIOD

The contractor shall be responsible for the rectification of defects in the works for a period 3 years from the date of taking over of the works by the BSCDCL or clients whichever is later. Any defects discovered and brought to the notice of the contractor forthwith shall be attended to and rectified by him at his own cost and expense. In case the contractor fails to carry out these rectifications, the same may without prejudice to any other right or remedy available, be got rectified by BSCDCL at the cost and expense of the contractor.

TheContractorisexpectedtocarryouttheconstructionworkinWorkmenlikemannersoas to meetthe requirement and specification for the project. It isexpected that the Workmanshipandmaterialswillbereasonablyfitforthepurposeforwhichtheyarerequired.

Defectsordefectiveworkiswherestandardandqualityofworkmanship andmaterialsas specifiedinthecontractisdeficient. Defectisdefinedasafailureofthecompletedprojectto satisfytheexpress orimplied qualityorquantityobligations oftheconstruction contract. Defectiveconstructionworksareastheworkswhichfailshortof complyingwiththeexpress

descriptionsorrequirementsofthecontract,especiallyanydrawingsorspecificationswith any impliedtermsandconditionsastoits quality,workmanship,durability,aesthetic, performanceordesign. Defectsinconstructionprojectsareattributabletovariousreasons.

Someofthedefectsarestructuraldefectsresultsincracksorcollapseof faultydefective plumbing,inadequateorfaulty drainagesystem,inadequateorfaultyventilation,coolingor heatingsystems,inadequatefiresystemsetc. Thedefectscouldbevariousonaccountsof differentreasonsforvariety oftheprojects.

TheEngineeringIncharge/ProjectOfficershallissuethepracticalcompletioncertificatefor theproject. DuringtheDefectLiabilityPeriodwhichcommenceson completionofthework, theEngineeringIncharge shallinformorthecontractorisexpectedtobe informedofany defective works by the Employer's representative of the defects and make good at contractor'scostwithanintentionofgivingopportunitytothecontractorofmakinggoodthe defectsappearedduringthatperiod. Itisthecontractor'sobligationunderthecontractorrectify thedefectsthatappearduringDefectLiabilityPeriodandthecontractorshall withina reasonabletimeafterreceiptofsuchinstructionscomply with thesameat his owncost. The EngineeringIn charge/ProjectOfficershallissueacertificatetothateffectandcompletionof makinggooddefectsshallbedeemedforallthepurposeofthiscontracttohavetakenplace onthedaynamedinsuchdefectliabilitycertificate.

Ifdefectiveworkorworkmanshipordesignhavebeenknowinglycovered-uporconceivedsoastoconstitutefraud,commencementoftheDefectLiabilityPeriodmay bedelayed. The decidedperiod maybedelayeduntil**discover**actuallyoccursonatleastthedefectcould havebeendiscoveredwithreasonablediligence,whicheverisearlier.

Also,incaseofdefect,theEngineershallgivenoticetotheContractorofanyDefectsbefore theendof theDefectsLiabilityPeriod,whichbeginsat.TheDefectsLiabilityPeriodshallbe extendedforaslongasDefectsremaintobecorrected. EverytimenoticeofDefect/Defects isgiven,theContractorshallcorrectthenotifiedDefect/DefectswithinthedurationoF time specifiedbytheEngineer'snotice.TheEngineermayissuenoticetotheContractortocarry outremovalofdefectsordeficiencies, ifany,noticed inhisinspection, orbroughttohis notice.TheContractorshallremovethedefectsanddeficiencieswithintheperiodspecified inthenoticeandsubmittotheEngineeracompliancereport.

ItistheCompletionStagewhenthecontractorhascompletedall oftheworksandfixedallof thedefects thatwereonthe list ofissue byEngineer-in-charge. When thishappens, the engineer must issue a 'Certificate of Completion'. On theissue of 'Certificateof Completion','the'DefectLiabilityPeriod'starts.Thecontractoralsomustissuea'Certificatestateme nt'asanacknowledgmenttotheengineernotlaterthan14daysafterthe'Certificate ofCompletion'hasbeenissued.Duringthe'DefectLiabilityPeriod',thecontractorhasto obey allwritteninstructionsfromtheengineertocarryoutrepairsandfix anydefectswhich appearinthePermanentWorks.Ifthecontractordoesnot,duetohisownfaultsfinishthe repairworksorfixthedefectsby theendof'DefectLiabilityPeriod','the'DefectLiability Period'willcontinueuntilallworksinstructedbyengineerisdone.

RESTRICTION ON SUBLETTING

The contractor shall not sublet or assign the whole or part of the works except where otherwise provided, by the contract. The provision of labouron piece work basis shall not be deemed to be a subletting under this clause.

The contractor may entrust specialist items of works like MEP services, Water Proofing, interiors, landscaping etc. to the agencies specialized in the specific trade. The contractor shall give the names and details of such firm whom it is going to employ for approval of BSCDCL. These details shall include the expertise, financial status, technical manpower, equipment, resources and list of works executed and on hand of the specialist agency. Further, prior written approval is required from BSCDCL to deploy such agency / sub-contractor.

FORCE MAJEURE

Any delay in or failure to perform of either party, shall not constitute default so as to give rise to any claim for damages, to the extent such delay or failure to perform is caused by an act of God, or by fire, explosion, flood or other natural catastrophe, governmental legislation, orders or regulation etc. Failure of the client / owner to hand over the entire site and / or release funds for the project, to BSCDCL, shall also constitute force majeure. The time for performance of the obligation by the parties shall be deemed to be extended for a period equal to the duration of the force majeure event. Both parties shall make their best efforts to minimize the delay caused by the force majeure event. If the failure / delay of the client /owner in handing over the entire site and / or in releasing the funds continues even on the expiry of the stipulated date of completion, BSCDCL, may, at the request of the contractor, foreclose the contract without any liability to either party. In the event of such foreclosure, the contractor shall not be entitled to any compensation whatsoever. If prior to such foreclosure the contractor has brought any materials to the site, the Engineer-in-Charge shall always have the option of taking over of all such materials at their purchase price or at the local current rates, whichever is lower.

NO COMPENSATION CLAUSE

The contractor shall have no claim whatsoever for compensation or idle charges against BSCDCL on any ground or for any reason, whatsoever.

DIRECTION FOR WORKS

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

The Engineer-in-Charge and his representative shall communicate or confirmtheir instructions to the contractor in respect of the execution of work during their site inspection in a ‘Works Site Order Book’ maintained at the site office of Engineer-in-Charge. The contractor or his authorized representative shall confirm receipt of such instructions by signing against the relevant orders in the book.

WORK IN MONSOON AND RAIN

The execution of the work may entail working in the monsoon also. The contractor must maintain labour force as may be required for the job and plan and execute the construction and erection according to the prescribed schedule. No special/ extra rate will be considered for such work in monsoon. The contractors’ rate shall be considered inclusive of cost of

dewatering due to rains required if any and no extra rate shall be payable on this account. The stipulated period for completion of project includes the monsoon period, holidays & festivals.

WORK ON SUNDAYS, HOLIDAYS AND DURING NIGHT

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

WATER AND ELECTRICITY

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

LAND FOR LABOUR HUTS/SITE OFFICE & STORAGE ACCOMMODATION

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

The security deposit of the contractor shall be released only after contractor demolishes all structures including foundations and gives back clear vacant possession of this land In the event the contractor has to shift his labour campus at any time during execution of the work on the instructions of local authorities or as per the requirement of the work progress or as may be required by BSCDCL, he shall comply with such instructions at his cost and risk and no claim whatsoever shall be entertained on this account.

WATCH, WARD AND LIGHTING OF WORK PLACE

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

SCHEDULE OF QUANTITIES / BILL OF QUANTITIES

The quantities shown against the various items of work are only approximate quantities which may vary as per the actual requirement at site. No item which is not covered in the bill of quantities shall be executed by the Contractor without the approval of the BSCDCL. In case any Extra/Substituted item is carried out without specific-approval, the same will not be paid.

WATER PROOF TREATMENT

3.8 The water proof treatment shall be of type and specifications as given in the schedule of quantities.

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

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

The BSCDCL reserves the right to get the quality of treatment checked in accordance with recognized test methods and in case it is found that the **c**hemicals with the required concentration and rate of application have not been applied, or the water proofing treatment is not done as per specifications, the contractor will be required to do the re-treatment in accordance with the required concentration & specifications at no extra cost failing which no payment for such work will be made. The extent of work thus rejected shall be determined by BSCDCL.Water proofing shall be got done through approved / specialized agencies only with prior approval of Engineer-in-Charge.

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

During the execution of work, if any damage shall occur to the treatment already done, either due to rain or any other circumstances, the same shall be rectified and made good to the entire satisfaction of Engineer-In-Charge by the contractor at his cost and risk.

The contractor shall make his own arrangement for all equipment's required for the execution of the job. The contractor whose tender is accepted shall execute Guarantee Bond in the prescribed form as appended for guaranteeing the water proofing treatment.

INDIAN STANDARDS

Wherever any reference is made to any IS in any particular specifications, drawings or bill of quantities, it means the Indian Standards editions with up to date amendments issued till last date of receipt of tender documents.

CENTERING & SHUTTERING

Marine plywood or steel plates or any material mentioned elsewhere in the tender document or as approved by Engineer-in-Charge shall be used for formwork. The shuttering plates shall be cleaned and oiled before every repetition and shall be used only after obtaining approval of BSCDCL's Engineers at site. The number of repetitions allowed for plywood and steel shuttering shall be at the discretion of Engineer-in-Charge of BSCDCL depending upon the condition of shuttering surface after each use and the decision of Engineer-in-Charge in this regard shall be final and binding on the contractor. No claim whatsoever on this account shall be admissible.

RECORDS OF CONSUMPTION OF CEMENT & STEEL

For the purpose of keeping a record of cement and steel received at site and consumed in works, the contractor shall maintain a properly bound register in the form approved by the BSCDCL, showing columns like quantity received and used in work and balance in hand etc. This register shall be signed daily by the contractor's representative and BSCDCL's representative.

The register of cement & steel shall be kept at site in the safe custody of BSCDCL's Engineer during progress of the work. This provision will not, however, absolve the contractor from the quality of the final product.

In case cement or steel quantity consumed is lesser as compared to the

theoretical requirement of the same as per MORTH/UADD/MPPWD/CPWD (as the case may be) specifications/ norms, the work will be devalued and/ or a penal rate (i.e. double the rate at which cement/ steel purchased last) recovery for lesser consumption of cement/ steel shall be made in the item rates of the work done subject to the condition that the tests results fall within the acceptable criteria as per MORTH/UADD/MPPWD/CPWD (as the case may be) specifications otherwise the work shall have to be dismantled and redone by the contractor at no extra cost. In case of cement, if actual consumption is less than 98% of the theoretical consumption, a recovery shall be effected from the contractors bills at the penal rate for the actual quantity which is lower than 98% of theoretical consumption.

TESTS AND INSPECTION

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

WORKS TO BE OPEN TO INSPECTION

All works executed or under the course of execution in pursuance of this contract shall at all times be open to inspection and supervision of the BSCDCL. The work during its

progress or after its completion may also be inspected, by Chief Technical Examiner of Government of India (CTE) and/or an inspecting authority of State Government of State in which work is executed and/or by third party checks by owner/lients. The compliance of observations/improvements as suggested by the inspecting officers of BSCDCL/CTE/ State authorities/ Owners shall be obligatory on the part of the Contractor at the cost of contractor.

BORROW AREAS

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

3.9 CARE OF WORKS

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

CO-ORDINATION WITH OTHER AGENCIES

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

SETTING OUT OF THE WORKS

The contractor shall be responsible for the true and proper setting out of the works and for the correctness of the position, levels, dimensions and alignment of all parts of the works. If at any time during the progress of works, shall any error appear or arise in the position, levels, dimensions or alignment of any part of the works, the contractor shall at his own expenses rectify such error to the satisfaction of Engineer-in-charge. The checking of any setting out or of any line or level by the engineers of BSCDCL shall not in any way relieve the contractor of his responsibility for the correctness.

NOTICE BEFORE COVERING UP THE WORK

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

SITE CLEARANCE

The contractor shall ensure that the working site is kept clean and free of obstructions for easy access to job site and also from safety point of view. Before handing over the work to the BSCDCL the contractor shall remove all temporary structures like the site offices, cement go-down, stores, labour hutments etc., scaffolding rubbish, debris etc. left over materials tools and plants, equipment's etc., clean the site to the entire satisfaction of the Engineer-in-charge. If this is not done the same will be got done by BSCDCL at his risk and cost.

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

SET-OFF OF CONTRACTOR'S LIABILITIES

BSCDCL shall have the right to deduct or set off the expenses incurred or likely to be incurred by it in rectifying the defects and/or any claim under this agreement against the Contractor from any or against any amount payable to the contractor under this agreement including security deposit and proceeds of performance guarantee.

POSSESSION PRIOR TO COMPLETION

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

When the whole of the works or the items or the groups of items of work have been completed the contractor will give a notice to that effect to the Engineer in writing. The Engineer shall within 7 days of the date of receipt of such notice inspect the works and give instructions in writing to the contractor specifying the balance items of work which are required to be done by the contractor and shall also notify the contractor of any defect in the works affecting completion.

3.10 The contractor shall during the course of execution prepare and keep updated a complete set of 'as built' drawings to show each and every change from the contract drawings, changes recorded shall be countersigned by the Engineer-in-Charge and the contractor. Four copies of 'as built' drawings shall be supplied to BSCDCL by the contractor within 30 days of the completion. All costs incurred in this respect shall be borne by the contractor.

EMPLOYMENT OF PERSONNEL

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

In case BSCDCL observed misconduct negligence or incompetence etc. on the part of any representative, agent, servant and workmen or employees etc. of the contractor, the BSCDCL shall have full power and without giving any reason to the contractor, instruct the contractor to remove such engineer / staff / worker from site and provide suitable replacements. The decision of the Engineer-in-charge shall be final and binding on the contractor. The contractor shall not be allowed any compensation on this account.

TECHNICAL STAFF FOR WORK

The contractor shall employ at his cost the adequate number of technical staff during the execution of this work depending upon the requirement of work. For this purpose the numbers to be deployed, their qualification, experience as decided by BSCDCL shall be final and binding on contractor. The contractor shall not be entitled for any extra payment in this regard.

The technical staff should be available at site, whenever required by BSCDCL to take instructions.

Within 15 days of Letter of Intent, the contractor shall submit a site organizational chart and resume including details of experience of the Project-in-Charge and other staff proposed to be deputed by him and the technical team shall be deputed by them on the Project after getting approval from Engineer-in-Charge. If desired by the contractor at later date, the Project-in-Charge and other staff whose resume is approved by BSCDCL can be replaced with prior written approval of BSCDCL and replacement shall be with equivalent or superior candidate only. Decision of Engineer-in-Charge shall be final and binding on the contractor.

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

In case the contractor fails to employ the staff as aforesaid he shall be liable to pay a reasonable amount not exceeding a sum of Rs. 50,000(Rupees Fifty Thousand only) for each month of default in the case of each person. The decision of the Engineer-in-charge as to number of Technical Staff to be adequate for the project and the period for which the desired strength of technical staff was not employed by the contractor and as to the reasonableness of the amount to be deducted on this account shall be final and binding on the contractor as to the amount and the contractor's liability to pay the said amount.

VALUABLE ARTICLES FOUND AT SITE

All gold, silver and other minerals of any description and all precious stones, coins, treasure, relics, antiques and all other similar things which shall be found in, under or upon the site, shall be the property of the owner/ BSCDCL.

MATERIALS OBTAINED FROM DISMANTLEMENT TO BE OWNER'S

PROPERTY

All materials like stone, boulders and other materials obtained during the work of dismantling, excavation etc. will be considered BSCDCL/owner property and such materials shall be disposed off to the best advantage of BSCDCL/owner according to the instructions in writing issued by the Engineer-in-charge.

FURNISHED OFFICE ACCOMMODATION & MOBILITYCOMMUNICATION TO BE ARRANGED BY CONTRACTOR

On acceptance of tender, the contractor at his own cost will construct a suitably equipped office at site with basic facilities such as telephone(s), fax, internet, photocopier, computer(s) and printer(s) along with operator(s), regular electric & drinking water supply and and e-vehiclesfortheBSCDCL's staff / Engineer in Charge (EIC)withdriver,fuelandmaintenanceetc.as per the requirement of the project. The contractor shall maintain the aforesaid facilitiesintact/operational during the tenancy of the contract or maximum up to 6 months beyond the stipulated contractual completion date if the work is delayed due to any reasons. Operation and maintenance cost of all such materials, equipment's / services shall be borne by the contractor.
The contractor shall also make sufficient arrangement for photography/video-graphy so that photographs video can be taken of any specific activity at any point of time. The contractor shall also make arrangement of software like MS Project etc. for the purpose of preparing progress report etc.

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

LABOUR LAWS
LABOUR LAWS TO BE COMPLIED BY THE CONTRACTOR

The contractor shall obtain a valid license under the contract labour (Regulation & Abolition) Act 1970 and the contract labour Act (Regulation &Abolition) Central Rules 1971 and amended from time to time, and continue to have a valid license until the completion of the work including defect liability period. The contractor shall also adhere by the provision of the child labour (Prohibition and Regulation) Act. 1986 and as amended from time to time.

The contractor shall also comply with the provisions of the building and other Construction Workers (Regulation of Employment & Conditions of Service) Act, 1996 and the building and other Construction Workers Welfare Cess Act, 1996.

Any failure to fulfill above requirement shall attract the penal provisions of this contract arising out the resultant for non-execution of the work before the commencement of work. No labour below the age of 18 years shall be employed on the work.

Payment of wages:

The contractor shall pay to labour employed by him either directly or through subcontractors, wages not less than fair wages as defined in the BSCDCL Contractor's Labour Regulations or as per the provisions of the Contract Labour (Regulation and Abolition) Act, 1970 and the contract Labour (Regulation and Abolition) Central Rules, 1971, wherever applicable.

The contractor shall, notwithstanding the provisions of any contract to the contrary, cause to be paid fair wage to labour indirectly engaged on the work, including any labour engaged by his sub-contractors in connection with the said work, as if the labour had been immediately employed by him.

In respect of all labour directly or indirectly employed in the works for performance of the contractor's part of this contract, the contractor shall comply with or cause to be complied with the BSCDCL contractor's Labour Regulations in regard to payment of wages, wage period, deductions from wages recovery of wages not paid and deductions unauthorized made, maintenance of wage books or wage slips, publication of scale of wages and other terms of employment, inspection and submission of periodical returns and all other matters of the like nature or as per the provisions of the Contract Labour (Regulation and Abolition) Act, 1970, and the Contract Labour (Regulation and Abolition) Central Rules, 1971, wherever applicable.

(a) The Engineer-in-Charge concerned shall have the right to deduct from the moneys due to the contractor any sum required or estimated to be required for making good the loss suffered by a worker or workers by reason of non-fulfilment of the conditions of the contract for the benefit of the workers, non-payment of wages or of deductions made from his or their wages which are not justified by their terms of the contract or non-observance of the Regulations.

(b) Under the provision of Minimum Wages (Central) Rules, 1950, the contractor is bound to allow to the labours directly or indirectly employed in the works one day rest for 6 days continuous work and pay wages at the same rate as for duty. In the event of default, the Engineer-in-Charge shall have the right to deduct the sum or sums not paid on account of wages for weekly holidays to any labours and pay the same to the persons entitled thereto from any money due to the contractor by the Engineer-in-Charge concerned

The contractor shall comply with the provisions of the Payment of Wages Act, 1936, Minimum Wages Act, 1948, Employees Liability Act, 1938, Workmen's Compensation Act, 1923, Industrial Disputes Act, 1947, Maternity Benefits Act, 1961, and the Contractor's Labour (Regulation and Abolition) Act 1970, or the modifications thereof or any other laws relating thereto and the rules made there under from time to time.

The contractor shall indemnify and keep indemnified BSCDCL against payments to be made under and for the observance of the laws aforesaid and the BSCDCL Contractor's Labour Regulations without prejudice to his right to claim indemnity from his sub-contractors.

The laws aforesaid shall be deemed to be a part of this contract and any breach thereof shall be deemed to be a breach of this contract.

LABOUR SAFETY PROVISION

The contractor shall be fully responsible to observe the labour safety provisions:

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

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

OBSERVANCE OF LABOUR LAWS

The contractor shall be fully responsible for observance of all labour laws applicable including local laws and other laws applicable in this matter and shall indemnify and keep indemnified BSCDCL against effect or non observance of any such laws. The contractor shall be liable to make payment to all its employees, workers and sub-contractors and make compliance with labour laws. If BSCDCL or the client/ owner is held liable as "Principal Employer" to paycontributions etc. under legislation of Government or Court decision in respect of the employees of the contractor, then the contractor would reimburse the amount of such payments, contribution etc. to BSCDCL and/ or same shall be deducted from the payments, security deposit etc. of the contractor.

The Contractor shall submit proof of having valid EPF registration certificate. He shall within 7 days of the close of every month, submit to BSCDCL a statement showing the recoveries of contributions in respect of each employee employed by or through him and shall furnish to BSCDCL such information as the BSCDCL is required to furnish under the provisions of para 36 B of the EPF scheme 1952 to the EPF authorities and other information required by EPFO authorities from time to time. He shall also submit a copy of challan every month in token of proof of having deposited the subscription and contribution of workers engaged on the project.

In case, the contractor is not complying the above provision BSCDCL shall withhold payment to the extent of 4.70% (Four point Seven Zero percent) of the value of the Running Account bill and shall release only after the submission of above mentioned details. If it is incumbent upon BSCDCL to deposit withhold amount with EPF authorities, the withhold amount shall be deposited by BSCDCL with EPF authorities. In such a case BSCDCL shall not refund this withheld amount to the contractor even after the production of EPF registration certificate.

MINIMUM WAGES ACT

The contractor shall comply with all the provisions of the minimum wages Act, 1948, contract labour Act (Regulation & Abolition) 1970, and rules framed there under and other labour laws/local laws affecting contract labour that may be brought into force from time to time.

LABOUR CESS

The rates of the contractor shall be inclusive of labour cess. BSCDCL shall make a recovery @ 1% on account of labour cess from each RA bill of the contractor and labour cess so recovered/deducted shall be deposited with the Labour Board of the concerned state. In case the Labour Board is not established in the state, recovery made by BSCDCL on account of labour cess shall be retained under suspense account and will

be deposited with the Labour Board at later date as & when the Labour Board is constituted in the state.
Every contractor, sub-contractor, affiliates, their legal assigns or heirs as the case may, shall be responsible for registration of every Building worker who has completed eighteen years of age but has not completed sixty years of age and who has been engaged in any Building or Other Construction Work for not less than Ninety Days during the preceding twelve months; with the Board / Funds as applicable under various sections of "THE BUILDINGS AND OTHER Construction workers (regulation of employment and conditions of service) act, 1996 and the building and other Construction workers' welfare cess act, 1996.

The contractor shall also be responsible for maintaining register of beneficiaries i.e. the workers in such form as may be prescribed by the competent authority & the same shall be kept open at all reasonable times for inspection of relevant authority and officials of client / BSCDCL.

The contractor shall be further responsible for maintaining such register & records; giving such particulars of Building workers employed by him, the work performed by them, the number of hours of work which shall constitute a normal working day, the wages paid to them, the receipts given by them and, such other particulars in such form as may be prescribed by the authority or BSCDCL.

In the event of contractor failing to comply with the above clause(s) in part or in full, BSCDCL, without prejudice to any other rights or remedy available under law or any other clause(s) of contract, shall be at absolute liberty to forfeit any sum or sums that are payable or could become payable on account of execution of contract work and decision of Engineer-in-charge shall be final & binding in this regard on the contractor.

RECOVERY OF COMPENSATION PAID TO WORKMEN

In every case in which by virtue of the provisions sub-section (1) of Section 12, of the Workmen's Compensation Act, 1923, BSCDCL is obliged to pay compensation to a workman employed by the contractor, in execution of the works, BSCDCL will recover from the contractor, the amount of the compensation so paid; and, without prejudice to the rights of the BSCDCL under sub-section (2) of Section 12, of the said Act, BSCDCL shall be at liberty to recover such amount or any part thereof by deducting it from the security deposit or from any sum due to the contractor whether under this contract or otherwise. BSCDCL shall not be bound to contest any claim made against it under sub-section (1) of Section 12, of the said Act, except on the written request of the contractor and upon his giving to BSCDCL full security for all costs for which BSCDCL might become liable in consequence of contesting such claim.

ENSURING PAYMENT AND AMENITIES TO WORKERS IF CONTRACTOR FAILS

In every case in which by virtue of the provisions of the Contract Labour (Regulation and Abolition) Act, 1970, and of the Contract Labour (Regulation and Abolition) Central Rules, 1971, BSCDCL is obliged to pay any amounts of wages to a workman employed by the contractor in execution of the works, or to incur any expenditure in providing welfare and health amenities required to be provided under the above said Act or under the BSCDCL Contractor's Labour Regulations, or under the Rules framed by

Government from time to time for the protection of health and sanitary arrangements for workers employed by BSCDCL's Contractors, BSCDCL will recover from the contractor, the amount of wages so paid or the amount of expenditure so incurred; and without prejudice to any other right or remedy available under this contract, BSCDCL shall be at liberty to recover such amount or any part thereof by deducting it from the security deposit or from any sum due by BSCDCL to the contractor whether under this contract or otherwise BSCDCL shall not be bound to contest any claim made against it under sub-section (1) of Section 20, sub-section (4) of Section 21, of the said Act, except on the written request of the contractor and upon his giving to the BSCDCL full security for all costs for which BSCDCL might become liable in contesting such claim.

CHANGE IN FIRM'S CONSTITUTION TO BE INTIMATED

Where the contractor is a partnership firm, the prior approval in writing of the Engineer-in-Charge shall be obtained before any change is made in the constitution of the firm. Where the contractor is an individual or a Hindu undivided family business concern such approval as aforesaid shall likewise be obtained before the contractor enters into any partnership agreement where under the partnership firm would have the right to carry out the works hereby undertaken by the contractor. If prior approval as aforesaid is not obtained, the contract shall be deemed to have been assigned in contravention as per conditions of tender document hereof and the same action may be taken, and the same consequences shall ensue as provided in the said conditions of contract.

INDEMNITY AGAINST PATENT RIGHTS

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

LAW COVERING THE CONTRACT

This contract shall be governed by the Indian laws for the time being in force.

LAWS, BYE-LAWS RELATING TO THE WORK

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

CONTRACT AGREEMENT

The Contractor shall enter into a Contract Agreement with the BSCDCL within 10 (TEN) days from the date of Letter of Intent or within such extended time, as may be granted by the BSCDCL failing which no payment shall be released to the contractor. The cost of stamp papers, stamp duty, registration, if applicable on the contract, shall be borne by the Contractor. In case, the contractor does not sign the agreement as above or start the work within 10 (Ten) days of the issue of Letter of Intent, his earnest money is liable to be forfeited and Letter of Intent consequently will stand withdrawn.

MANNER OF EXECUTION OF AGREEMENT

The agreement as per prescribed Performa as enclosed shall be signed at the office of the BSCDCL within 10(TEN days) days from the date of issue of Letter of Intent. The Contractor shall provide for signing of the Contract, appropriate Power of Attorney and the requisite documents/ materials. Unless and until a formal contract is prepared and executed, the Letter of Intent read in conjunction with the Tendering Documents will constitute a binding contract.

The agreement will be signed in five originals and the Contractor shall be provided with one signed original and the other four originals will be retained by the BSCDCL

The Contractor shall provide free of cost to the BSCDCL all the Engineering data, drawings and descriptive materials submitted along with the tender, in at least three (3) copies to form an integral part of the Agreement within seven 7 days after issuing of Letter of Intent.

Subsequent to signing of the Agreement, the Contractor at his own cost shall provide to the BSCDCL with at least five (5) true hard bound copies of Agreement within thirty (30) days of its signing.

JURISDICTION

The agreement shall be executed at BHOPAL on non-judicial stamp paper purchased in BHOPAL and the courts in BHOPAL alone will have jurisdiction to deal with matters arising there from, to the exclusion of all other courts.

ARBITRATION

1. Arbitration Procedure:

If the efforts, to resolve all or any of the disputes through conciliation fail, then such a dispute shall be referred within 30 days from conclusion of conciliation process to a Sole Arbitrator who would be nominated by Executive Director Bhopal Smart City Development Corporation Limited, Bhopal. The arbitration and conciliation act 1996 as amended from time to time will be applicable. The venue of such arbitration shall be at Bhopal. The award of the sole Arbitrator shall be binding on all parties. The cost of Arbitration shall be borne by the respective parties. There will be no objections if the sole arbitrator nominated or appointed is an employee of BSCDCL.

2. The place of arbitration shall be Bhopal, M.P.

3. English Language

The request for arbitration, the answer to the request, the terms of reference, any written submissions, any orders and awards shall be in English and, if oral hearings take place, Englishshall be the language to be used in the hearings. The award shall be made in writing.

4. Enforcement of Award

The Parties agree that the decision or award, which shall be a speaking order, resulting from arbitration shall be final and binding upon the Parties and shall be enforceable in accordance with

the provision of the Arbitration and Conciliation Act 1996 subject to the rights of the aggrieved parties to secure relief from any higher forum.

5. Performance during Arbitration

The Arbitration Proceedings shall be governed by Indian Arbitration and Conciliation Act 1996, as amended from time to time including provisions in force at the time the reference is made. Pending the submission of and/or decision on a Dispute and until the arbitral award is published; the Parties shall continue to perform their respective obligations under this Agreement without prejudice to a final adjustment in accordance with such award. The courts at Bhopal shall have the sole exclusive jurisdiction to try all the cases arising out of this agreement.

6. Notices

That any notice under the terms of this License shall be in writing by registered post or delivered personally and signed by the party or his/its duly authorized representative giving such notice. All activities including day to day management, billing, termination etc. will be carried out from the office of the CEO, Smart City Development Corporation Limited Bhopal or by his duly authorized representative. Notice shall be addressed as follows:

Chief Executive Officer

SECTION-4

LABOUR SAFETY, HEALTH AND REGULATIONS INCLUDING FORMS

LABOUR SAFETY PROVISIONS

Suitable scaffolds should be provided for workmen for all works that cannot safely be done from the ground, or from solid construction except such short period work as can be done safely from ladders. When a ladder is used an extra mazdoor shall be engaged for holding the ladder and if the ladder is used for carrying materials as well, suitable footholds and hand holds shall be provided on the ladder and the ladder shall be given an inclination not steeper than ¼ to 1 (1/4 horizontal and 1 vertical).

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

Working platforms, gangways, and stairways should be so constructed that they should not sag unduly or unequally, and if the height of the platform or the gangway or the stairway is more that 3.6m (12 feet) above ground level or floor level, they should be closely boarded, should have adequate width & should be suitable fastened as described in (2.0) above.
Every opening in the floor of a building or in a working platform shall be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be 90 cm (3 feet).

Safe means of access shall be provided to all working platforms and other working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9m. (30 feet) in length while the width between side rails in rung ladder shall in no case be less than 29 cm. (11.5”) for ladder up to and including 3m (10 feet) in length. For longer ladders this width should be increased at least 1/4" for each additional 30 cm (1 ft.) of length. Uniform step spacing shall not exceed 30 cm (12"). Adequate precautions shall be taken to prevent danger from electrical equipment. No materials on any of the sites of the work shall be so stacked or placed as to cause danger or inconvenience to any person or the public. The contractor shall provide all necessary fencing and lights to protect the public from accident, and shall be bound to bear the expenses of defense of every suit, action or other proceeding at law that may be brought by any person for injury sustained owing to neglect of the above precautions and to pay any damages and cost which may be awarded in any such suit, action or proceedings to any such person or which may, with the consent of the Contractor, be paid to compensate any claim by any such person.

EXCAVATION AND TRENCHING

All trenches, 1.2mts.(four feet) or more in depth, shall at all times be supplied with at least one ladder for each 30m.(100 feet) in length or fraction thereof, ladder shall be extended from bottom of the trench to at least 90cm (3feet) above the surface of the ground. The side of the trenches, which are 1.5 m. (5feet) or more in depth shall be stepped back to give suitable slope or securely held by timber bracing, so as to avoid the danger or sides to collapsing. The excavated materials shall not be placed within 1.5m (5 feet) of the edges of the trench or half of the depth of the trench whichever is more.

Cutting shall be done from top to bottom. Under no circumstances undermining or undercutting shall be done.

Demolition - Before any demolition work is commenced and also during the progress of the work following precautions shall be observed:

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

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

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

All necessary personal safety equipment's as considered adequate by the Engineer-in-charge should be kept available for the use of persons employed on the site and maintained in a condition suitable for immediate use, and the contractor should take adequate step to ensure proper use of equipment by those concerned. The following safety equipment shall be invariably provided.

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

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

4.1 Those engaged in welding works shall be provided with welders protective eye shields.

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

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

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

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

Before entry, presence of Toxic gases should be tested by inserting wet lead acetate paper which changes color in the presence of such gases and gives indication of their presence. Presence of Oxygen should be verified by lowering a detector lamp into the manhole. In case, no Oxygen is found inside the sewer line, workers should be sent only with Oxygen kit.

Safety belt with rope should be provided to the workers. While working inside the manholes such rope should be handled by two men standing outside to enable him to be pulled out during emergency.

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

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

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

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

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

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

The workers engaged for cleaning the manholes / sewers should be properly trained before allowing to work in the manhole.

The workers shall be provided with Gumboots or non sparking shoes, bump helmets and gloves non sparking tools, safety lights and gas masks and portable air blowers (when necessary). They must be supplied with barrier cream for anointing the limbs before working inside the sewer lines.

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

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

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

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

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

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

4.1.3 Overalls shall be supplied by the Contractor to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.

4.1.4.1 a) White lead, sulphate or lead work products containing those pigments shall not be used in painting operation except in the form of paste or of paints ready for use. Measures shall be taken whenever required in order to prevent danger arising from the application of paint in the form of spray.

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

b) Adequate facilities shall be provided to enable working painter to wash during and on cessation of work.
c) Suitable arrangements shall be made to prevent clothing put off during working hours being spoiled by painting materials.

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

The BSCDCL may require when necessary a medical examination of workers.

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

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

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

b) These shall be of good mechanical construction, sound material and adequate strength and free from patent, defects and shall be kept in good working order. Every rope used in hoisting or lowering materials or as a means of suspension shall be of durable quality and adequate strength, and free from patent defects.

Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years should be in-charge of any hoisting machine including any scaffolding, winch or giving signals to operator.

In case of every hoisting machine and of every chain ring hook, shackle swivel and pulley block used in hoisting or as means of suspension the safe working load shall be ascertained by adequate means. Every hoisting machine and all gear referred to above shall be plainly marked with the safe working load. In case of a hoisting machine having a variable safe working load, each safe working load and the conditions under which it is applicable shall be clearly indicated. No part of any

machine or any gear referred to above in this clause shall be loaded beyond the safe working load except for the purpose of testing.

In case of BSCDCL machines, the safe working load shall be notified by the Engineer-in-Charge. As regards Contractor's machines the Contractor shall notify the safe working load of the machine to the Engineer-in-charge whenever he brings any machinery to site of work and get verified by the Engineer-in-Charge.

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

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

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

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

Notwithstanding the above Clauses from (i) to (xiv) there is nothing in these to exempt the contractor from the operations of any other Act or Rule in force in the Republic of India.

In Addition the Contractor shall also follow Safety and Health policy attached with the tender document

SECTION-5

FORMS AND FORMATS

Appendix - 'N'

PROFORMAS:PROFORMA

-I

Thelistof similar works as stated in the Minimum Qualification requirement for Bidders for Experience in High rise Building and Similar Works – Clause I

PROFORMA-I					
Sr.No.	NameoftheProject	Name of the employer	Stipulated date ofcompletion	Actual date of completion	Actual Cost of work done
1	2	3	4	5	6

NOTE:

Scanned Attested copies of completion/performance certificates from the Engineer-in-Chargeforeachworkshouldbe annexedinthesupportofinformationfurnishedintheabove proforma.

Worksshallbegroupedfinancialyear-wise.

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PROFORMA-II

YearlyturnoverofCivilEngineeringConstructionWorksduringthelast threeyears.

PROFORMA-II					
Sr.No.	Financialyear	Annual Turnover of Civil EngineeringWorks	Updated value to currentyear	Average of last 3years	PageNo.
1					
2					
3					
Total					

NOTE: Theabovefiguresshalltallywiththeauditedbalancesheetsuploadedby the BiddersdulycertifiedbyCharteredAccountant.

FORM XXV

DETAILS OF THE BALANCE WORK IN HAND AS ON_____

(UPTO THE PRECEDING MONTH OF SUBMISSION OF BID) WITH BSCDCL

(To be submitted in Envelop-1)

S. No	Name of the Unit/Zone/SBG/RGB	Contract Value	Date of start as per LOI/ Contract	Date of completion as per LOI /Contract	Work done up to the preceding month of submission of bid	Balance value of work

Note: The bidder shall also include the value of all such works which are awarded tobidder but yet not started up to the preceding month of submission of bid.

Appendix - 'O'

FORM XXVI

AFFIDAVIT

(To be submitted by bidder on non-judicial stamp paper of Rs. 100/- (Rupees Hundred only) duly attached by Notary Public)

(To be submitted in Envelop-1)

Affidavit of Mr. .....S/o .....

R/o .....

I, the deponent above named do hereby solemnly affirm and declare as under:

That I am the Proprietor/Authorized signatory of M/s ……..

Having its Head Office/Regd. Office at ……..

That the information/documents/Experience certificates submitted by M/s……. along with the tender for …… *(NAME OF WORK*)……

To BSCDCL Ltd. are genuine and true and nothing has been concealed.

I shall have no objection in case BSCDCL verifies them from issuing authority (ies). I shall also have no objection in providing the original copy of the document(s), in case BSCDCL demand so for verification.

I hereby confirm that in case, any document, information & / or certificate submitted by me found to be incorrect / false / fabricated, BSCDCL at its discretion may disqualify / reject / terminate the bid/contract and also forfeit the EMD / All dues.

I shall have no objection in case BSCDCL verifies any or all Bank Guarantee(s) under any of the clause(s) of Contract including those issued towards EMD and Performance Guarantee from the Zonal Branch /office issuing Bank and I/We shall have no right or claim on my submitted EMD before BSCDCL receives said verification.

That the Bank Guarantee issued against the EMD issued by (name and address of the Bank) is genuine and if found at any stage to be incorrect / false / fabricated, BSCDCL shall reject my bid, cancel pre-qualification and debar me from participating in any future tender for three years.

I, ..., the Proprietor / Authorised signatory of M/s..... do hereby confirm that the contents of the above Affidavit are true to my knowledge and nothing has been concealed there from..... and that no part of it is false.

Verified at ..... this..... day of .....

DEPONENT

ATTESTED BY (NOTARY PUBLIC)

APPLICATION FOR EXTENSION OF TIME

(To be completed by the Contractor)

P A R T –I

Name of Contractor

Name of the work as given in the Agreement

Agreement No.

Estimated amount put to tender

Date of commencement work as per agreement

Period allowed for completion of work as per agreement

Date of completion stipulated as per agreement

Period for which extension of time has been give previously

Extension granted

First extension vide Engineer-in-charge letter No… ……date	Months	Days
2nd extension vide Engineer-in-charge letter No…… date	Months	Days
3rd extension vide Engineer-in-charge letter No……. date	Months	Days
4th extension vide engineer-in-charge letter No……. date	Months	Days

Total extension previously given

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

Period for which extension is applied for:

Hindrances on account of which extension is applied for with dates on which hindrances occurred, and the period for which these are likely to last.

Serial No.

Nature of hindrance

Date of Occurrence

Period for which it is likely to last

Period for which extension required for this particular hindrance.

Over lapping period, if any, with reference to item

Net extension applied for

Remarks, if any

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

Extension of time required for extra work.

Details of extra work and on the amount involved:

Total value of extra work

Proportionate period of extension of time based on estimated amount put to tender on account of extra work.

Total extension of time required for 11 & 12

Submitted to the Engineer-in-Charges office.

SIGNATURE OF
CONTRACTOR

DATE

APPLICATION FOR EXTENSION OF TIME

(PART – II)

Date of receipt of application from Contractor for the work in the Engineer-in-charge office.

Acknowledgement issued by Engineer-in-charge vide his letter No.dated

Engineer-in-charge remarks regarding hindrances mentioned by the Contractor.

Serial No.

Nature of hindrance

Date of occurrence of hindrance

Period for which hindrance, is likely to last

Extension of time period applied for by the contractor

Over lapping period, if any, giving reference to items which over lap

Net period for which extension is recommended.

Remarks as to why the hindrance occurred and justification for extension recommended.

Engineer-in-charge recommendations.

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

SIGNATURTE OF ENGINEER-IN-CHARGE

PROFORMA FOR EXTENSION OF TIME

P A R T –III

To

NAME

ADDRESS OF THE CONTRACTOR

SUBJECT:

Dear Sir(s)

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

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

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

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

Yours faithfully,

FOR Bhopal Smart City Development Corporation Ltd.

PROFORMA OF BANK GUARANTEEIN LIEU OF E M D (TENDER BOND)

(Judicial Stamp paper of appropriate value as per stamp Act-of respective state)

Bhopal Smart City Development Corporation Ltd.

Near Tatpar Petrol Pump, Sector A, Berkheda,

Bhopal, Madhya Pradesh 462023

In consideration of Bhopal Smart City Development Corporation Limited, having its Registered Office at, Near Tatpar Petrol Pump Sector A, Berkheda (hereinafter called "BSCDCL" which expression shall unless repugnant to the subject or context include its successors and assigns) having issued Notice Inviting Tender No..... and M/s..... having its Registered Head Office at..... (hereinafter called the "TENDERER") is to participate in the said tender for.....

Whereas BSCDCL, as a special case, has agreed to accept an irrevocable and unconditional Tender Bond Guarantee for an amount of Rs..... valid upto.....from the tenderer in lieu of Cash Deposit of Rs..... required to be made by the tenderer, as a condition precedent for participation in the said tender.

We the ..... (hereinafter called the "BANK") having its Registered, Office at..... and branch office at..... do hereby unconditionally and irrevocably undertake to pay immediately on demand in writing and without demur/protest any amount but not exceeding Rs ..... Any such demand made by BSCDCL shall be conclusive and binding on us irrespective of any dispute or differences that may be raised by the tenderer. Any change in the constitution of the tenderer or the Bank shall not discharge our liability under the guarantee.

We, the..... Bank, lastly undertake not to revoke this guarantee during its currency without the prior consent of BSCDCL in writing and this guarantee shall remain valid upto.....Unless a claim is made within three months from the date of expiry i.e.

..... (three months after the date of expiry), we shall be relieved of our liability

under this guarantee thereafter.

FOR AND ON BEHALF OF BANK

PLACE :

DATED :

WITNESS.

1.

2

PROFORMA OF BANK GUARANTEE (PERFORMANCE)

(Judicial Stamp paper of appropriate value as per stamp Act-of respective state)

Bhopal Smart City Development Corporation Ltd.

Near Tatpar Petrol Pump, Sector A, Berkheda,

Bhopal, Madhya Pradesh 462023

Whereas the Bhopal Smart City Development Corporation Limited, having its Registered Office at BSCDCL Near Tatpar Petrol Pump Sector A, Berkheda, Bhopal (hereinafter called "BSCDCL" which expression shall include its successors and assigns) having awarded a work order/contract / supply order No. dated (hereinafter called the contract) to M/s. .... (hereinafter called the contractor / supplier) at a total price of Rs..... subject to the terms and conditions contained in the contract.

WHEREAS, the terms and conditions of the contract require the contractor to furnish a

bank guarantee for Rs.... .... (Rupees..... .....) being ..... % of the total value of the contract for proper execution and due fulfillment of the terms and conditions contained in the contract.

We, the Bank, (hereinafter called the "Bank") do hereby unconditionally and irrevocably undertake to pay to BSCDCL immediately on demand in writing and without protest/or demur all moneys payable by the contractor/supplier to BSCDCL in connection with the execution/supply of and performance of the works/equipment, inclusive of any loss, damages, charges, expenses and costs caused to or suffered by or which would be caused to or suffered by BSCDCL by

reason of any breach by the contractor/supplier of any of the terms and conditions contained in the contract as specified in the notice of demand made by BSCDCL to the bank. Any such demand made by BSCDCL on the bank shall be conclusive evidence of the amount due and payable by the bank underthis guarantee. However, the Bank's liability under this guarantee, shall be limited to Rs..... in the aggregate and the bank hereby agrees to the following terms and conditions:-

(i) This guarantee shall be a continuing guarantee and irrevocable for all claims of BSCDCL as specified above and shall be valid during the period specified for the performance of the contract including the period of maintenance/warranty i.e. up to.....

(ii) We, the said bank further agree with BSCDCL that BSCDCL shall have the fullest liberty without our consent and without affecting in any manner our obligations and liabilities hereunder to vary any of the terms and conditions of the said contract or to extend time for performance of contract by the contractor from time to time or to postpone for any time or from time to time any of the powers exercisable by BSCDCL against the contractor/supplier under the contract and forbear or enforce any of the terms and conditions relating to the said contract and we shall not be relieved from our liability by reason of any such variations or extension being granted tothe contractor or for any forbearance, act or omission on the part of BSCDCL or any indulgence by BSCDCL to the contractor or by any such matter or thing whatsoever, which under the law relating to the sureties would, but for this provision, have effect of so relieving us.

This guarantee/undertaking shall be in addition to any other guarantee or security whatsoever BSCDCL may now or at any time have in relation to the performance of the works/equipment and the company shall have full re-course to or enforce this security in performance to any other security or guarantee which the BSCDCL may have or obtained and there shall be no forbearance on

the part of the company in enforcing or requiring enforcement of any other security which shall have the effect of releasing the Bank from its full liability. It shall not be necessary for BSCDCL to proceed against the said contractor/supplier before proceeding against the Bank.

This guarantee/ undertaking shall not be determined or affected by the liquidation or winding up, dissolution or change of constitution or insolvency of the supplier/ contractor, but shall in all respects and for all purposes be binding and operative until payment of all moneys payable to BSCDCL in terms thereof are paid by the Bank.

The Bank hereby waives all rights at any time inconsistent with the terms of this Guarantee and the obligations of the bank in terms hereof, shall not be otherwise effected or suspended by reasons of any dispute or disputes having been raised by the supplier/contractor (whether or not pending before any Arbitrator, Tribunal or Court) or any denial of liability by the supplier/contractor stopping or preventing or purporting to stop or prevent any payment by the Bank to BSCDCL in terms hereof.

We, the said Bank, lastly undertake not to revoke this guarantee during its currency except with the previous consent of BSCDCL in writing. Unless a claim is made in writing

within three months from the date of expiry of this guarantee i.e.....

(three months after the date of expiry) we shall be relieved from all liabilities under this guarantee thereafter.

Signed this ..... day of ..... at…….

For and on behalf of Bank

WITNESS.

1._____

__

2._____

PROFORMA OF BANK GUARANTEE

(FOR MOBILIZATION ADVANCE)

(Judicial Stamp paper of appropriate value as per stamp Act-of respective state)

Bhopal Smart City Development Corporation Limited,

Near Tatpar Petrol Pump, Sector A, Berkheda,

Bhopal, Madhya Pradesh 462023

1.0 In consideration of the Bhopal Smart City Development Corporation Limited, having its Registered Office at BSCDCL, Near Tatpar Petrol Pump, Sector A, Berkheda, Bhopal (hereinafter called "BSCDCL" which expression shall unless repugnant to the subject or context include his successor and assigns) having agreed under the terms and conditions of Contract No..... dated..... made between..... and BSCDCL in connection with..... (hereinafter called "the said contract") to make at the request of the Contractor a Mobilization Advance of Rs..... for utilizing it for the purpose of the Contract on his furnishing a guarantee acceptable to BSCDCL, we the ..... Bank Ltd., (hereinafter referred to the "the said Bank") and having our registered office at..... do hereby guarantee the due recovery by BSCDCL of the said advance as provided according to the terms and conditions of the Contract. We..... do hereby undertake to pay the amount due and payable under this Guarantee without any demur, merely on a demand from BSCDCL stating that the amount claimed is due to BSCDCL under the said Agreement. Any such demand made on the..... shall be conclusive as regards the amount due and payable by the..... under this guarantee and..... agree that the liability of the ..... to pay BSCDCL the amount so demanded shall be absolute and unconditional notwithstanding any dispute or disputes raised by the Contractor and notwithstanding any legal proceeding pending in any court or Tribunal relating thereto. However, our liability under this Guarantee shall be restricted to an amount not exceeding Rs..... We ……. Bank further agree that BSCDCL shall be the sole judge of and as to whether the amount claimed has fallen due to BSCDCL under the said agreement or whether the said Contractor has not utilized the said advance or any part thereof for the purpose of the Contract and the extent of loss or damage caused to or suffered by BSCDCL on account of the said advance together with interest not being recovered in full and the decision of BSCDCL that the amount has fallen due from contractor or the said Contractor has not utilized the said advance or any part thereto for the purpose of the contract and as to the amount or amounts of loss or damage caused to or suffered by BSCDCL shall be final and binding on us.

We, the said Bank, further agree that the Guarantee herein contained shall remain in full force and effect till the said advance has been fully recovered and its claims satisfied or discharged and till BSCDCL certify that the said advance has been fully recovered from the said Contractor, and accordingly discharges this Guarantee

subject, however, that BSCDCL shall have no claims under this Guarantee after the said advance has been fully recovered, unless a notice of the claims under this Guarantee has been served on the Bank before the expiry of the said Bank Guarantee in which case the same shall be enforceable against the Bank.

BSCDCL shall have the fullest liberty without affecting in any way the liability of the Bank under this Guarantee or indemnity from time to time to vary any of the terms and conditions of the said Contract or the advance or to extend time of performance by the said Contractor or to postpone for any time and from time to time of the powers exercisable by it against the said Contractor and either to enforce or forbear from enforcing any of terms and conditions governing

the said Contract or the advance or securities available to BSCDCL and the said Bank shall not be released from its liability under these presents by any exercise by BSCDCL of the liberty with reference to the matters aforesaid or by reasons of time being given to the said Contractor or any other forbearance, act or omission on the part of BSCDCL or any indulgence by BSCDCL to the said Contractor or of any other matter or thing whatsoever which under the law relating to sureties would but for this provision have the effect of so releasing the bank from its such liability. 5.0 It shall not be necessary for BSCDCL to proceed against the Contractor before proceeding against the Bank and the Guarantee herein contained shall be enforceable against the Bank notwithstanding any security which BSCDCL may have obtained or obtain from the Contractor or shall at the time when proceedings are taken against the Bank hereunder be outstanding or unrealized.

We, the said Bank, lastly undertake not to revoke this Guarantee during its currency except with the previous consent of BSCDCL in writing and agree that any change in the constitution of the said Contractor or the said Bank shall not discharge our liability hereunder.

Dated this .....day of.....

Dated For and on behalf of Bank

(NAME AND DESIGNATION)

PROFORMA OF BANK GUARANTEE

(IN LIEU OF SECURITY DEPOSIT)

(Judicial Stamp paper of appropriate value as per stamp Act-of respective state)

Bhopal Smart City Development Corporation Ltd.,

Near Tatpar Petrol Pump, Sector A, Berkheda, Bhopal

In consideration of the Bhopal Smart City Development Corporation Ltd., having its Registered Office at Near Tatpar Petrol Pump Sector A, Berkheda(hereinafter called "BSCDCL") which expression shall include its successors and assigns having awarded to M/s..... (hereinafter called "the Supplier/Contractor") which expression shall wherever the subject or context so permits includes its successors and assigns) a Contract in terms inter-alia of BSCDCL's letter No..... dated..... and the Contract/Purchase Conditions of BSCDCL and upon the condition of the Supplier/Contractor furnishing Security for the performance of the Supplier's obligations and /or discharge of the contractor's/supplier's liability under and/or in connection with the said supply contract upto a sum of Rs..... (Rupees..... only)

We,..... ((hereinafter called "The Bank") which expression shall include its successors and assigns) hereby undertake and guarantee payment to BSCDCL forthwith on the same day on demand in writing and without protest or demur of any and all moneys payable by the supplier/contractor to BSCDCL under, in respect or in connection with the said contract inclusive of all the losses, damages, costs, charges and expenses and other moneys payable in respect of the above as specified in any notice of demand made by BSCDCL to the Bank with reference to this guarantee up to

and aggregate limit of Rs…....(Rupees.....only) and the bank hereby

agree with BSCDCL that:

This Guarantee shall be continuing guarantee and shall …… remain valid and irrevocable for all claims of BSCDCL and liabilities of Supplier/Contractor arising upto and until midnight of.....

This Guarantee shall be in addition to any other Guarantee or Security whatsoever that BSCDCL now or at any time have in relation to the Supplier's obligations/liabilities under and/or in connection with the said supply/contract, and

BSCDCL shall have full authority to take recourse or to enforce this Security in preference to any other Guarantee or Security which BSCDCL may have or obtain and no forbearance on the part of BSCDCL in enforcing or requiring enforcement of any other Security shall have the effect of releasing the Bank from its liability hereunder.

BSCDCL shall be at liberty without reference to the Bank and without affecting the full liability of the Bank hereunder to take any other security in respect of the Supplier's/Contractor's obligations and/ or liabilities under or in connection with the said supply/contract or to grant time and / or indulgence to the supplier / contractor or to increase or otherwise vary the prices or the total contract value or to release or to forbear from enforcement of all or any of the conditions under the said supply / contract and / or the remedies of BSCDCL under any other security/securities now or hereafter held by BSCDCL and no such dealings, increase(s) or other indulgence(s) or arrangement(s) with the supplier / contractor or releasing or forbearance whatsoever shall have the effect of releasing the Bank from its full liability to BSCDCL hereunder or prejudicing rights of BSCDCL against the Bank. This Guarantee shall not be determined or affected by the liquidation or winding up, dissolution or change of constitution or insolvency of the supplier / contractor but shall in all respects and for all purposes be binding and operative until payment of all moneys payable to BSCDCL in terms thereof.

5. The Bank hereby waives all rights at any time inconsistent with the terms of this Guarantee and the obligations of the Bank in terms hereof shall not be otherwise affected or suspended by reason of any dispute or disputes having been raised by the supplier /contractor (whether or not pending before any Arbitrator, Tribunal or Court) or any denial or liability by the supplier/ contractor stopping/ preventing or purporting to stop or prevent any payment by the Bank to BSCDCL in terms thereof.

   The amount stated in any notice of demand addressed by BSCDCL to the Guarantor as liable to be paid to BSCDCL by the supplier/contractor or as suffered or incurred by BSCDCL on account of any losses or damages, costs, charges and / or expenses shall as between the Bank and BSCDCL be conclusive of the amount so liable to be paid to BSCDCL or suffered or incurred by BSCDCL as the case may be and payable by the Guarantor to BSCDCL in terms hereof subject to a maximum of Rs ..... (Rupees ..... only),

   Unless demand or claim under this Guarantee is made on the Guarantor in writing

   within three months form the date of expiry of the Guarantee i.e upto ..... the Guarantor shall be discharged from all liabilities under this Guarantee there under.

Notwithstanding anything contained herein before our liability under this guarantee is

restricted to Rs . ..... (Rupees .....only). This guarantee will expire on..... Any claim under this Guarantee must be received by us within three months from the date of expiry i.e. ..... (date, three months after the expiry date) and if no such claim has been received by us by that date all your rights under this guarantee will cease.

For and on behalf of the Bank

Place

Date

WITNESS:

1. 2.

PROFORMA OF BANK GUARANTEE

(FOR MOBILIZATION ADVANCE WITH INTEREST BEARING)

(Judicial Stamp per Stamp Act - paper of appropriate value as respective state)

Bhopal Smart City Development Corporation Limited,

Bhopal, Pin- 462023

In consideration of the Bhopal Smart City Development Corporation Limited., having its Registered Office at Bhopal -462023 (hereinafter called “BSCDCL” which expression shall unless repugnant to the subject: or context Include his successor and assigns) having agreed under the terms and conditions of Contract No. dated made between (name of the contractor) and BSCDCL in connection with (name of work) (hereinafter called “the said contract”) to make at the request of the Contractor a Mobilization Advance of Rs. _____ carrying interest @ … % p.a. for utilizing it for the purpose of the Contract on his furnishing a guarantee acceptable to BSCDCL, we the Bank (hereinafter referred to the “the said Bank”) and having our registered office at do hereby guarantee the due recovery by BSCDCL of the said advance alongwith interest as provided according to the terms and conditions of the contract. We ...

do hereby undertake to pay the amount due and payable under this Guarantee without any demur, merely, on a demand from BSCDCL stating that the amount claimed is due to BSCDCL under the said Agreement. Any such demand made on the said bank shall be conclusive as regards the amount due and payable by the said contractor under this guarantee and agree that the liability of the said bank to pay BSCDCL the amount so demanded shall be absolute and unconditional notwithstanding any dispute or disputes raised by the Contractor and notwithstanding any legal proceeding pending in any court or Tribunal relating thereto. However, our liability under this Guarantee shall be restricted to an amount not exceeding Rs … inclusive of interest @ …….% p.a.

We the said bank further agree that BSCDCL shall be the sole judge of and as to whether the amount claimed has fallen due to BSCDCL under the said agreement or whether the said Contractor has not utilized the said advance or any part thereof for the purpose of the Contract and the extent of loss or damage caused to or suffered by BSCDCL on account of the said advance together with interest not being recovered in full and the decision of BSCDCL that the amount has fallen due from' contractor or the said Contractor has not utilized the said advance or any part thereto for the purpose of the contract and as to the amount or amounts of loss or damage caused to or suffered by BSCDCL shall be final and binding on us.

We, the said Bank, further agree that the Guarantee herein contained shall remain

in full force and effect till the said advance has been fully recovered and its claims satisfied or discharged and till BSCDCL certify Contractor, and accordingly discharges this Guarantee subject, however, that BSCDCL shall have no claims under this Guarantee unless a notice of the claims under this Guarantee has been served on the Bank before the expiry of the said Bank Guarantee in which case the same shall be enforceable against the Bank.

BSCDCL shall have the fullest liberty without affecting in any way the liability of the Bank under this Guarantee or indemnity from time to time to vary any of the terms and conditions of the said Contract or the advance or to extend time of performance by the said Contractor or to postpone for any time and from time to time of the powers exercisable by it against the said Contractor and either to enforce or forbear from enforcing any of terms and conditions governing the said Contract or the advance or securities available to BSCDCL and the said Bank shallnot be released from its liability under these presents by any exercise by BSCDCL of the liberty with reference to the matters aforesaid or by reasons of time being given to the said Contractor or any other forbearance, act or omission on the part of BSCDCL or any indulgence by BSCDCL to the said Contractor or of any other matter or thing whatsoever which under the law relating to sureties would but for this provision have the effect of so releasing the bank from its such liability.

It shall not be necessary for BSCDCL to proceed against the Contractor before proceeding against the Bank and Guarantee herein contained shall be enforceable against the Bank notwithstanding any security which BSCDCL may have obtained or obtain from the Contractor or shall at the time when proceedings are taken against the Bank hereunder be outstanding or unrealized.

We, the said Bank, lastly undertake not to revoke this Guarantee during its currency except with the previous consent of BSCDCL in writing and agree that any change in the constitution of the said Contractor or the said Bank shall not discharge our liability hereunder.

Dated this…..… day of…….....

Place:

Date:

Witness:

FORM FOR GUARANTEE BOND(If applicable)

FOR ANTI-TERMITE TREATMENT

THIS AGREEMENT made this____ day of Two thousand _____ between M/s_____ (hereinafter called the guarantor of the one part and M/s Bhopal Smart City Development Corporation Limited, hereinafter called the BSCDCL hereinafter called the OWNER of the other part.

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

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

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

In witness where of these presents have been executed by the Guarantor_____ and by_____ for and on behalf of BSCDCL on the day of month and year first above written.

Signed sealed and delivered by (Guarantor)

IN THE PRESENCE OF:
1.

2.

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

1.

2.

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

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

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

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

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

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

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

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

The decision of the Engineer-in-Charge with regard to cause of leakage shall be final

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

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

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

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

1.

2.

Signed for and on behalf of the BSCDCL by _____

In presence of:

1.

2.

PROFORMA OF

INDENTURE FOR SECURED ADVANCE OR CREDIT

THIS INDENTURE made this day of _____ Between _____

(hereinafter called the contractor) which expression shall where the Context as admits or implies be deemed to include his executor/administrators and assign of the one part and National Buildings Construction Corporation Ltd., having its Registered Office at BSCDCL, Bhopal (hereinafter called the Engineer) which expression shall where the context so admits or implies be deemed to include its successors and assign of the other part.

Whereas by an agreement dated (hereinafter called the said agreement). The

Contractor has agreed to construct.....

And whereas the Contractor has applied to the Engineer that he may be or be given credited for materials brought by him to the site of the work subject to the said agreement for use in construction of the work.

NOW THIS INDENTURE WITNESSETH that in pursuance of the said agreement and in consideration of the sum of Rs._____ (Rupees _____ only) paid to the contractor by the Engineer. The receipt where the Contractor hereby acknowledges and of such advance or credited (if any) as may be made to him as aforesaid the Contractor hereby covenants and agrees with The Engineer and declares as follows:

That all sums given as advance or credit by The Engineer to the Contractor as aforesaid shall be employed by the Constructor in or toward the execution of the said works and for no other purpose whatsoever.

That the material for which the advance or credit is given are offered to and accepted by The Engineer as security and are absolutely the Contractor's own property and free from encumbrances of any kind the Contractor will not make any application for or receives further advance or credit on the security or material which are not absolutely his own property and free from encumbrances of any kind and the Contractor shall indemnify The Engineer against any claims to any material in respect of which advance or credit has been made to him as aforesaid.

That the said material and all other material on the security of which any further advance or advances or credit may be given as aforesaid (hereinafter called the said materials) shall be used by the Contractor s solely in the execution of the said works in accordance with the direction of the Engineer and in terms of said agreement.

That the Contractor shall make at his own cost all necessary and adequate arrangement for the proper safe custody and protection against all risks of the said material and that until used in the construction as aforesaid the material shall remain at the site of the said works in Contractor's custody and on his responsibility and shall at all times be open to inspection by The Engineer. In the events of the materials or any part thereof being stolen, destroyed or damaged or becoming deteriorated in greater degree than in due to reasonable use and wear thereof the Contractor will replace the same with other materials of like quality of repair and make good the same as required by The Engineer.

That said material shall not on any account be removed from the site of work expect with the written permission of The Engineer.

That the advance shall be repayable in full when or before Contractor receives payment from The Engineer of the price payable to him for the said work under the term and provisions of the said agreement. Provided that if any intermediate payments are made to the Contractor on account of work done then on the occasion of each payment The Engineer will be at liberty to make a recovery from the Contractor's bill from such payments by deducting there from the value of the said materials than actually used in the contraction and in respect of which recovery has not been made previously. The value of this purpose being determined in respect of each description of materials at the rates at which the amounts of the advance as made under these presents was calculated.

That if the Contractor shall at any time make at any default in the performance of observance in respect of any of the terms and provisions of the said agreement or of that provisions the total amount of the advance or advances that may still be owing to The Engineer, shall immediately on the happening of such default be repayable by the Contractor to The Engineer together with interest thereon at 12% p.a. from the date of respective dated to such advance or advances to the date of payment and with all costs. Damages and expenses incurred by The Engineer in or for recovery hereof or the Contractor hereby covenants and agrees with The Engineer to repay and pay the same respective to him accordingly

That the Contractor hereby charges all the said materials with the repayment to The Engineer of all sums advances or credit as aforesaid and all costs. Charges, damages and expenses payable under these presents PROVIDED ALWAYS it is hereby agreed and declared that notwithstanding anything in the said agreement and without prejudice to the powers contained therein if and wherever the covenant for payment and repayment herein before contained shall be become enforceable and the money owing shall not be paid in accordance therewith. The Engineer may at any time thereafter adopt all or any of the following courses he may deem best:

Seize the utilize the said material or any part thereof in the completion of the said works in accordance with the provision in that behalf contained in the said agreement debating the Contractor with the actual cost of effecting such completion and the amount due in respect of advance or credit under these presents and crediting the Contractor with value of work done as if he has carried it out in accordance with the said agreement and the rates thereby provided if the balance is against the Contractor is to pay the same to the engineer on demand.

Remove and sell by public action the seized materials or any part thereof and out of the money arising from the sale repay the engineer under these presents and pay over the surplus (if any) to the Contractor.

Deduct all or any part of the moneys owing from any sums due to the contractor under said agreement.

Expect in the event of such default on the part of contractor as aforesaid,interest or the said advance shall not be payable.

That in the event of conflict between the provisions of these presents and the said agreements, the provision of these presents shall prevail and in the event of any dispute or difference arising over the construction or effect of these presents, the settlement of which has not been hereinbefore expressly provided for the same shall so far as is lawful be subject to jurisdiction of BHOPAL courts only.

IN WITNESS whereof the said the engineer and the contractor hereunto set their respective hands and seals the day year first above written.

Signed Sealed and delivered by

Contractor The Engineers

AGREEMENT FORM

This agreement made this day of (Month) (Year), between the **Bhopal Smart City Development Corporation Limited (BSCDCL),** a company incorporated under the Companies Act, 1956 having its Registered Office at BSCDCL, Bhopal 462023 (hereinafter referred to as the "BSCDCL" which expression shall include its administrators, successors, executors and assigns) of the one part and **M/s(NAME OF CONTRACTOR)** (hereinafter referred to as the 'Contractor' which expression shall unless the context requires otherwise include its administrators, successors, executors and permitted assigns) of the other part.

WHEREAS, BSCDCL, has desirous of construction of **(NAME OF WORK)** (hereinafter referred to as the "PROJECT") on behalf of the **(NAME OF OWNER/MINISTRY)** (hereinafter referred to as "OWNER"), had invited tenders as per Tender documents vide NIT No. _____.

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

NOW THEREFORE THIS DEED WITNESSETH AS UNDER:

ARTICLE 1.0 – AWARD OF CONTRACT

SCOPE OF WORK

BSCDCL has awarded the contract to **(NAME OF CONTRACTOR)** for the work of **(NAME OF WORK)** on the terms and conditions in its letter of intent No.

_____ dated _____ and the documents referred to therein. The award has taken effect from **(DATE)** i.e. the date of issue of aforesaid letter of intent. The terms and expressions used in this agreement shall have the same meanings as are assigned to them in the "Contract Documents" referred to in the succeeding Article.

ARTICLE 2.0 – CONTRACT DOCUMENTS

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

BSCDCL Notice Inviting Tender vide No. _____ date _____and BSCDCL's tender documents consisting of:

General Conditions of Contract (GCC) along with amendments/errata to GCC (if any) issued (Volume-I).

Special Conditions of Contract including Appendices & Annexures, Volume-II.

Bill of Quantities along with amendments/corrigendum of schedule items, if any (Volume-II).

_____
_____

(NAME OF CONTRACTOR) letter proposal dated _____ and their subsequent communication:

Letter of Acceptance of Tender Conditions dated _____

_____

_____

BSCDCL's detailed Letter of Intent No. _____ dated ____ including Bill of Quantities. Agreed time schedule, Contractor's Organization Chart and list of Plant and Equipment's submitted by Contractor.

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

ARTICLE 3.0 – CONDITIONS & CONVENANTS

The scope of Contract, Consideration, terms of payments, advance, security deposits, taxes wherever applicable, insurance, agreed time schedule, compensation for delay and all other terms and conditions contained in BSCDCL's

Letter of Intent No. _____ dated _____ are to be read in conjunction with other aforesaid contract documents. The contract shall be duly performed by the contractor strictly and faithfully in accordance with the terms of this contract.

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

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

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

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

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

ARTICLE 4.0 – NO WAIVER OF RIGHTS

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

ARTICLE 5.0 – GOVERNING LAW AND JURISDICTION

The Laws applicable to this contract shall be the laws in force in India and jurisdiction of BHOPAL Court (s) only.

Notice of Default

Notice of default given by either party to the other party under the Agreement shall be in writing and shall be deemed to have been duly and properly served upon the

parties hereto, if delivered against acknowledgment due or by FAX or by registered mail duly addressed to the signatories at the address mentioned herein above.

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

For and on behalf of:	For and on behalf of:
(NAME OF CONTRACTOR)	(M/s Bhopal Smart City Development Corporation)
WITNESS:	WITNESS:
1.	1.

FORM 7 - FORM OF POWER OF ATTORNEY FOR SIGNING THE BID DOCUMENTS

(On a Stamp Paper of relevant value)

Know all men by these presents, we, ... (name of Contractor and address of the registered office) do hereby irrevocably constitute, nominate, appoint and authorize Mr / Ms..... son/daughter/wife of ..... and presently residing at ....., who is presently employed with us and holding the position of ..... as our true and lawful attorney (hereinafter referred to as the "Attorney") to do in our name and on our behalf, all such acts, deeds and things as are necessary or required in connection with or incidental to submission of bid for the for **"DESIGN, SUPPLY, CONSTRUCTION, ERECTION AND TESTING COMMISSIONING OF AUTOMATED SOLID WASTE COLLECTION,SEGREGATION AND TRANSPORTATION SYSTEM INCLUDING 5 YEARS O & M FOR AREA BASED DEVELOPMENT UNDER BHOPAL SMART CITY ON EPC BASIS."**being developed by the BSCDCL including but not limited to signing and submission of all applications, proposals/bids and other documents and writings, participating in pre-bid and other conferences and providing information/ responses to BSCDCL, representing us in all matters before BSCDCL, signing and execution of all contracts and undertakings consequent to acceptance of our proposal and generally dealing with BSCDCL in all matters in connection with or relating to or arising out of our Proposal for the said work and/or upon award thereof to us till the entering into of the agreement with BSCDCL.

AND GENERALLY to act as our Attorney or agent on behalf of us in relation to the bid for **"DESIGN, SUPPLY, CONSTRUCTION, ERECTION AND TESTING COMMISSIONING OF AUTOMATED SOLID WASTE COLLECTION,SEGREGATION AND TRANSPORTATION SYSTEM INCLUDING 5 YEARS O & M FOR AREA BASED DEVELOPMENT UNDER BHOPAL SMART CITY ON EPC BASIS."**(and to execute and do all instruments, acts, deeds, matters and things in relation to the said Proposal or any incidental or ancillary activity, as fully and effectually in all respects as we could do if personally present.

AND We hereby agree to ratify and confirm and agree to ratify and confirm all acts, deeds and things whatsoever lawfully done or caused to be done by our said Attorney and that all acts, deeds and things done by our said Attorney in exercise of the powers hereby conferred shall and shall always be deemed to have been done by us.

IN WITNESS WHEREOF WE, ... THE ABOVE NAMED PRINCIPAL HAVE EXECUTED THIS POWER OF ATTORNEY ON THIS ..... DAY OF ....., 2018

For

.....

(Signature, name, designation and address)

Witness

1.

2.

Notarized

Accepted

(Signature, name, designation and address of the Attorney)

AFFIDAVIT *(Black listing)

1. I, the undersigned, do hereby certify that all the statements made in the Tender document are true and correct.

2. The undersigned also hereby certifies that neither our firm M/s. _____ nor any of its constituent partners are blacklisted by any of the Govt./Semi Govt. institutions and not have abandoned any work of buildings / Infrastructures works in India nor any contract awarded to us for such works have been rescinded, during last five years prior to the date of this application.

Signed by an Authorized Officer of the Firm

_____

Title of Officer

_____

Name of Firm

_____

Date

SECTION-6

SPECIAL CONDITION OF CONTRACT (SCC)

SPECIAL CONDITIONS OF CONTRACT (SCC)

GENERAL-

6.1 The following special conditions shall be read in conjunction with General conditions of contract. If there are any provisions in these Special Conditions, which are at variance with the provisions of General Conditions of Contract, the provisions in the Special Conditions shall take precedence.

6.2 Where any portion of Special Conditions of Contract is repugnant to or at variance with any provision of the instructions to Tenderer and General Conditions of Contract and / or the other documents forming part of the contract then unless a different intention appears the provision of the Special Conditions of Contract shall be deemed to override the provisions of the general conditions of contract and / or the other documents forming part of the contract only to the extent such repugnant/various in the special conditions of contract as are not possible of being reconciled with the provisions in the special conditions of contract as are not possible of being reconciled with the provision with instructions to Tenderer or General Conditions of contract and / or the other documents from part of the contract.

6.3 Working drawing shall be according to the drawing given in the Tender document.

6.4 Items mentioned in the BOQ may vary or any changes are needed then it should bring to the attention of BSCDCL.

6.5 Working drawings are given by BSCDCL in tender document; if any deviations found and correction required then it should be brought to BSCDCL for rectification.

6.6 The items which are missing or not defined in the given BOQ in this Tender Document, then the contractor has to submit the items for approval to BSCDCL.

6.7 The contractor has to submit sample of the items defined in BOQ the same to be Approved by BSCDCL, before use.

6.8 It is percentage rate tender bidder should quote percentage above or below of PAC.

6.9 Contractors shall construct/refurbish Store, Cement Godown, Lab, Office for their use or shall make for BSCDCL. The space shall be provided by BSCDCL.

8.0 Additional Conditions;

1.1 Excavated good earth declared surplus or otherwise shall be disposed of at designated locations as per the directions of BSCDCL, which shall be different from the disposal site for disintegrated rock etc.

1.2 For soil required for re-filling, if sufficient space is not available for stacking at site of excavation, the Contractor shall make his own arrangements for transporting and

stacking the earth elsewhere and then bring it back for re-filling. Nothing extra shall be paid on this account for to and fro carriage.

1.3 Disposal of surplus excavated earth including mud, liquid mud, dismantled RCC, dismantled brick work etc. shall be made only in the dumping yard approved by local authority. It will be the responsibility of the contractor to get the permission for dumping yard from local authority as required. If any royalty /fees is payable to local authority, such royalty / fees shall also be borne by the contractor. Disposal shall be carried out strictly as per the regulations of local authority. However, the above materials shall not be removed out of owner's premises without prior written authorization of BSCDCL.

1.4 All the Charges required for vetting of the designs done by The Contractor by IIT or any other reputable agency approved by BSCDCL etc. shall be deemed to have been included in the quoted rates.

1.5 The Contractor shall, at his own expense and without extra charges, make provision for all pumping, dewatering, dredging orbailing out water, if necessary, irrespective of the source of water. The water so pumped out shall be discharged as per local byelaws and as approved by the Engineer-in-charge. The Contractor shall also take all necessary precautions in diverting channels and in discharging the drained water as not to cause damage to the works, crops or any other property within/outside the plot. Excavated area for the basement/ foundation trenches shall be kept free from water while all the works below Ground level are in progress. Nothing extra shall be paid on this account in terms of time and cost.

1.6 Further contractor shall take all necessary precautions to protect and safe guard the foundation of the adjacent building / Structure / Overhead/Underground utilities. Nothing extra shall be payable on this account.

2.0 Construction Power, Water and other facilities

2.1 BSCDCL may provide construction power for office purpose only, at one point, on chargeable basis. Client shall not provide power for any other purpose and the Contractor shall be exclusively responsible to make his own arrangements for supply of power for his use including area illumination, construction activities, fabrication, without any extra cost to Client.

2.2 BSCDCL shall provide water for construction purpose at one point, the vicinity of the site of work. Contractor shall make all arrangements for distribution, storage, use and drainage of the same at his own cost.

2.3 BSCDCL shall endeavor to provide land out of available land to the Contractor, for the sole purpose of field office using Contractor's own container (porta cabin). No land shall be provided for accommodation of workers/labour.

2.4 The Contractor shall remove all temporary buildings / facilities etc. before leaving the site after completion of works in all respect. In the event that Contractor fails to clear the site within 3 weeks after receiving intimation from BSCDCL to do so, BSCDCL shall be free to engage the services of any third party to clear the site at Contractors risk and cost. All expenses incurred on this account shall be recovered from the Contractor.

2.5 If BSCDCL provides water and electricity, the cost for such facility will be borne by the contractor at the prevailing rates of local Government bodies as per actuals.

3.0 TAXES, DUTIES, ROYALTY, PRICES

3.1 Royalty

3.1.1 All royalties etc., as may be required for any Borrow Areas, including right of way etc. to be arranged by Contractor shall be deemed to have been included in the quoted prices.

3.1.2 Contractor's quoted rates should include the royalty on different applicable items as per the prevailing State Government rates.

4.0 Underground and overhead structures

4.1 The Contractor will familiarise himself with and obtain information and details from BSCDCL in respect of all existing structures, overhead lines, existing pipelines and utilities existing at the job site before commencing work. The Contractor shall execute the work in such a manner that the said structures, utilities, pipelines etc. are not disturbed or damaged, and shall indemnify and keep indemnified BSCDCL from and against any destruction thereof or damages thereto.

5.0 Electrical Contractor's License

5.1 The CONTRACTOR or its nominated Sub-Contractor(s), as the case may be, shall have a valid electrical contractor's license for working in the State in which the job site is located. The CONTRACTOR shall furnish a copy of the same to Engineer-in-charge before commencement of any electrical work or work pertaining to Electrical System.

6.0 Project Review Meetings

6.1 The contractor, immediately on award of work shall submit details of his key personnel to be engaged for the work at site. In addition, he shall furnish the Engineer-in-Charge detailed organogram of his staff involved with the work.

6.2 The Contractor shall present the programme and status at various review meetings as required.

6.3 Weekly Review Meetings: Shall be attended by Local Team headed by Project - in-Charge.

Agenda	a) Weekly programme v/s actual achieved in the past week and programme for next week. b) Remedial Actions and hold up analysis. c) Client query approval.

6.4 Monthly Review Meetings: Shall be attended by Project-in-Charge and the Management Representative who can take independent decisions

Agenda	a) Progress Status/Statistics. b) Completion Outlook. c) Major hold ups / slippages. d) Assistance required. e) Critical issues. f) Client query/approval. g) Anticipated cash flow requirement for next two months

7.0 PROJECT OFFICE ACCOMMODATION

7.1 The contractor shall provide, erect and maintain at his own cost separate temporary water tight, Puff insulated air-conditioned office accommodation in the form of two (02) Nos. Porta Cabins each of size 20' X 10' or Quantity and Size of Porta cabin as approved by BSCDCL at designated locations for the use by BSCDCL with the following minimum facilities in each cabin. These shall be available till handing over of the project.

- **7.1.1** Toilet facility - 1 No. portable for each cabin
- **7.1.2** Modular Work Stations - 3 Nos. in each cabin
- **7.1.3** Executive Chairs - 3 Nos. shoulder rest
- **7.1.4** Visitors Chairs - 6 Nos.
- **7.1.5** Overhead Storage Racks - All along the walls
- **7.1.6** Adequate Number of Power plugs –
- **7.1.7** White Board with Markers - 1 No. in each cabin
- **7.1.8** Pin-Up Display board of size as required
- **7.1.9** Free Drinking water, stabilised power and lighting as required for the duration of the Project.
- **7.1.10** Janitorial and Housekeeping services

7.2 The contractor has to relocate the Porta Cabins if required as per the exigencies of the work and as directed by BSCDCL without any extra cost. After completion of the Project the Contractor shall take away this material and the site shall be cleaned free from all construction debris.

8.0 RECOMMENDED MAKES OF MATERIALS

8.1 A list of recommended makes of materials is as per Tender document

8.2 The order of preference amongst the various products/materials shall be as follows:

- **8.2.1** The products / materials shall be as per the Brand specified in the Tender document
- **8.2.2** If the Brand is not specified then the products/material shall be ISI marked and the same shall be got approved by the Engineer-in-Charge before execution.
- **8.2.3** If ISI marked product/material is not available, the same shall be as approved by the Engineer-in-Charge before execution.

8.3 In case of natural products such as Kota stone, Marble, Granite etc.,

- 8.3.1 the stones used shall be of **premium** grade and they shall be homogenous in colour with consistency in pattern, texture, tone, marking and colour. No discolouration, spots, fissures or cracks and pocked surfaces shall be allowed.
- 8.3.2 Where it is difficult to guarantee uniformity in colour and other properties, contractor shall make all efforts to match the colour, shade, texture of the product with the approved sample. If in the opinion of the BSCDCL there is significant variation in properties, BSCDCL shall direct the contractor to remove the same from the site immediately and replace with products matching with the approved sample within reasonable period. The decision of BSCDCL shall be final and binding.

9.0 COMPLETION CERTIFICATES/ NOC FROM LOCAL STATUTORY BODIES

9.1 Contractor has to arrange at his own cost building/ work completion certificates or NOCs if required to be obtained, from the local statutory bodies of central and state govt. such as Municipal Corporation, electrical, safety, Fire authority, Chief Controller of Explosives (CCOE) etc. Any fees required for obtaining such NOCs shall be paid by BSCDCL on production of relevant depository challans/ receipts from such Govt. authorities. Initial building approval drawings shall be made available by BSCDCL

9.2 The application on behalf of BSCDCL for submission to relevant authorities along with copies of required certificates complete in all respects shall be prepared and submitted by the Contractor well ahead of time so that the actual construction / commissioning of the work is not delayed for want of the approval / inspection by concerned authorities.

9.3 The inspection of the works by the authorities shall be arranged by the Contractor and necessary co-ordination and liaison work in this respect shall be the responsibility of the Contractor.

10.0 TOOLS, PLANTS AND MACHINERY

10.1 The Contractor shall provide and install at site adequate T&P for construction of the Project Works. The deployment of T&P shall be planned as per work requirement to suit the nature, quantum and speed of the work for lifting/hoisting construction materials/equipment etc.

10.2 The T&P shall be maintained in good working condition throughout the progress of work.

10.3 All adequate precaution regarding formal upkeep of valid Statutory/Safety credentials of major construction equipment as directed by BSCDCL, their installation, operation, maintenance, materials etc., shall be taken care of.

10.4 The operating staff to be deployed shall be properly qualified and adequately trained and experienced. All safety precautions shall be taken during the project duration, against possible accident. The Contractor shall deploy his representative to effectively enforce the safety rules and regulations in this regard.

10.5 The list of T&P is as follows : Nil

11.0 Construction Equipment & Mechanisation of Construction Activities

11.1 The above list is only minimal and indicative. The contractor shall deploy all necessary tools and plants as per the requirement of the work.

11.2 The Contractor shall without prejudice to his overall responsibility to execute and complete the work as per specifications and Time Schedule, progressively deploy adequate equipment, and tools & tackles and augment the same as decided by Engineer-in-Charge depending on the exigencies of the work so as to suit the construction schedule.

16.0 CENTRING AND SHUTTERING FOR R.C.C WORK:-

16.1 The work is to be completed within 24 months, hence the contractor shall adopt a suitable system complying with BIS standards regarding stripping time, with requisite number of sets of centring and shuttering. The slab cycle for each of the structures has to be designed for completing the construction

within the stipulated completion time of the respective building, and the same shall be got approved by BSCDCL.

17.0 INTERFERENCE WITH TRAFFIC AND ADJOINING PROPERTIES/ BUILDINGS

17.1 In case any operation connected with the Works requires temporary diversion of the traffic, or obstruction or closure of any road, or any other 'right of way', the approval of BSCDCL and the respective competent authorities shall be obtained at least one week in advance.

17.2 The Contractor shall at all times during execution of the Works, ensure an uninterrupted flow of traffic around the plot so as not to cause any nuisance to the general public.

17.3 If in order to avoid undue interference with the traffic and adjoining properties, BSCDCL instructs the Contractor to take special precautions or work within restricted time periods; the Contractor shall carry out the Works during such time and in such manner as directed by BSCDCL.

18.0 LIGHTING & WATCH AND WARD:

18.1 The contractor shall at his own cost take all precautions to ensure safety of life and property by providing necessary barriers, area lighting at the construction site and approaches, watchmen, necessary watch towers etc. during progress of work at all hours including night hours, if required, as directed by the Engineer-in-charge.

18.2 The Contractor shall be responsible for the watch and ward of the all construction premises and buildings, safety of all fittings and fixtures including sanitary and water supply fittings and fixtures provided by him against pilferage and breakage during the period of installation till handing over of all the works to BSCDCL.

19.0 Monthly Bills of Contractor

Contractor shall submit Monthly bills for the work Executed. Minimum amount of such bills shall not be less than 5 % of Contract value.

20.0 Payment Schedule :

Following payment schedule shall be adopted for MEP Works:

S.	Activity	Payment (%)
1.	Network System for Automated Solid waste management (Refer Item no. 2 Price bid Boq) a. On Supply and delivery of material at site as per approved procurement schedule and on approval of engineer in charge b. On Installation and testing of material at site and on approval of engineer in charge c. On satisfactory commissioning entire to the satisfaction of engineer in charge	 40% payment of approved rate under item no. 2 20% payment of approved rate under item no. 2 40% payment of approved rate under item no. 2
2.	Transfer Station payment for Civil, architectural, electrical, plumbing fire fighting, security and safety and remaining misc works Payment will be done on pr-rata basis only after the completion of above works	

21.0 Time period of the Project

Entireprojectshouldbecompletedanddeliveredwithin Twenty Four Months oftimefromthedate ofawardofcontractthatincludesMonsoon.

ThetimeallowedforcarryingouttheworkasenteredintheTendershallbestrictlyobserved bytheContractorandshallbereckonedfromthedateonwhichtheLetterofAcceptanceis giventotheContractor. Theworkshallthroughoutthestipulatedperiodofthecontractbe proceededwithallduediligenceastimebeingdeemedtobetheessenceofthecontracton the partoftheContractor.

TheContractor shouldcomplete thephysicalworkasfaraspossibleasperphase givenbelow:

¼ofthework in .. ¼ofthetime

½ofthework in .. ½ofthetime

¾ofthework in .. ¾ofthetime

Fullofthetheworkin .. Fullofthetime

Fullworkwillbecompletedin Twenty Four monthsincluding Monsoon

Howeverdeviationsifanyfromabovephasingwillbegotdulyapprovedby theengineer incharge.

Theprogramforcompletionofworkshallbea partoftheContractDocument inthe formofBarChart/GANTTChart. TheContractorissupposedtocarryouttheworkand keeptheprogressasperBarChart/GANTTChart. TheContractorshallcompletethework aspertheSchedulegiveninthe Contractandtheprogramsubmittedbythe Contractor.

22.0 Contract Execution

Allrequireddocumentsforexecutionofthecontractshallbesubmittedwithin30daysfrom the date of issue ofletter of acceptance. Ifthe documents are not submitted within the stipulatedtimeapenaltyofRs5000/-perdaywillbeapplicabletothecontractor.Allcontract documents need to be duly affixed with stamp duty properly signed along with evidence/proofofpaymentofsecurity/contractdeposit/within30daysfromthedateofletter ofacceptancereceivedbyhim

IftheamountoftheContractDeposittobepaidaboveisnotpaidwithin30daysfromthe dateofissue ofLetter ofAcceptance, theTender /Contractor alreadyaccepted shallbeconsideredascancelled andlegalstepsbetakenagainstthecontractorforrecoveryofthe amounts.

TheamountofSecurityDepositretained bythe BSCDCL shallbereleased afterexpiryof perioduptowhichthecontractorhasagreedtomaintaintheworkingoodorderisover. In theeventof thecontractorfailingorneglectingtocompletetherectificationworkwithinthe perioduptowhichthecontractorhasagreedtomaintaintheworkingoodorder,theamount ofsecuritydepositretainedby BSCDCLshallbeadjustedtowardstheexcesscostincurredby theDepartmentonrectificationwork.

23.0 Action when whole of security deposit / Retention Money is forfeited:

In any case in which under any Clause of this contract, the contractor shall have rendered himself liable to pay compensation amounting to the whole of this security deposit whether paid in one sum or deducted by installments or in the case of abandonment of the work owning to serious illness or death of the contractor or any other cause, the Engineer-in-Charge shall have power to adopt any of the following process, as he may deem best suited to the interest of BSCDCL -

(a) To rescind the contract (for which recession notice in writing to the contractor shall be conclusive evidence) and in that case, the security deposit of the contract shall stand forfeited and be absolutely at the disposal of BSCDCL .

(b) To carry out the work or any part of the work departmentally debiting the contractor with the cost of the work, expenditure incurred on tools and plant, and charges on additional supervisory staff including the cost of work-charged establishment employed for getting the un-executed part of the work completed and crediting him with the value of the work done departmentally in all respects in the same manner and at the same rates as if it had been carried out by the contractor under the terms of his contract. The certificate of the Engineer-in-Charge as to the costs and other allied expenses so incurred and as to the value of the work so done departmentally shall be final and conclusive against the contractor.

(c) To order that the work of the contractor be measured up and to take such part thereof as shall be un-executed out of his hands, and to give it to another contractor to complete, in which case all expenses incurred on advertisement for fixing a new contracting agency, additional supervisory staff including the cost of work charged establishment and the cost of the work executed by the new contract agency will be debited to the contractor and the value of the work done or executed through the new contractor shall be credited to the contractor in all respects and in the same manner and at the same rates as if it had been carried out by the contractor under the terms of his contract. The certificate of the Executive Engineer as to all the cost of the work and other expenses incurred as aforesaid for or in getting the un-executed work done by the new contractor and as to the value of the work so done shall be final and conclusive against the contractor.

In case the contract shall be rescinded under Clause (a) above, the contractor shall not be entitled to recover or be paid any sum for any work there for actually performed by him under this contract unless and until the Executive Engineer shall have certified in writing the performance of such work and the amount payable to him in respect thereof and he shall only be entitled to be paid the amount so certified. In the event of either of the courses referred to in Clause (b) or (c) being adopted and the cost of the work executed departmentally or through a new contractor and other allied expenses exceeding the value of such work credited to the contractors amount of excess shall be deducted from any money due to the contractor, by BSCDCL under the contract or otherwise, howsoever, or from his security deposit or the sale proceeds thereof provided, however, the contractor shall have no claim against BSCDCL even if the certified value of the work done departmentally or through a new contractor exceeds the certified cost of such work and allied expenses, provided always that whichever of the three courses mentioned in clauses (a), (b) or

(c) is adopted by the Executive Engineer, the contractor shall have no claim to compensation for any loss sustained by him by reason of his having purchase or procured any materials or entered in to any engagements or made any advance on account of or with a view to the execution of the work or the performance of the contract.

Contract may be rescinded and security deposit forfeited for bribing a public officer or if contractor becomes insolvent

If the contractor assigns or sublets his contracts or attempt so to do, or become insolvent or commence any proceeding to get himself adjudicated and insolvent or make any composition with his creditors, or attempt so to do or if bribe, gratuity, gift, loan, perquisite, reward or advantage, pecuniary or otherwise, shall either directly or indirectly be given promised or offered by the contractor or any of his servants or agents through any public officer, or person in the employ of BSCDCL /Govt. in any way relating to his office or employment, or if any such officer or person shall become in any way directly or indirectly interested in the contract the Engineer In-charge may thereupon, by notice in writing rescind the contract and the Security Deposit of the Contractor shall thereupon stand forfeited and be absolutely at the disposal of BSCDCL and the same consequences shall ensure as if the contract had been rescinded under above clause J hereof; and in addition the contractor shall not be entitled to recover or be paid for any work therefore actually performed.

SECTION-7

SCOPE OF WORK, EMPLOYER'S REQUIREMENT AND TECHNICAL SPECIFICATIONS

DETAILED SCOPE OF WORK

1.0 GENERAL

This section gives the detailed scope of work to be performed by the Contractor on EPC/turnkey basis for the 'Design, Supply, Construction, Erection and Commissioning of Automated Solid Waste Collection, Segregation and transportation of waste to the processing and landfill site identified and approved by the authorities, including Operation and Maintenance for 5 years for ABD area under Bhopal Smart City. The O&M includesFive years of defect liability period.The Contractor shall follow the Technical Specifications detailed in WHF, Section 7 of this Tender document, in performing the Works.

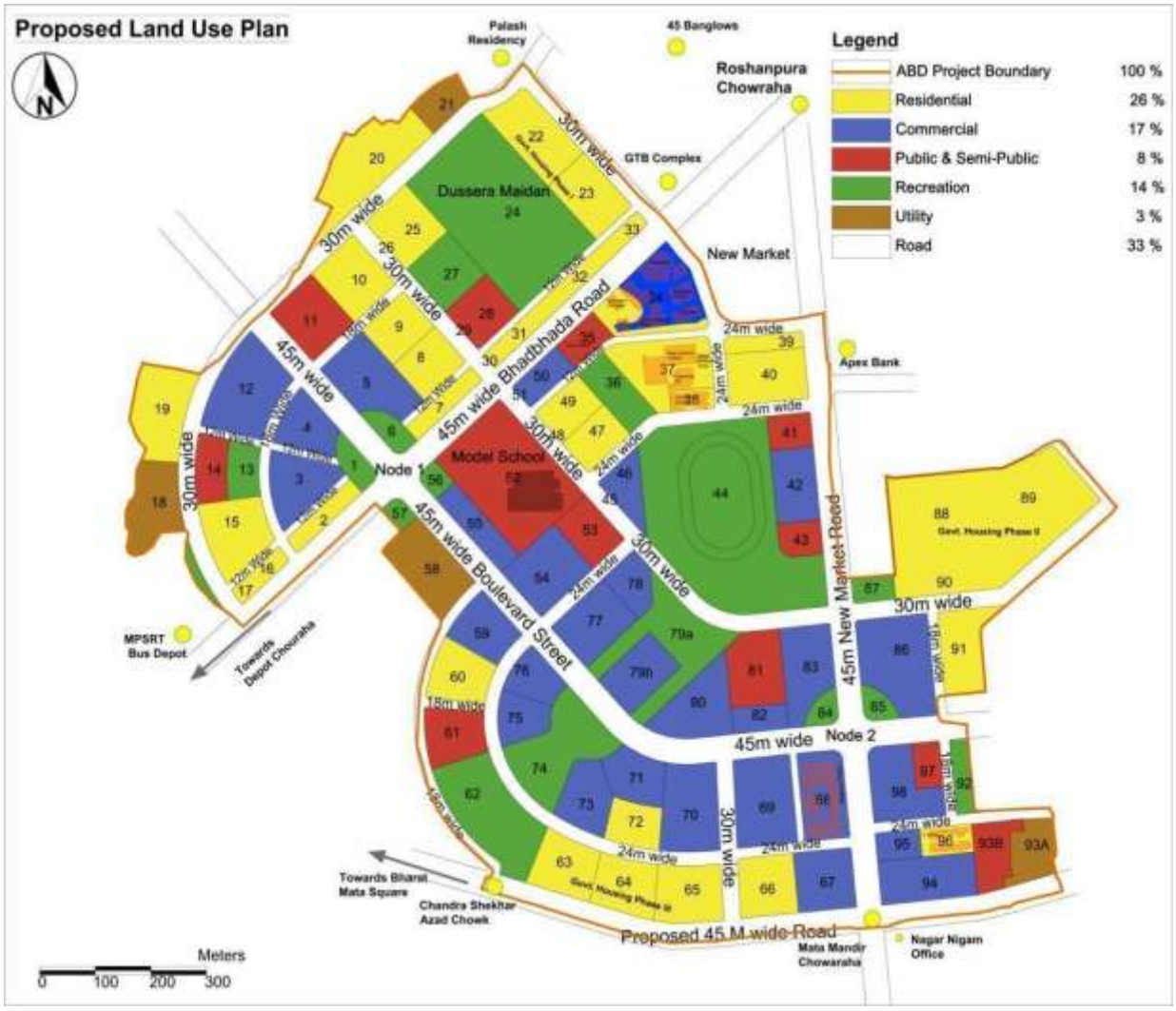
2.0 ABD MASTER PLAN

In light of Local authority (BDA and BMC) planning regulations, URDPFI Guidelines, Smart City Guidelines, Best Practices and Bhopal SCP, appropriate solutions and guidelines in areas of Smart physical infrastructure, Smart digital infrastructure and Smart service infrastructure is considered on priority for development to achieve the objective set by MoUD in Smart City Mission.

Planning principles and design guidelines are devised to develop overarching framework for preparation of layout plan based on which design brief including land use breakup, proposed density, FAR, etc is developed. The design was based on progressive approach with continuous consultation with the BSCDCL.

In Master Plan layout, while transforming vision to physical development various zones have been identified based on the character, uses and activities planned in each zone. It elaborates overall framework of existing and proposed street network, pedestrian and bicycle network, green space network, physical and social infrastructure, etc.

The Mixed-use land use in ABD area shall facilitate an urban development that blends residential, commercial, cultural and institutional uses. All these functions are physically and functionally integrated with the provision of pedestrian connections. The land use of ABD area is mixed use residential in nature with Transit nodes flanked with Commercial use. The greens and open spaces interlink the site within and outside.



3.0 INTRODUCTION

The proposed AWC system within the ABD area will be having two Transfer Stations for collecting the waste generated in segregated manner. (Please refer to Annexure --Automated Solid Waste Network and Transfer Station Drawing)Based on the approved Master Planning, the ABD area will achieve the ultimate population by 2020. Hence the automated solid waste is to be designed for the ultimate capacity as per the current tender scope. The ultimate quantum of solid waste generated is give below:

SWM generation within ABD area

Sr. No.	Type of Waste	Quantity of Waste (T/ day)
1	Biodegradable Waste	23.59
2	Recyclable Waste	26.53
3	Inert Waste	8.84
Total SWM		**58.89**

The waste generated accounts the various population and areas within project boundary (Residential, Floating, Open spaces and Roads) which can overall contribute to the waste generation till next 30 years. For the collection aspects, the waste generation phase wise and its further bifurcation for effective treatment & disposal is proposed in the SWM plan.

Physical and Chemical Composition of Bhopal Municipal Corporations

S. No.	Parameters	Councils
A	**Physical Parameters**	
1	Bio degradable	40 – 45%
2	Combustible	15 – 20%
3	Recyclables	10 – 15%
4	Inerts	7 – 8%
B	**Chemical parameters**	
1	Moisture	20 – 25%
2	C:N Ratio	20 - 25
3	Calorific Value	900 - 1100 kcal/kg

The density of the biodegradable wastes is taken as 500 kg/ cum

Based on the Master Plan we have divided the ABD area into two parcels, North and South. Each parcel will have its own transfer stations for collection of the segregated waste and transfer to respective landfill sites.

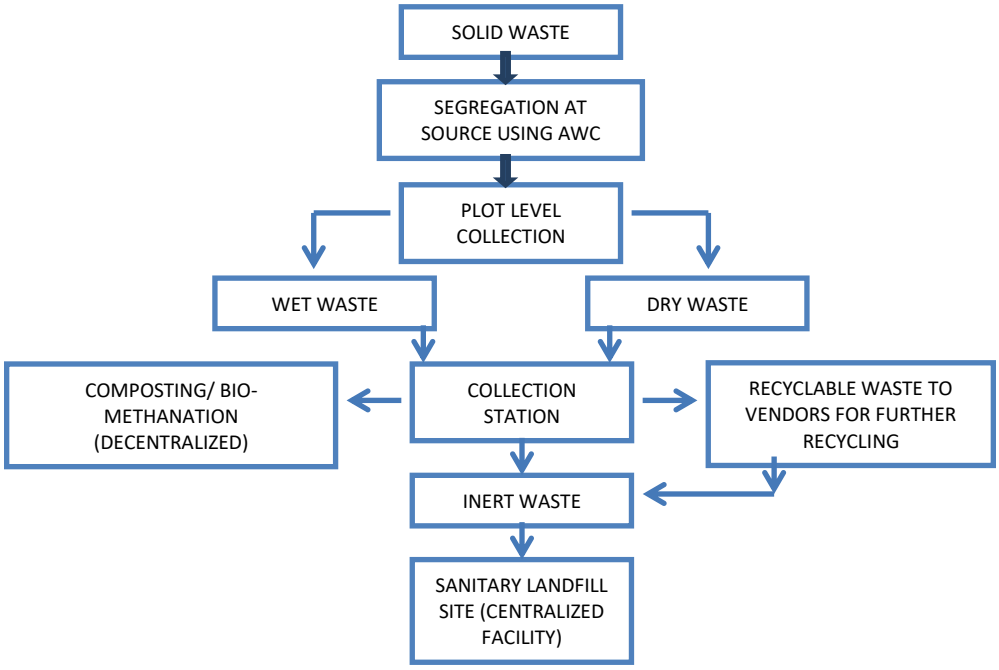
Battery Limit: Receipt of solid waste

The receiving automated solid waste pipe network should enter into each of the plot area by 15m and should be left out with necessary arrangement to enable the respective plot developers to integrate with the proposed buildings in the respective plot

Battery Limit: Disposal of solid waste

The segregated inert solid waster at transfer station should be transferred to the landfill site.

The waste treatment strategy is given in the below**Error! Reference source not found.**,



Concept Plan for SWM system at ABD area, Bhopal

4.0 Automated Waste Collection System (AWC):

Anautomated vacuum waste collection system, also known as pneumatic refuse collection, or automated vacuum collection(AVAC) system, transports waste at high speed through underground pneumatic tubes to a collection station where it is compacted and sealed in containers. When the container is full, it is transported away and emptied. The system helps facilitate separationandrecyclingof waste.

The process begins with the deposit of trash into building chutes/outdoor units, which may be specialized for waste, recycling, or compost. The waste is then pulled through an underground pipeline by air pressure difference created by large industrial fans, in response to sensors that indicate when the trash needs to be emptied and help ensure that only one kind of waste material is travelling through the pipe at a time. The pipelines converge on a central processing facility that uses automated software to direct the waste to the proper container, from there to be trucked to its final location, such as a landfill or composting plant.

Advantages of Automated Waste Collection System:

- Automated Waste Collection System (AWS) through chute system
- Minimum Human Intervention
- Minimize space requirement
- Minimize impact on health
- Waste sucked through pipes at a speed of 80-90 km/hr

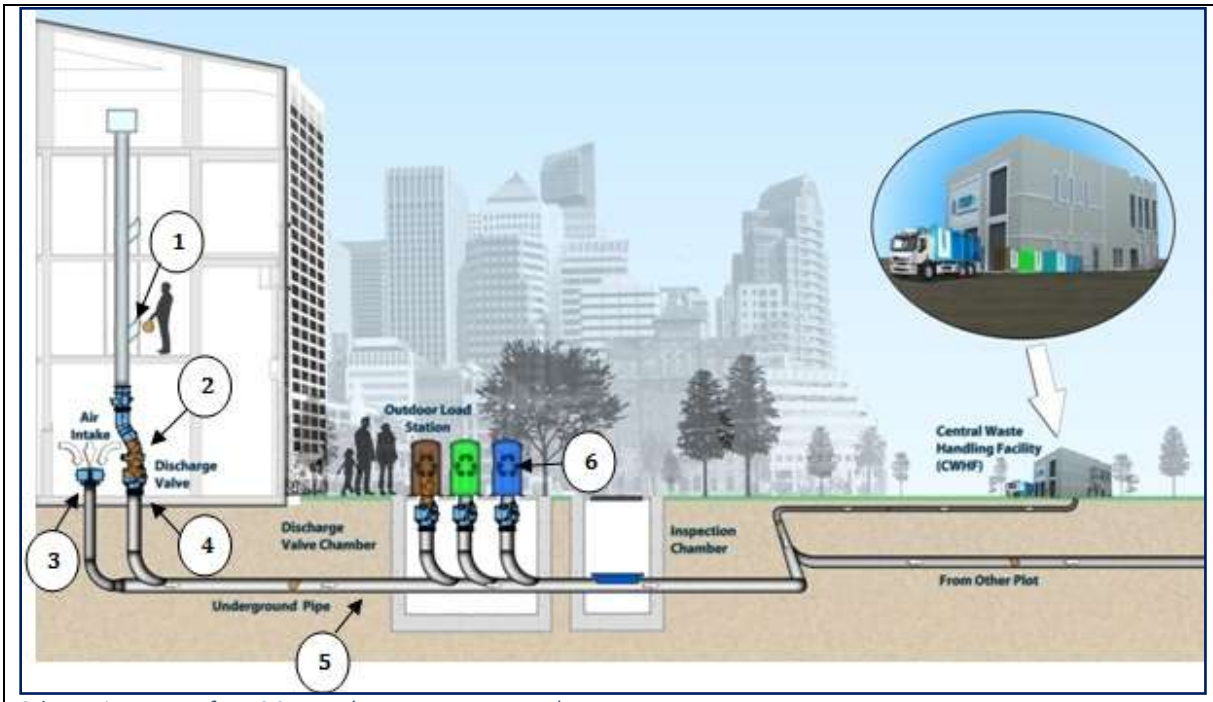
- Waste Treatment through Advanced Technology

The system would be capable for:

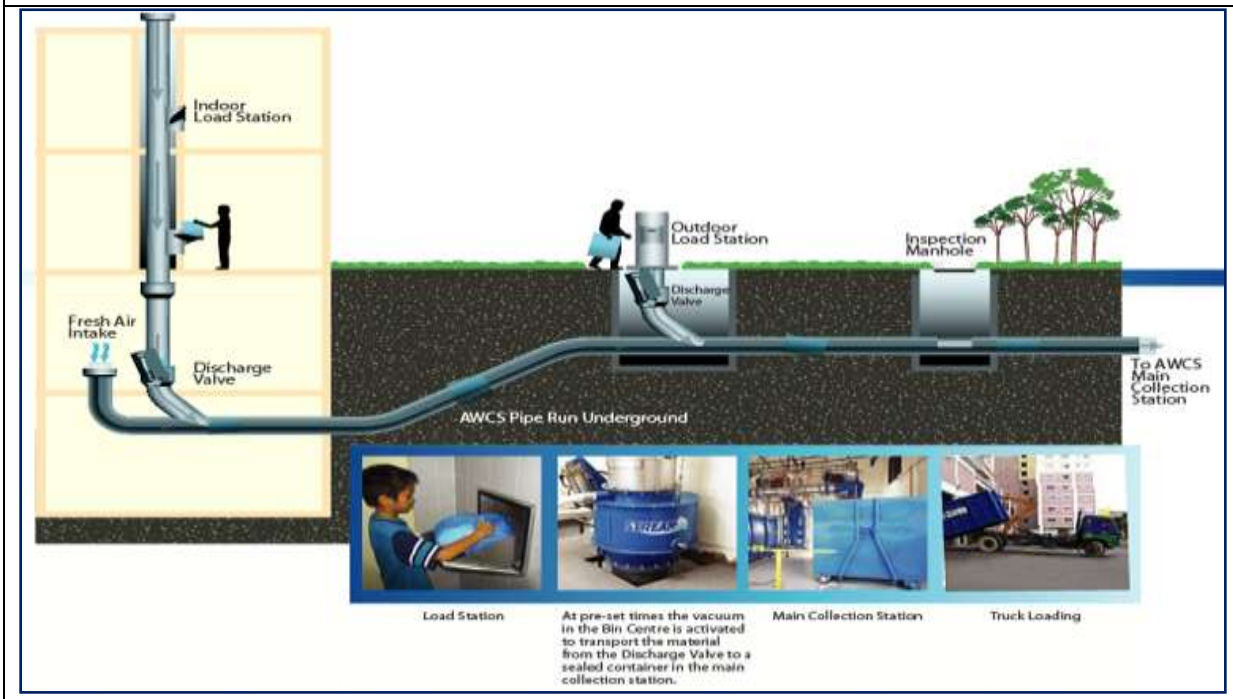
- Collection of waste from various primary and secondary locations
- Chutes and bins are connected through this system
- It also helps in segregation of waste
- It transports waste from different locations to a centrally located processing facility unit equipped with secondary segregation and treatment), thus no requirement of external waste transportation within the ABD Area.
- It will help in sorting of waste, thus with minimum human intervention, waste can easily be sorted into various categories.
- It would help in minimization of waste related nuisance within the township as this system would be running 24 X 7 underground.

How this system works:

- Chutes are used to feed waste into the system
- Storage section holds the waste between transport cycles
- Primary air inlet creates an active high-speed air path in the pipe network
- Discharge valves are periodically opened to allow movement of waste into the active air path
- Transport waste from the pipe path between the storage chambers and the Waste Handling Facility (WHF)
- Outdoor load stations that may also feed smaller quantities of waste material into the system



Schematic Layout of AWC System (Waste Management)



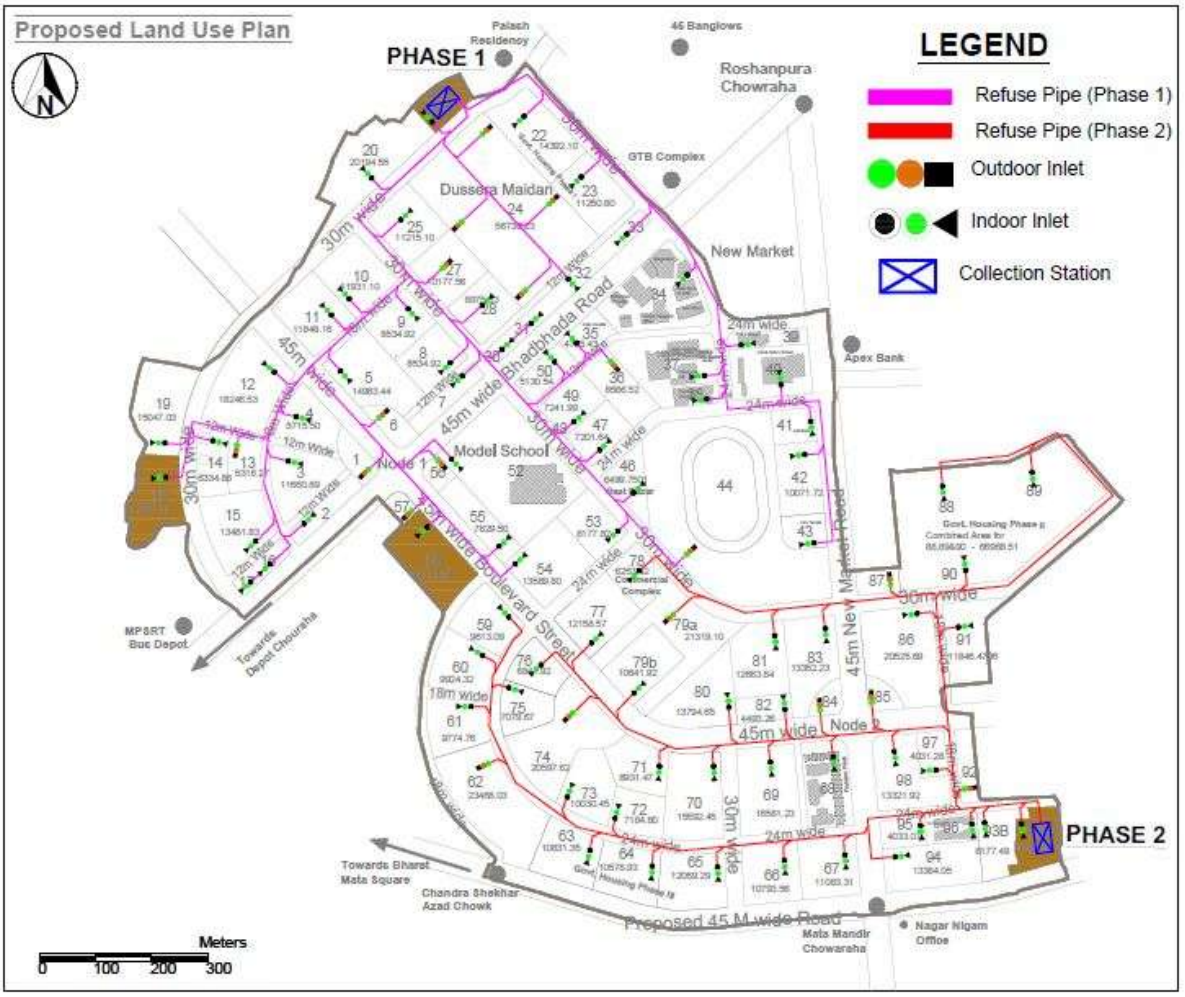
Integrated Approach for internal and external waste collection

Waste Collection from Public Areas

The wet waste collected separately will be treated using Bio Methanation process for generating electricity which can be used for plant operation and excess will be diverted to the other requirements within ABD area.

5.0 PROJECT LOCATION AND NETWORK

These plot is government owned land and currently govt. houses are constructued. The site is has little vegetation. In the proposed Master Plan, Plot No. 21 has 30 m wide road on the one side and for Plot No. 93 has 45 m wide road runs on one side and 24 along other side. As per the design requirements automatic solid waste network is divided in the two phases. The waste handling facility for phase I is situated in plot no. 21 and for phase II is situated plot in plot no. 93 respectively.



6.0

The objective of Automated Solid Waste Management System to be established by this Tender is the effective collection of solid waste generated from ABD Area and transferring it to the Waste Collection Station. At the Waste Collection Station, the solid waste is to be segregated to paper, plastics, metals and non-recyclables. The compacted non-recyclable waste is to be transported to the nearby Landfill. The Automated System shall have as minimum human intervention as possible.

Note:

1. The chutes for Govt. Housing Phase I, II & III is already taken in the respective awarded tenders. Contractor has to consider items only from these chutes to plot connection.

2. The contactor has to take items for Commercial Complex (plot no. 78), Haat Bazar (plot no. 46) and Dushera Maidan (plot no. 24) to connect these building to automated solid waste management network.
3. The existing building in the ABD area shall be considered to connect them with automated solid waste management network.
4. Facility for utility duct is already provided in the ABD Area for the pipe network laying. Only for road ROW less than 18m pipe network shall be buried or as per required site conditions.
5. For rest undeveloped plots in the ABD area, contractor has to lay the network upto plot level connection. Plot developer has to provide chutes upto the plot connection.
6. Bins shall be considered by the contractor for the along the road network, sitting areas and open/green spaces.

2.1 Definitions

2.1.1 Waste: In this Tender document, Waste refers to the solid waste generated from the ABD Area. The waste shall have the characteristics and composition of commercial refuse.

2.1.2 Vertical garbage chutes: In this Tender document, vertical garbage chutes refer to the vertical chutes provided in the in the govt. Buildings for the disposal of waste into the Automated Waste Collection System.

2.1.3 Temporary storage section: In this Tender document, temporary storage section refers to the storage section provided for the temporary storage of waste below the vertical garbage chutes.

2.1.4 Waste Conveyance Pipes: In this Tender document, waste conveyance pipes refer to the pipe which carries the waste from the Temporary storage section to the Central Waste Handling Facility.

2.1.5 WHF: Waste Handling Facility (WHF) is the Waste Handling Facility constructed for managing the waste from the sources. The WHF shall have necessary equipment for the collection, segregation and compaction of waste.

2.1.6 AWCS: Automated Waste Collection System (AWCS) refers to the Automated System to be provided by the Contractor for the collection of waste from the temporary storage section and transportation to WHF.

2.1.7 AWSCS: In this Tender document, Automated Waste Segregation and Compaction System (AWSCS) refer to the Automated System for segregation and compaction of waste which includes the Segregators, Compactorsand associated equipment.

2.1.8 Residue Transportation System: In this tender document, residue transportation system refers to the system for transportation of compacted non-recyclables from WHF to the nearby landfill identified.

2.1.9 Waste Bags: In this Tender document, waste bags refer to the bags in which waste is disposed off into the vertical garbage chutes.

2.1.10 Bins: In this Tender document, bins refer to the bins provided for collecting the segregated waste fractions (paper, plastics, non-recyclables) from the segregator.

2.1.11 Detachable Container: In this Tender document, detachable container refers to the containers in which the segregated waste is getting emptied from the bins and when it is full, it is taken away by trucks to designated places (recycling vendors for recyclables and landfill for non-recyclables)

2.1.12 Trucks: In this Tender document, truck refers to truck with hydraulically operated lifting mechanism for transportation of detachable containers.

2.2.1 Location of WHF

There are two waste handling facility proposed at plot no. 21 and 93 respectively.

The information given above is provided for the general information of the Contractor and the Engineer-in-Charge takes no responsibility whatsoever for their correctness and the Contractor is required to make their own enquiries and obtain such information and confirmation as is considered necessary by them.

The Contractor shall not be entitled to any claim in whatever manner on account of any error or difference of opinion in regard to these details

7.0 SCOPE OF WORK

Thissection describes the scope of workto be performed by the Contractor which includes the design, supply, construction, erection, testing and commissioning of AWCS and AWSCS for the waste from ABD with Operation and Maintenance for a period of 5 years.

The Contractor shall collect waste from the buildingsand plot of ABD Area and transport it to WHF by means of AWCS. The waste shall be received in the WHF in a air-waste separator which shall separate, waste from air. The waste is conveyed from the waste

separator to the waste segregator which shall segregate the waste to metals, paper, plastics and non-recyclables. The Contractor shall identify recycling vendors and sell the compacted recyclables to them. The non-recyclables shall be disposed in the nearby landfill. The Contractor shall identify the nearby landfill and obtain necessary permission for dumping the compacted non-recyclables.

The Operation & Maintenance of the entire system shall be done by the Contractor for a period of 5 years.The AWCS consist of Feeder system and Waste Conveyance Pipe Network. The Contractor shall coordinate with the tower building contractor and design suitable connection between the vertical garbage chutes and AWCS. The waste bags fall down from each floor of the government housing building by gravity.

The Contractor shall perform all coordination with Building Contractors of government housing building(designated vertical chute duct provider) to ensure seamless integration of the same in the AWCS

3.1 Feeder System Components

The feeder system shall consist of, but not limited to the following

i Temporary storage section

ii Discharge Valve

iii Waste level switch

iv Air inlet valves

3.1.1 Temporary storage section

In the ground floor of each tower, a temporary waste storage section shall be designed in the AWCS by the Contractor. There shall be airtight connection between the vertical garbage chutes and the temporary storage section. The temporary storage section shall have a capacity of 500 litres.

3.1.2 Discharge Valve

A discharge valve shall be designed below the storage section which discharges the waste to the AWCS when the level of waste in the storage section reaches above 85% of the height of the temporary storage section or at 24 hour intervals. The opening of the discharge valve shall be based on time or level cycles, whichever is earlier.

3.1.3 Waste Level Switch

The waste level switch shall assist in the efficient removal of waste from the temporary storage section to the AWCS. The level switch shall activate the waste removal from the temporary storage section when the level of waste in the storage section reaches above 85% of the height of the temporary storage section.

3.1.4 Air Inlet valves

The air inlet valves shall be designed to suck the necessary air required for carrying the waste to the WHF. This valve shall be operated pneumatically

3.2 Waste Conveyance Pipe

All the vertical garbage chutes shall be linked to waste conveyance pipes through the temporary storage section. The Contractor shall design the automated transfer of waste from the temporary storage section to the WHF through a waste conveyance pipe. The waste shall be carried by air through the waste conveyance pipe. The Contractor shall perform the design, providing, lowering, laying, jointing, backfilling , testing and commissioning of the waste conveyance pipes along the designated route as per the 'routing and location of WHF' as given in figure above. The waste conveyance pipe shall have inspection chambers and access covers for routine maintenance at strategic locations.

The waste conveyance system consists of the following components:

i. Waste Conveyance Pipe
ii. Valves and Fittings
iii. Inspection chambers and Access covers

The waste conveyance pipe shall convey the waste to the air-waste separators located in WHF.

3.3 Waste Handling Facility (WHF):

The WHF shall be designed for the automatic collection, segregation and compaction of waste which shall include, but not limited to the following

i Receiving the waste from the waste conveyance pipes
ii Separate the waste from the carrier air
iii Cleaning of the air from the air-waste separator
iv Segregate the waste into metals, paper, plastics and non-recyclables.

v The segregated waste shall be compacted into containers

vi The transportation of compacted non-recyclables to the landfill

The waste from the air-waste separators shall be segregated and compacted into containers by the AWSCS. The Contractor shall design the AWSCS in such a way that there is effective segregation of waste to paper, plastics, metals and non recyclables. The waste shall be segregated to metals, paper, plastics and non-recyclables. Each type of segregated waste shall be compacted and stored in different containers. The compacted non-recyclables shall be transported to landfill every day.

The total area available for WHF plant is 450 m^2 (15x30). The Contractor shall design, construct and erect the WHF building and the associated civil, electrical and mechanical works including, but not limited to

a. WHF building with proper entry and exit for trucks.
b. Loading/ Unloading area for trucks.
c. Approach road and internals road for the smooth and free movement of trucks and other vehicles.
d. Drainage
e. Water supply system for potable uses, fire fighting and cleaning. For water supply for cleaning, the water has to be taken from treated water rising Main and has to be stored in the sump in WHF area and a suitable jet washing system has to be provided by the Contractor.
f. Power supply system for all the electrical and mechanical equipment.
g. Room lighting and emergency lighting for the WHF
h. Ventilation arrangement with fresh air filters &propeller exhaust fans for WHF building and split AC units for control room.
i. Noise control and acoustic treatment system
j. Telecommunication facility

3.4 The WHF shall consist of, but not limited to the following

i. Exhausters
ii. Compressed air system
iii. Air-Waste Separator
iv. Waste Segregator with bins
v. Waste Compactors

vi. EOT cranes

vii. Exhaust air cleaning system

viii. Fire Alarm system and Portable type fire extinguishers

3.4.1 Exhausters

Exhausters shall be provided to create the air flow required for transporting the waste in the AWCS. When the discharge valve opens and discharges the waste to the waste conveyance pipe, the waste shall be carried away by the carrier air to the WHF. The velocity of air flow created by the exhausters shall ensure the smooth and fast transport of waste through the waste conveyance pipes, without any blockage in the system.

3.4.2 Compressed air system

Compressed air system shall be provided for the operation of all pneumatically operated valves & segregator unit.

3.4.3 Air-Waste separator

The waste carried to the WHF by the air flow shall first enter the Air-waste separator. The air-waste separators shall separate the waste from the carrier air. The carrier air shall be diverted to air-cleaning system. The waste shall be conveyed to the segregator.

3.4.4 Waste Segregator with bins

The output waste from the air-waste separator shall be fed to the waste segregator. The waste segregator shall segregate the waste to metals, plastics, paper and non recyclables. Each segregated waste fraction shall be received in bins. The bins, when full shall be replaced by empty bins. The full bins shall be emptied to the detachable containers with the help of EOT crane. If during segregation, the Contractor identifies significant quantity of biodegradable waste (if the biodegradable fraction is more than 30% of the total quantity of non-recyclables) in the non-recyclable waste fraction, it should not be send to landfill for dumping.

3.4.5 Waste Compactor

Segregated waste shall be compacted before transportation. The full bins from the waste segregator shall be emptied to the detachable containers. The waste compactor shall compact the waste in the containers to required compaction ratios which can optimize the waste transportation by trucks.

3.4.6 EOT Cranes

EOT cranes shall be provided which shall be enabling the movement of bins and containers. The full bins shall be lifted from the segregator's receiving end by the EOT cranes. When full bins are lifted from the segregator's receiving end, empty bins shall be placed at the segregator's receiving end, by the EOT cranes. The full bins shall be lifted to empty them to the detachable container by the EOT cranes. After the waste compaction the containers shall be lifted & unloaded in the loading/unloading bay. Also the empty containers from the loading/unloading area shall be lifted and kept back near the waste compactors.

3.4.7 Exhaust Air Cleaning System

The exhaust air cleaning system shall remove the dust, superfine particles, odour, excess moisture and pathogens from the exhaust air to permissible limits as per the applicable regulations.

There shall be noise control system which shall ensure that the noise from the exhaust air release is within permissible limits.

3.4.8 Fire Alarm system and Portable fire extinguishers.

An automated fire detection and alarm system shall be provided in the WHF along with portable fire extinguishers of suitable type.

3.5 Residue Waste transportation system

The compacted non-recyclables shall be transported to an existing Landfill site identified for its disposal. The Contractor shall identify an existing Landfill site where the non-recyclables can be dumped and obtain necessary permission from the concerned authority for dumping the compacted non-recyclables.

The Residue waste transportation system shall consist of detachable containers and trucks. The waste gets compacted in the detachable containers. The trucks shall have hydraulically operated lifting mechanism which can lift the detachable containers. The truck shall transport the containers till the Landfill site. The hydraulic mechanism shall tip the compacted non-recyclables from the container to the Landfill and bring the empty container back to the WHF.

3.6 Electrical System:

3.7 Instrumentation and Controls

- Automation of AWCS and AWSCS

  The plant shall be designed with all control and instrumentation equipment necessary to enable the plant to be operated from a single point.

  The control system shall include a visual display unit that provides rendering of the plant, enabling instigation of automatic control activities and manual over-ride, and indicating running status and key performance data for all component plant.

  The system shall also provide for the analysis, trending and archiving of selected performance data. Refer WHF section 7 part 4 for the Instrumentation and control specification.

3.8 General Requirements

3.8.1 Permits, approvals and clearances

The Contractor shall obtain all necessary approvals for the setting up of waste management system which includes but not limited to

i Authorization from MP State Pollution Control Board for setting up waste segregation and disposal facility in order to comply with the implementation programme laid down in Schedule I of Municipal Solid Waste (Management and Handling) Rules, 2016, notified by the Government of India.

ii Any other relevant approval

3.8.2 Services on all days a year

The AWCS and AWSCS shall beoperated on all days of the year. Automation is required to the extent possible to ensure the smooth and efficient operation of the system throughout the year.

3.8.3 Co-ordination with other Contractors

The Contractor shall ensure proper coordination with the other Contractors working in the area.

3.8.4 Shop Drawings

The Contractor shall submit shop drawings which shall indicate dimensions, description of materials, general construction, component connections, anchorage methods, hardware, including specific requirements

3.8.5 Routine and Breakdown Maintenance

It is absolutely Contractor's responsibility to look after all sorts of maintenance whether routine, preventive or break down or any other type of maintenance. The Contractor will be responsible to carry out day-to-day as well as periodic maintenance necessary to ensure smooth and efficient performance of the AWCS, AWSCS and Residue Transportation System.

3.8.6 O & M Manual

The Contractor shall prepare Operation & Maintenance (O&M) Manual for the entire AWCS, AWSCS and transportation of compacted non-recyclables to landfill during the O& M period of 5 years.

3.8.7 Work Plan

The Contractor shall prepare work plan for deployment of labour, trucks and equipment.

3.8.8 Deployment of Manpower

Contractor shall engage sufficient manpower to ensure smooth, efficient and satisfactory operation and maintenance of the AWCS, AWSCS and Residue Transportation system having qualification and experience required for due performance of the Contract. Since the whole system shall be automated to the extent possible to avoid human intervention, the deployment of manpower shall be limited to the bare minimum required.

3.8.9 All equipment and trucks

The Contractor shall procure all the equipment and trucks required for the smooth, efficient and satisfactory operation of AWCS, AWSCS and Residue Transportation System. The equipment and trucks procured shall conform to the specifications detailed in WHF Section 7 of this Tender document.

3.8.10 All Consumables for Operation& Maintenance

The Contractor at his expense shall provide all consumables like fuel, lubricants etc. which the Contractor may need to operate and maintain the AWCS and AWSCS equipment and the trucks for Residue Transportation System in good running condition

3.8.11 Environmentally friendly design

The AWCS and AWSCS shall be designed to ensure minimum negative impact on the environment. The WHF shall have noise control and air cleaning facilities to avoid any negative impact on environment. There shall not be any exceedance of regulatory limits

or violations of environmental regulations. There shall be 100 % compliance with all applicable regulations.

3.8.12 General Requirements of design

In general, the design shall assure

- Safe, adequate, uninterrupted collection, segregation, compaction and transportation of waste
- Optimization of collection, segregation, compaction and transportation processes
- Minimization of design, construction, operation, administrative and oversight costs
- Optimum use of power and other resources
- Optimization of Project schedule
- High quality services to the users,
- Safety of the operators and the systems
- Effective response to both standard and unusual operating conditions and shall take care of thechanges in waste generation patterns.
- Sound design and quality construction for long-term operational reliability
- Optimized maintenance and renewal/replacement programs to preserve the reliability and value of the system in a cost-effective manner,
- Stabilized cost of operation and maintenance and renewal/replacement during the period of O& M of 5 years.
- Ease of continued operation and maintenance of the AWCS and AWSCS during construction, start-up and testing.

3.9 Supply of material

The Contractor shall deliver, handle and store as per the manufacturer's recommendations all the required material including, but not limited to the following

i. The Bags for disposing waste to the vertical chutes.
ii. All pipes and Fittings
iii. The equipment in WHF

For the government housing building, one temporary waste storage section shall be provided by the contractor.Also pipes for the conveyance of waste from temporary storage area to the WHF shall be provided by the contractor.Transportation; handling and storage shall at all times be performed in a manner to avoid product damage. The equipment in the WHF shall include but not limited to the following:

a. Exhausters for creating the necessary suction required for carrying the waste through AWCS
b. All the pneumatically operated valves and necessary ancillaries.
c. Air-Waste separators
d. Air cleaning system which shall remove the fine dust, particulate matter, odour or any undesirable compounds and pathogens from the air separated from the waste.
e. Segregator
f. EOT crane
g. All piping & fittings, supports etc.
h. Air Compressor and dryer
i. Containers
j. Bins
k. Compactors
l. Trucks

The Contractor shall remain responsible for care and custody of all the required material and equipment

3.10 SHOP INSPECTION

Shop inspection and tests as per specified codes and standards shall be arranged by CONTRACTOR, to enable the PURCHASER / ENGINEER to inspect the equipment. In the event of waiver to any inspection / test as intimated by PURCHASER / ENGINEER , CONTRACTOR shall submit test certificates for PURCHASER's / ENGINEER's approval. Sufficient copies of inspection certificates shall be furnished as per Schedule of distribution of documents. The BIDDERs shall include these services in his scope.

3.11 START-UP AND COMMISSIONING

- The CONTRACTOR's scope of work shall include erection, trial runs, testing, start-up, performance recalibration, commissioning and performance / Acceptance tests covered in this specification.
- Performance testing of complete works and the individual equipment to prove the guarantees offered.

- CONTRACTOR shall furnish calibration certificates for the instruments to be used for testing and commissioning at shop and site. The calibration certificates furnished by the CONTRACTOR shall not be more than 12 months old.
- Factory Acceptance Tests (FAT)

  (a) Contractor shall demonstrate functional integrity of the various I&C items including the system hardware and software covered in this specification. No material or equipment shall be transported until all required tests are completed & Purchaser gives the dispatch clearance.

  (b) Contractor shall submit QAPs for Control Panel, cables and all other items covered in the specification to Purchaser/ Consultant for approval. The FAT for the items shall be performed in accordance with the approved QAPs.

  (c) Testing & FAT shall be carried out in two phases. The minimum requirement for testing during these two phases shall be as follows:

  (d) Under the first phase bidder shall perform tests at his works to ensure that all components function in accordance with the specifications. A test report shall be submitted for the Purchaser's review within one week of completion of this test.

  (e) Contractor shall notify the Purchaser at least three (3) weeks prior to factory acceptance test. This shall be the second phase of testing which shall be carried out systematically, fully and functionally test all hardware and software.

  (f) The FAT for the Control Panel shall be performed by the contractor & witnessed by Purchaser / Consultant in accordance with the approved QAP. The Control Panel shall be inspected by the Purchaser / Consultant before despatch from the Contractor's place.

  (g) For Other items like instruments, cables etc. Contractor shall provide the test certificates as per QAPs approved by the Purchaser/ Consultant for the same.

- Site Acceptance Tests (SAT)

(a) Full integrated site acceptance test shall be performed before hand over of total system to the Purchaser. The test shall demonstrate functionality of the entire system supplied & erected by the Contractor. The Contractor shall provide all personnel, test facilities, equipment and tools etc. for the same. All test instruments shall have calibration certificates from approved test house, valid for minimum 6 months. A test procedure is required for approval 2 weeks prior to the schedule start. The total Control Panel shall be tested for three days at full load condition as part of SAT.

(b) Commissioning of works

(c) Commissioning Procedure shall be carried out in a methodical sequence as follows

(i) Start-up,
(ii) Initial running,
(iii) Operability adjustment,
(iv) Stable operation
(v) Final adjustment

(d) The Contractor shall check the operating conditions of the system by constantly monitoring operating data.

(e) The Contractor shall specify for each discrete part of the works, the operational data to be recorded and the manner in which the data is to be taken.

(f) All the operating data shall be recorded, evaluated and submitted to the Purchaser.

- The CONTRACTOR shall submit sufficient copies of AS-BUILT drawings.

3.12 Operation and Maintenance

The Operation and Maintenance (5 years) of the AWCS, AWSCS and Residue Transportation System shall be done as per the Technical and General Specifications for Operation and Maintenance detailed in WHF Section 9. The O&M should include, but not limited to the following

i Training to users

The Contractor shall provide training to the users of the system. The precautions while using the system, the types of waste which can/ cannot be thrown to the system etc should be made clear to the users.

ii Cleaning and maintenance

The AWCS and AWSCS systems shall be cleaned at frequent intervals and should be maintained clean during the entire period of O&M.

iii Product Support and Warranties

The Contractor shall provide product support and warranties of all mechanical and electrical equipment associated with AWCS and AWSCS.

iv Spare Parts

The Contractor shall provide spare parts for all the equipment for AWCS and AWSCS as and when required.

The Contractor shall ensure proper handing over of the O&M of the system, at the end of the contract period of 5 years.

CIVIL WORKS

CONTENTS

GENERAL BUILDING WORKS

APPLICABLE CODES AND SPECIFICATIONS

The more important Codes, Standards and Publications applicable to this section are listed hereinafter:

Code Reference	Description
IS: 110	Ready mixed paint, brushing, grey filler, for enamels for use over primers
IS: 269	Specification for 33 grade Ordinary Portland Cement
IS: 280	Specification for mild steel wire for general engineering purposes
IS: 287	Recommendations for maximum permissible moisture content of timber used for different purposes
IS: 383	Specification for coarse and fine aggregates from natural sources for concrete
IS: 456	Code of practice for plain and reinforced concrete
IS: 712	Specification for building limes
IS: 1077	Specification for common burnt clay building bricks
IS: 1124	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones
IS: 1200	Methods of measurement of building and Civil engineering works
IS: 1489 (Part 1)	Portland Pozzolana Cement: Flyash based
IS: 1489 (Part 2)	Portland Pozzolana Cement: Calcined clay based
IS: 1542	Specification for sand for plaster
IS: 1597	Code of practice for construction of stone masonry: Part 1 Rubble stone masonry
IS: 1661	Code of practice for application of cement and cement-lime plaster finishes
IS: 1834	Specification for hot applied sealing compound for joint in concrete
IS: 2074	Ready mixed paint, air drying, red oxide-zinc chrome, priming
IS: 2116	Specification for sand for masonry mortars
IS: 2185	Specification for concrete masonry units (Parts 1 & 2)
IS: 2212	Code of practice for brickwork

Code Reference	Description
IS: 2250	Code of practice for preparation and use of masonry mortars
IS: 2395 (Parts 1 & 2)	Code of practice for painting concrete, masonry and plaster surfaces (Parts 1 & 2)
IS: 2402	Code of practice for external rendered finishes
IS: 2572	Code of practice for construction of hollow concrete block masonry
IS: 2645	Specification of integral cement waterproofing compounds
IS: 2691	Specification for burnt clay facing bricks
IS: 2750	Steel Scaffoldings
IS: 3620	Specification for laterite stone block for masonry
IS: 3696	Safety code of scaffolds and ladders (Parts 1 & 2)
IS: 4082	Recommendation of Stacking and Storage of construction materials
IS: 5410	Cement paint, colour, as required
IS: 6041	Code of practice construction of autoclaved cellular concrete block masonry
IS: 6042	Code of practice for construction of light weight concrete block masonry
IS: 8042	Specification for white Portland cement
IS: 8112	Specification for 43 grade Ordinary Portland Cement
IS: 12269	Specification for 53 grade Ordinary Portland Cement
Legend	
IS	Indian Standards

QUALITY ASSURANCE AND QUALITY CONTROL

1.1 The work shall conform to high standards 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.

1.2 At the site level the Contractor shall arrange the materials, their stacking/ storage in appropriate manner to ensure the quality. Contractor shall provide equipment and manpower to test continuously the quality of materials, assemblies, etc., as directed by the Engineer. The tests shall be conducted continuously and the results of tests maintained. In addition, the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes and evenness of the surface.

1.3 The Engineer shall be free to carry out such tests as may be decided by him at his sole discretion, 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.

1.3.1 The test shall be conducted at the Site laboratory that may be established by the Contractor or at any other Standard Laboratory selected by the Engineer.

1.3.2 The Contractor shall transport the samples to the laboratory for which nothing extra shall be payable. In the event of Contractor failing to arrange transportation of the samples in proper time Engineer shall have them transported and recover two times the actual cost from the Contractor’s bills.

1.3.3 The testing charges shall be borne by the Contractor.

1.3.4 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.

Part -1: GENERAL REQUIREMENTS

1.0 PREAMBLE

These specifications cover the items of works in structural and non structural parts of the works coming under purview of this document on Design build contract basis. All work shall be carried out in conformation with this specification. In general, provisions of Indian Standards, Indian Roads Congress Codes and other National Standards shall be followed. These specifications are not intended to cover the minute details. The work shall be executed in accordance with the best modern industry practices. All Codes and Standards referred to in these specifications shall be the latest published ones.

The work to be performed under this specification consists of design, engineering, preparation of detailed specifications, general arrangement, construction, fabrication and erection drawings including supply of all labour, materials, consumables, equipment, temporary works, temporary labour and staff colony, constructional plant, fuel supply, transportation and all incidental works not shown or specified but reasonably implied or necessary for the completion and proper functioning of the campus, all in strict accordance with the specifications, including revisions and amendments thereto as may be required during the execution of the work.

The work shall be carried out according to the detailed design, drawings and specifications to be developed by the Contractor and approved by the Engineer/ Engineer's Representative. For all buildings, structures, etc., necessary details are to be developed by the Contractor keeping in view the statutory & functional requirements of the campus and facilities and providing enough space and access for operation, use and maintenance. Certain minimum requirements are indicated in this specification for guidance purpose only. However, the bidder's offer shall cover the complete requirements as per the best prevailing practices and to the complete satisfaction of the Engineer.

The scope shall also include setting up a complete testing laboratory in the field by the Contractor to carry out all relevant tests required for the works.

Civil Works

i. Design and construction of entire Central Waste Handling Facility Building consisting of exhausters, air-waste separators, air cleaning system, segregators, compactors, conveyor belts, segregated waste collection bins, containers, etc.

ii. Design and construction of approach and internal roads for the smooth movement of vehicles hauling recyclable and non recyclable waste including storm water drains along the roads, footpath, footpath kerbs, street lighting as per internal layout plan and technical specifications.

iii. The design and construction of drains at the Central Waste Handling facility site for proper drainage.

iv. RCC Foundation shall be provided for major equipment such as Exhausters, Compactors,segregators, electrical equipments and panels, etc.

v. The bidder shall carry out works for providing, lowering & laying jointing testing and commissioning of Carbon Steel pipe of API 5L Grade Balong with necessary valves, fittings and accessories.

1.1 DETAILED DESIGN BY CONTRACTOR

1.1.1 The Contractor's detailed design shall comply with the Engineer's requirements as outlined in the Master Plan, Design Specifications and Drawings, which are made part of this specification. All other materials and components shall be accommodated within the locations, space and dimensions indicated on the layout drawings.

1.1.2 The detailed design of buildings and structures shall be evolved considering the strength and serviceability requirements as per the relevant standards and specifications, functional, technological, operation & maintenance of MEP services and other requirements for efficient operation, ensuring comfortable working environment for personnel, satisfying the aesthetic requirements. Special care shall be taken to provide elegance and aesthetics, with effective use of appropriate treatment, materials, fittings and finishes.

1.1.3 The Contractor shall design and construct all buildings and structures to meet the stipulated performance and quality requirements of the Contract and to the approval of the Engineer.

Approval by the Engineer shall not relieve the Contractor of any of his responsibilities under the Contract.

1.2 The bid purpose drawings are provided to enable Contractor to carry out design for the project in line with the specification requirements. These drawings are indicative only and represent the minimum construction, quality, scope, dimensional and space requirements. The drawings are issued subject to increase in quantity, quality and space requirement as recommended by the Contractor or as may be instructed by the Engineer to accommodate the actual operational requirements of the Project.

1.3 The Contractor shall himself make all necessary independent investigations and studies to ensure that the design of all buildings/ structures including all

foundations and site development meets with the requirements of the Contract and is suitable and adequate for the purpose.

1.4 Contractor shall inspect the site, examine and obtain all information required and satisfy himself for site conditions such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work, availability of local labour, materials and their rates, local working conditions, weather, tidal / flood levels, subsoil conditions, natural drainage, etc. Ignorance of the site conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time. The submission of a bid by the Contractor will be construed as evidence that such an examination was made and any later claims / disputes in regard to price quoted shall not be entertained or considered by the Owner on account of ignorance of prevailing site conditions.

1.5 SURVEY DATA

1.5.1 The Owner has carried out a preliminary survey of the area and drawings indicating the survey detail along with contours are enclosed. This should be treated as for information only. It is the responsibility of the Contractor to verify the various features on his own before submission of bid.

The Owner does not take any responsibility for correctness of various features / contour shown on the drawing.

1.5.2 The Contractor is not eligible for any extra cost or any extension of time if the results from his detailed survey and actual conditions at site are at variance to any extent from the information given in the Survey drawing furnished by Owner.

1.6 A preliminary Geotechnical Investigation was carried out at the site by the Owner has been made available to the Contractor in good faith. The Contractor may execute further detailed site investigations to ascertain the correctness of data and satisfy himself about the physical characteristics of the soils in order to confirm the necessary design of foundations and structures of the project and shall acquaint himself fully in regard to the intent and meaning of the subsurface data as indicated by the geotechnical investigation report and other data provided by the Owner.

2.0 DESCRIPTION OF SITE RELATED INVESTIGATIONS AND SITE DEVELOPMENT WORKS

2.1 SITE RELATED INVESTIGATIONS

2.1.1 Topographical Surveying

(a) Precision Surveying shall be carried out under the direction and control of a Licensed Land Surveyor. Precision theodolites used shall be of one second accuracy. Self-aligning levels shall be used for precision level survey. All Bench Mark (BM) levels of the survey shall be established with reference to the nearest GTS bench mark available. Precision leveling shall

be carried out for establishing the BM at site by carrying levels from GTS BM adopting double circuit leveling.

(b) All boundary lines shall be located with their distances, included angle and bearings and boundary pillars constructed. Number of pillars shall be adequate to mark the boundary limits without any dispute. A closed traverse survey shall be carried out with precision theodolite to form the framework for the detailed survey work.

(c) The two reference line, North-South line and East-West line at right angles to each other shall be established with grid pillars constructed at 100 metres c/c in both directions in such a way that these pillars will not be disturbed during construction. Coordinates shall be painted on these grid pillars. Pillars shall also be painted using synthetic enamel paint for easy identification. Bench mark pillars shall be provided at least at 6 locations. These pillars shall be properly protected to prevent their disturbance during construction activities. BM shall be distinguished from grid pillars with different type of painting.

(d) Spot levels shall be taken in a grid of 5 meters and contours shall be established at an interval of 500 mm. All contour levels shall be with respect to MSL.

(e) The survey map should identify all topographical features such as but not limited to buildings, structures, underground utilities, burial grounds, wells, natural drains, roads, footpaths, depressions, rock out crops, underground sources, overhead transmissions lines, telephone lines or any other obstruction, trees and prominent vegetation. In addition, all wet land and marshy stretches shall also be identified. Contractor shall prepare contour map to a scale of 1 in 1000 in Autocad. In addition, Contractor shall prepare LS and CS of the site at suitable intervals to adequately represent actual topography. For natural drains and other water courses sections at closer intervals shall be provided. In case the site is situated on the sea shore or river bank, the coastal regulation zone (CRZ) shall be clearly marked in the contour plan, in addition to highest water level occurred once in 50 years.

(f) Contractor shall furnish one soft copy in the form of CD along with six copies of all survey drawings to the Owner for his reference.

2.1.2 Geotechnical Investigation

(a) Detailed geotechnical investigation to verify the results of the preliminary investigation by Owner, shall be carried out by the Contractor.

(b) Based on the plot plan developed, the Contractor shall prepare field and laboratory testing scheme and obtain the approval of Owner prior to commencing the investigation. It shall be ensured that the boreholes are provided and spread judiciously to cover all major structures as well as equipment foundations.

(c) Following minimum field tests shall be conducted:

- Bore Holes and standard penetration tests,
- Static Plate load tests,
- Cyclic Plate load tests,
- Permeability tests,
- Field density tests,
- Vane Shear tests,
- Static Cone and dynamic cone Penetration tests,
- Soil resistivity tests,
- Pressure meter tests,
- CBR tests,
- Initial Pile Load Tests,

(d) All bore holes shall be sunk up to a depth of 45.0 m or 5.0 m continuous into hard rock whichever is earlier.

(e) Standard penetration tests (SPT) and collection of undisturbed soil samples (UDS) shall be carried out alternatively at 1.0 m intervals and at significant change of strata. The interval shall be increased to 1.5 m below 5.0 m depth of boring. UDS shall be replaced by SPT in cohesion less strata. Even in highly weathered / disintegrated rock, where core recovery is poor, SPT shall be conducted. The first SPT in any borehole shall be conducted at 1.0m depth.

(f) In rock strata, core recovery and Rock Quality Designation (RQD) shall be noted carefully for each run, immediately after cores are taken out of barrel.

(g) During boring, the level at which ground water is struck shall be carefully noted. Ground water samples shall be collected for chemical analysis. Water samples shall be collected before the addition of water or drilling mud to the hole.

(h) Following minimum laboratory tests shall be conducted: (Preferably on Undisturbed soil samples and if UDS is not possible, on remoulded soil samples).

- Grain size analysis,
- Hydrometer analysis,
- Sieve analysis,

- Specific Gravity,
- Chemical Analysis of soil and ground water including Sulphates, Chlorides, pH value, etc.,
- Chemical Analysis of 2:1, Water: Soil extract of the samples giving SO3 content,
- Consistency Index: Liquid Limit, Plastic Limit, Plasticity Index, Shrinkage Limit and Shrinkage ratio,
- Consolidation test giving all relevant parameters,
- Swelling pressure and free swell index for expansive soils,
- Unconfined Compressive Strength on soil samples,
- Direct Shear Test,
- Tri axial Compressive Strength Tests,
  - Unconsolidated Undrained Test,
  - Consolidated Undrained Test,
  - Consolidated Drained Test,
- Moisture-density relations for Standard Proctor and Modified Proctor tests,
- Crushing Strength, specific gravity, unit weight, water absorption test on Nx size rock specimens,
- Tests to determine CBR values for design of roads at different locations,

i) The Geotechnical investigation report shall necessarily include, but not be limited to the following information.

- Recommended types of foundation,
- Allowable safe bearing capacities and settlement values in different strata for shallow foundations indicating relevant design criteria adopted, method of analysis adopted etc.,
- If pile foundations are necessary, type of piles recommended with reasons for the same, length, diameter, allowable capacity (vertical,

lateral and pullout) of individual and groups of piles, negative skin friction if any and magnitude of estimated negative skin friction,

- Recommendations for values for modulus of sub grade reaction for foundation design,
- Type of cement to be used for concrete substructures and in stone / brick masonry foundations with reference to the chemical nature of subsoil and ground water,
- Recommendations regarding excavations (shallow & deep), embankment, safe side slopes for excavation and embankment, dewatering, site drainage, etc.,
- Recommended soil properties such as density, specific gravity, cohesion, angle of internal friction etc. for design,
- Precautions to be taken for design of lightly loaded structures when expansive soil is encountered with respect to swelling pressure and free swell index values obtained.CBR values for design of pavements.

2.1.3 Climatic and Traffic Data Collection

The Contractor shall be deemed to have collected information such as climatic, traffic, etc and all other data required for the satisfactory completion of works from the concerned authorities to his satisfaction. Claims due to ignorance of any such data requirements will not be considered after submission of Bid.

2.2 SITE DEVELOPMENT WORKS

2.2.1 Site Clearance

(a) The building areas in the site shall be cleared of all trees, shrubs or other vegetation, rubbish, slush etc and other objectionable matters. If any roots or stumps of trees are met during excavation, they shall also be removed. Where earth fill is intended, the area shall be stripped of all loose / soft patches or top soil containing objectionable matter before filling commences. Any structure or services existing at the site shall be removed / rerouted with the permission of the Engineer. Existing wells, pits, marshy areas etc shall be filled up with earth of approved quality.

(b) The Contractor shall be deemed to have visited and carefully examined the site and surroundings and to have satisfied himself about the nature of the existing structures, underground services, general site conditions, and the site

for disposal of surplus materials, debris etc and all other items affecting the work.

(c) Green Building Requirements like preserving top soil; erosion control etc shall be followed.

(d) Claims due to ignorance of site conditions will not be considered after submission of Bid.

2.2.2 Site Grading

(a) The bid drawing is indicating grade levels based on the preliminary survey work. The Contractor shall conduct a study on the site grading to fix the grade levels at various locations of the plot based on the detailed topographical survey conducted at site by him, and the information given by engineer to match the overall master plan and infrastructure master plan.

(b) The Contractor's site grading proposal may consider optimum use of locally available earth in addition to achieving the above objective. Fills shall normally be made up of CNS material capable of being compacted up to 95% Modified Proctor density. In case earth has to be borrowed from outside the plot boundary, the same shall be arranged by the Contractor himself.

Earth from Swamps, marshy as well as bogs, expansive type of clays, peat, organic material, material susceptible for combustion, material which will react with other material already used in work shall not be used as borrow material. A minimum side slope of 1 vertical: 2 horizontal shall be maintained at all slopes.

(c) Slopes shall be provided with proper protection to prevent erosion.

3.0 DOCUMENTS TO BE SUBMITTED BY BIDDER ALONG WITH DESIGN AND BUILD BID

PERTAINING TO CIVIL WORKS

3.1 Suggested plot plan locating all buildings, structures, facilities, roads, temporary site office, etc. with their plan dimensions.

3.2 A study note on proposed site grading with levels along with certified data collected from various agencies to arrive at the same. Also the source of earth to be used as fill having quality as per specification should be indicated.

3.3 Concept Note or Detailed write up on the following satisfying the statutory requirements,

3.3.1 Proposed shoring system for excavation during construction where water table is higher.

3.3.2 Proposed dewatering system during construction where water table is higher.

3.3.3 Waterproofing system and detailed methodology proposed for each area.

3.4 A report on foundation proposed for various structures, buildings and facilities based on the data furnished by the Engineer and further data collected by the Contractor. Allowable safe bearing capacity for open foundation, depth of foundation, need for pile foundations, type, length and capacity of piles, if piles are proposed, soil improvement if any required, special precaution against aggressive soil etc shall also be covered in the report.

3.5 Detailed design criteria proposed to be adopted for each building, structures etc.

3.6 List of software proposed to be used in various areas for analysis, design, drafting as well as project monitoring along with their sources and validation report for software.

3.7 Details of quality control laboratory with a list of testing equipment.

3.8 All deviations from bid document shall be furnished by Contractor in the format given in the specification document. Deviation furnished elsewhere in the bid other than at the place titled “Deviations” will not be considered as deviations.

3.9 Any exclusions from the scope mentioned and implied in these specifications, shall be clearly mentioned by the Contractor separately in a section titled “EXCLUSIONS”. Only the details mentioned in this section shall be considered as exclusions. All works, other than these, shall be deemed to be in the scope of this contract and shall be executed by the Contractor at no extra cost to the Engineer.

4.0 DOCUMENTS TO BE SUBMITTED BY CONTRACTOR AFTER THE AWARD OF CONTRACT

PERTAINING TO CIVIL WORKS

The following documents are to be submitted for the approval of the Engineer, prior to commencement of construction/ fabrication & erection.

The list is not exhaustive but indicative only:

4.1 Topographical survey drawings along with location and details of bench mark, grid and boundary pillars based on detailed survey conducted after the award of work.

4.2 Geotechnical investigation report based on additional geotechnical investigation carried out by Contractor along with foundation recommendation for various buildings / structures / facilities.

4.3 Site Grading and Storm Water Drainage Concept Note furnishing levels of various terraces, arrangement and details of drains, culverts etc for storm water drainage system within plot. The study shall also cover harvesting of rain water to the maximum extent.

4.4 General plot layout drawing with co-ordinates of roads, boundary wall, buildings and facilities, piping / cable corridors, provision of landscaping and green belt development, diversion drains etc.

4.5 Drawing showing underground facilities with co-ordinates of these facilities like buried pipes, buried cables, trenches, ducts, sewer, drains, sumps, pits, culverts, foundations etc.

4.6 Detailed Architectural floor plans, elevations, cross sections and perspective view (in colour) of all buildings/ structures. Detailed drawings of all architectural works shall include finish schedule, colour scheme (both internal and external), doors and windows, flooring and false ceilings, etc.

4.7 Detailed Design Reports for all buildings, structures and facilities along with design calculations and drawings for foundations/ substructure and superstructure and other structures within the premises. Design calculations to include dynamic analysis for all foundations subjected to dynamic loads. Design and drawing of vibration isolation system shall also be furnished in case the same will be supplied along with the equipment.

4.8 All other designs, details / drawings or any other submissions as indicated elsewhere in this specification and as required by the Engineer.

4.9 Details of corrosion protection measures for all structures.

4.10 Copies of all reports on investigation and studies carried out by the Contractor as per the scope.

4.11 Total quantity of concrete (grade wise), reinforcement steel (diameter wise) and structural steel (section wise) in all construction drawings.

4.12 Fabrication drawings for important structures or any other structure specifically called for by the Owner or his authorized representatives.

4.13 Contractor shall submit 6 copies of each drawing for each revision for approval before commencing any work. While scheduling contractor should consider approval period of 10-15 days for each drawing and calculation. The responsibility of scheduled approval from Engineer or Engineer's representative before commencing any work lies with contractor.

PART -2: DESIGN BASIS FOR CIVIL WORKS

The following design basis shall be followed in general for designing the building and its supporting structures.

1.1 STRUCTURAL SPECIFICATION

1.1.1 LOADS

The structures are designed for the following loads.

1.1.1.1 Dead Loads

The dead loads to be considered in design of structures are based on following density of materials as per IS-875(Part-I)-1987

Parameter	Value
Density of water	10 kN/m^3
Density of Plain Concrete	24 kN/m^3
Density of Reinforced Concrete	25 kN/m^3
Weight of brickwork (exclusive of plaster)	22.00 N/m^2 per mm thickness of brickwork

1.1.1.2 Live Loads

The live loads considered for the design are as per IRC: 875(Part-II)-1987 and are as follows.

Parameter	Value
Live load on roofs	1.50 kN/m^2
Live load on floors supporting equipment such as pumps, blowers, compressors, valves etc.	10.00 kN/m^2
Live load on all other floors walkways, stairways and platforms	5.00 kN/m^2

1.1.1.3 Wind Loads

Wind load on the structure is IS: 875 (Part-III)

1.1.1.4 Seismic Loads

Ahmedabad region falls in Zone III of Seismic map of India given in IS-1893-2000(Part-I).

1.1.2 COMBINATION OF LOAD CASES

Combinations of the above loads are carried out as IS: 456-2000.

1.1.3 DESIGN

a. Design of all Reinforced Concrete members are as per IS: 456-2000 & IS-3370:2009. Working Stress method is used for the design of all water retaining components.

b. All the liquid retaining structures shall be design for maximum design crack widths of 0.1mm for direct tension and flexure.

1.1.4 GRADE OF CONCRETE AND REINFORCEMENT

The following grade of concrete and steel shall be used:

a. For Water Retaining Structures – M30 concrete

b. For other Structures – M30 concrete

c. For all Structures – Fe 500 - HYSD reinforcement

1.1.5 CLEAR COVER TO REINFORCEMENT

The minimum clear cover to reinforcement shall be as follows:

a. For All Water Retaining Structures (Walls, Columns, Beams, Slab, Base Slab etc) – 50mm

b. The minimum cover to the main reinforcing bars for different members for non–water retaining structures shall be as follows unless stated otherwise:

Slab (Floor, Roof, Canopy and Staircase) 30 mm

Beams (Sides, Bottom & Top) 40 mm

Columns 50 mm

Pedestals (in contact with earth) 50 mm

Basement wall, retaining walls

i. Face in contact with earth 40 mm

ii. Interior face 30 mm

Foundations 75 mm

1.1.6 DESIGN CONDITIONS FOR UNDERGROUND OR PARTLY UNDERGROUND LIQUID RETAINING STRUCTURES

For design of all structures, water level is assumed as per geotechnical investigation report. All underground or partly underground liquid containing structures shall be designed for the following conditions:

i. Liquid depth up to full height of wall: no relief due to soil pressure from outside to be considered;

ii. Structure empty (ie., empty of liquid, any material, etc.): full earth pressure and surcharge pressure wherever applicable , to be considered ;

iii. Partition wall between dry sump and wet sump : to be designed for full liquid depth up to full height of wall;

iv. Partition wall between two compartments : to be designed as one compartment empty and other full;

v. Structures shall be designed for uplift in empty conditions with the water table as indicated in geotechnical report;

vi. Walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads;

vii. Underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab. A minimum factor of 1.2 shall be ensured against uplift or floatation.

viii. All the liquid retaining structures shall be design for maximum design crack widths of 0.1mm for direct tension and flexure.

1.1.7 SAFE BEARING CAPACITY

The data for safe bearing capacity of the soil shall be obtained from the soil investigation report.

PART – 3: EARTHWORK IN GRADING, EXCAVATION AND BACK FILLING

1.0 SCOPE

This specification covers the general requirements of earthwork in excavation in different materials, site grading, filling in areas as shown in drawing, filling back around foundations and in plinths, conveyance and disposal of surplus soils or stacking them properly as directed by the Engineer and all operations covered within the intent and purpose of this specification.

2.0 APPLICABLE CODES

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to.

1. IS 783 - Code of practice for laying of concrete pipes.
2. IS 1200 - Method of measurement of building and civil engineering works.

   (Part 1) - Part 1 Earthwork

   (Part 27) - Part 27 Earthwork done by mechanical appliances.
3. IS 3764 - Excavation work-code of safety.
4. IS 2720 - Methods of test for soils:

   (Part 1) - Part 1 Preparation of dry soil samples for various tests

   (Part 2) - Part 2 Determination of water content

   (Part 4) - Part 4 Grain size analysis

   (Part 5) - Part 5 Determination of liquid and plastic limit

   (Part 7) - Part 7 Determination of water content-dry density relation using light compaction

   (Part 8) - Part 8 Determination of water content-dry density relation using heavy compaction

   Part (9) - Part 9 Determination of dry density - moisture content relation by constant weight of soil method

   (Part 14) - Part 14 Determination of density index (relative density) of cohesionless soils

   (Part 28) - Part 28 Determination of dry density of soils in place, by the sand replacement method

(Part 29) - Part 29 Determination of Dry Density of Soils In-place by the Corecutter Method

(Part 33) - Part 33 Determination of the density in place by the ring and water replacement method

(Part 34) - Part 34 Determination of density of soil in place by rubber balloon method

(Part 38) - Part 38 Compaction control test (Hilf Method)

3.0 DRAWINGS

3.1 The Contractor shall furnish drawings wherever, such drawings are required to show areas to be excavated/ filled grade level, sequence of priorities etc. The Contractor shall obtain Engineer's approval before proceeding with works and follow strictly such approved drawings.

4.0 GENERAL

4.1 The Contractor shall furnish all tools, plants, instruments, qualified supervisory personnel, labour, materials any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the job in accordance with the specification requirements.

4.2 The Contractor shall carry out the survey of the site before excavation and set properly all lines and establish levels for various works such as earthwork in excavation for grading, foundations, plinth filling, roads, drains, cable trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/ grid lines at 8 m. intervals or nearer as determined by the Engineer based on ground profile. These shall be checked by the Engineer and thereafter properly recorded.

4.3 The excavation shall be done to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night for ensuring safety.

4.4 Rock/ soil excavated shall be stacked properly as directed by the Engineer. As a rule, all softer material shall be laid along the centre of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.

5.0 CLEARING

5.1 The area to be excavated/ filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter. If any roots or stumps of trees are met during excavation, they shall also be removed. The material so removed shall be burnt or disposed off as directed by the Engineer.

Where earth fill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter/ materials before fill commences.

6.0 PRECIOUS OBJECTS, RELICS, OBJECTS OF ANTIQUITY, ETC.

6.1 All gold, silver, oil, minerals, archaeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the Owner and the Contractor shall duly preserve the same to the satisfaction of the Owner and from time to time deliver the same to such person or persons as the Owner may from time to time authorise or appoint to receive the same.

7.0 CLASSIFICATION

7.1 All materials to be excavated shall be classified by the Engineer, into one of the following classes. No distinction shall be made whether the material is dry, moist or wet. The decision of the Engineer regarding the classification of the material shall be final and binding on the Contractor and not be a subject matter of any appeal or arbitration.

7.2 Any earthwork will be classified under any of the following categories:

7.2.1 Ordinary and Hard Soils

These shall include all kinds of soils containing kankar, sand, silt, murrum and/or shingle, gravel, clay, loam, peat, ash, shale, etc., which can generally be excavated by spade, pick axes and shovel, and which is not classified under "Soft and Decomposed Rock" and "Hard Rock" defined below. This shall also include embedded rock boulders not longer than 1 metre in any one direction and not more than 200 mm in any one of the other two directions.

7.2.2 Soft and Decomposed Rock

This shall include rock, boulders, slag, chalk, slate, hard mica schist, laterite and all other materials which in the opinion of Engineer is rock, but does not need blasting and could be removed with picks, hammer, crow bars, wedges, and pneumatic breaking equipment. The mere fact that the Contractor resorts to blasting for reasons of his own, shall not qualify for classification under 'Hard Rock'. This shall also include excavation in macadam and tarred roads and pavements. This shall also include rock boulders not longer than 1 metre in any direction and not more than 500 mm in any one of the other two directions. Masonry to be dismantled will also be measured under this item.

7.2.3 Hard Rock

This shall include all rock occurring in large continuous masses which cannot be removed except by blasting for loosening it. Harder varieties of rock with or without veins and secondary minerals which, in the opinion of the Engineer require blasting

shall be considered as hard rock. Boulders of rock occurring in such sizes and not classified under 7.2.1 and 7.2.2 above shall also be classified as hard rock. Concrete work both reinforced and unreinforced to be dismantled will be measured under this item, unless a separate provision is made in the Schedule of Quantities.

8.0 EXCAVATION

8.1 All excavation work shall be carried out by mechanical equipment unless, in the opinion of the Engineer, the work involved and time schedule permit manual work.

8.2 Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer. Rough excavation shall be carried out to a depth 150 mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed even below the final level and extra excavation filled up as directed by the Engineer. The final excavation if so instructed by the Engineer should be carried out just prior to laying the mud-mat.

8.3 The Contractor may, for facility of work or similar other reasons excavate, and also backfill later, if so approved by the Engineer, at his own cost outside the lines shown on the drawings or directed by the Engineer. Should any excavation be taken below the specified elevations, the Contractor shall fill it up, with concrete of the same class as in the foundation resting thereon, up to the required elevation. No extra shall be claimed by the Contractor on this account.

8.4 All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor in each individual case, for the method he proposes to adopt for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval, however, shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope. Removal of the slipped earth will not be paid for if the slips are due to the negligence of the Contractor.

8.5 Excavation shall be carried out with such tools, tackles and equipment as described herein before. Blasting or other methods may be resorted to in the case of hard rock; however not without the specific permission of the Engineer.

8.6 The Engineer may also direct that in some extreme case, the rock may be excavated by heating and sudden quenching for splitting the rock. Fire-wood shall be used for burning and payment shall be made for such work as called for in the schedule of quantities.

9.0 STRIPPING LOOSE ROCK

9.1 All loose boulders, semi-detached rocks (along with earthy stuff which might move therewith) not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of the Engineer, to fall or otherwise endanger the workmen, equipment, or the work, etc., shall be stripped off and removed away from the area of the excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion which was originally sound and safe.

9.2 Any material not requiring removal as contemplated in the work, but which, in the opinion of the Engineer, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed as directed by the Engineer. The cost of such stripping will be paid for at the unit rates accepted for the class of materials in question.

10.0 FILL, BACK FILLING AND SITE GRADING

10.1 GENERAL

All fill material will be subject to the Engineer's approval. If any material is rejected by the Engineer, the Contractor shall remove the same forthwith from the site at no extra cost to the Owner. Surplus fill material shall be deposited/ disposed off as directed by the Engineer after the fill work is completed.

No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Engineer.

10.2 MATERIAL

To the extent available, selected surplus soils from excavated materials shall be used as backfill. Fill material shall be free from clods, salts, sulphates, organic or other foreign material. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murrum or earth to fill up the voids and the mixture used for filling.

10.3 If any selected fill material is required to be borrowed, the Contractor shall make arrangements for bringing such material from outside borrow pits. The material and source shall be subject to prior approval of the Engineer. The approved borrow pit area shall be cleared of all bushed, roots of trees, plants, rubbish etc. Top soil containing salts/ sulphate and other foreign material shall be removed. The materials so removed shall be burnt or disposed off as directed by the Engineer.

The Contractor shall make necessary access roads to borrow areas and maintain the same, if such access road does not exist, at his cost.

10.4 Filling in pits and trenches around foundations of structures, walls etc.

As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches etc. shall be cleared of all debris, and filled with earth in layers not exceeding 15 cm., each layer being watered,

rammed and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of the Engineer. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless the Engineer is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and levelled to proper profile as directed by the Engineer or indicated on the drawings.

10.5 PLINTH FILLING

Plinth filling shall be carried out with approved material as described herein before in layers not exceeding 15 cm, watered and compacted with mechanical compaction machines. The Engineer may however permit manual compaction by hand tampers in case he is satisfied that mechanical compaction is not possible. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours allowed to dry and then the surface again compacted as specified above to avoid settlements at a later stage. The finished level of the filling shall be trimmed to the level/ slope specified. Where specified in the schedule of works, compaction of the plinth fill shall be carried out by means of 12 tonne rollers smooth wheeled, sheep-foot or wobbly wheeled rollers. In case of compaction of granular material such as sands and gravel, vibratory rollers shall be used. A smaller weight roller may be used only if permitted by the Engineer. As rolling proceeds, water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fill.

The thickness of each unconsolidated fill layer can in this case be up to a maximum of 300 mm. The Engineer will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used. Rolling shall commence from the outer edge and progress towards the centre and continue until compaction is to the satisfaction of the Engineer, but in no case less than 10 passes of the roller will be accepted for each layer.

The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated and filled and consolidated. At some locations/ areas it may not be possible to use rollers because of space restrictions etc. The Contractor shall then be permitted to use pneumatic tampers; rammers etc. and he shall ensure proper compaction.

10.6 SAND FILLING IN PLINTH AND OTHER PLACES

At places backfilling shall be carried out with local sand if directed by the Engineer. The sand used shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded condition shall be to the Contractor's account. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structures

on sand fill shall not be started until the Engineer has inspected and approved the fill.

10.7 FILLING IN TRENCHES

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes.

Where the trenches are excavated in soil, the filling from the bottom of the trench to the level of the centreline of the pipe shall be done by hand compaction with selected approved earth in layers not exceeding 8 cm; backfilling above the level of the centreline of the pipe shall be done with selected earth by hand compaction or other approved means in layers not exceeding 15 cm.

In case of excavation of trenches in rock, the filling up to a level 30 cm. above the top of the pipe shall be done with fine materials, such as earth, murrum, etc. The filling up of the level of the centreline of the pipe shall be done by hand compaction in layers not exceeding 8 cm. whereas the filling above the centreline of the pipe shall be done by hand compaction or approved means in layers not exceeding 15 cm. The filling from a level 30 cm. above the top of the pipe to the top of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

Filling of the trenches shall be carried simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

11.0 GENERAL SITE GRADING

11.1 Site grading shall be carried out as indicated in the drawings and as directed by the Engineer. Excavation shall be carried out as specified in the specification. Filling and compaction shall be carried out as specified under Clause 10.0 and elsewhere unless otherwise indicated below.

11.2 If no compaction is called for, the fill may be deposited to the full height in one operation and levelled. If the fill has to be compacted, it shall be placed in layers not exceeding 225 mm and levelled uniformly and compacted as indicated in Clause 10.0 before the next layer is deposited.

11.3 To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the Contractor at his cost.

11.4 Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed. This shall hold good for embankments as well.

11.5 The Contractor shall protect the earth fill from being washed away by rain damaged in any other way. Should any slip occur, the Contractor shall remove the affected material and make good the slip at his cost.

11.6 The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

11.7 If so specified, the rock as obtained from excavation may be used for filling and levelling to indicated grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 tonne roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

12.0 **FILL DENSITY**

12.1 The compaction, only where so called for, in the schedule of quantities/ items shall comply with the specified (Standard Proctor/ Modified Proctor) density at moisture content differing not more than 4 percent from the optimum moisture content. The Contractor shall demonstrate adequately at his cost, by field and laboratory tests that the specified density has been obtained.

13.0 **LEAD**

13.1 Lead for deposition/ disposal of excavated material, shall be as specified in the respective item of work. For the purpose of measurement of lead, the area to be excavated or filled or area on which excavated material is to be deposited/ disposed off shall be divided into suitable blocks and for each of the blocks, the distance between centrelines shall be taken as the lead which shall be measured by the shortest straight line route on the plan and not the actual route taken by the Contractor. No extra compensation is admissible on the grounds that the lead including that for borrowed material had to be transported over marshy or 'katcha' land/ route.

SITE FILLING

15.0 **SCOPE**

Apart from any other work/ purpose for which this specification may be made applicable by the Engineer, this shall generally govern work involving filling site/ plant over the entire area/ most of the area to raise the general grade level to the desired elevation. This work shall be carried out as per applicable clauses of

section “Earthwork in Grading, Excavation and Backfilling” particularly Clauses 10 and 11.

16.0 FILL MATERIAL

16.1 GENERAL

All fill material whether such material is brought from outside borrow areas or from excavation from within the site, will be subject to the Engineer’s approval. Notwithstanding any approval given to the fill material of borrow areas from which fill material is proposed to be brought, the Engineer/ Owner reserves the right to reject such material which in his opinion either does not meet the specification requirements or is unsuitable for the purpose for which it is intended.

16.2 BORROW AREAS

It shall be Contractor’s responsibility to locate suitable borrow areas for borrowing fill material. Such area will be inspected by the Engineer and approved before the Contractor makes arrangements to borrow the fill material. The top soil which may contain vegetation, rubbish, slush, etc. shall not be used. If demanded by the Engineer, the Contractor shall arrange to have trial pits of specified dimensions and numbers dug at locations specified, for the Engineer to examine the nature and type of material likely to be obtained from the borrow area.

16.3 LEAD, LIFT AND TRANSPORTATION

Unless separately provided for, all lead, lift and transportation required for bringing in the fill material from borrow areas or from excavation from within the site shall be included.

16.4 QUALITY

The borrowed soil shall be generally granular, and non-cohesive. It shall consist of sand, silty sand, murrum, ordinary soil, gravel and shingle. Dredged material shall also be free from sulphates, salts, organic, foreign and other harmful or objectionable materials. Any material rejected by the Engineer shall be removed from the site immediately.

17.0 ACCESS ROAD

Roads, whether of temporary or other nature, required to be constructed for access and for movement of men, materials, equipment, transport vehicles, vehicles carrying fill material etc. to or over borrow areas and/or to or over areas on which fill has to be deposited shall be constructed by the Contractor at his cost. Such costs shall be deemed to have been included in the unit rates quoted by the Contractor. Such access in roads shall be maintained in good condition during all seasons to ensure completion of work according to time schedule.

18.0 CLEARING

Site clearing before filling shall be carried out as specified in the section "Earthwork in Grading, Excavation and Backfilling".

19.0 **FILLING**

19.1 SAND FILL

19.1.1 Sandy fill shall be deposited to bring the grade level to desired elevation after compaction of fill.

19.1.2 Sandy fill shall be compacted, where so specified, by 12 tonne vibratory rollers as indicated in Clause 19.2.3 below. The fill material shall be compacted to the specified density, where so specified.

19.1.3 Compaction of sandy fill by flooding the area shall be carried out where so specified. In this case, the Contractor should ensure that the fill material is not washed away. This work shall be carried out as directed by the Engineer.

19.2 SOIL FILL

19.2.1 Approved soil fill consisting of ordinary soil, murrum, soil containing gravel, shingle etc. shall be deposited in layers not exceeding 200 mm. The Contractor should ensure that all clods of earth are broken down to a size not larger than 100 mm.

19.2.2 Where density of fill or use of rollers is not specified the fill shall be carried out as specified in Clause 19.1.3 above.

19.2.3 Where the fill material has to be compacted by use of rollers procedure as specified in Clause 10.5 of section "Earthwork in Grading, Excavation and Backfilling" shall be followed.

19.2.4 Where specified, the required density of fill shall be obtained by proper compaction.

20.0 - NOT USED

21.0 DEWATERING

21.1 SCOPE: This section covers the general requirements of dewatering excavations in general.

21.2 All excavations shall be kept free of water. Grading in the vicinity of excavation shall be properly closed to prevent surface water running into excavated areas. Contractor shall remove by pumping or other means approved by Engineer any water inclusive of rain water and subsoil water accumulated in excavation and keep all excavations dewatered until the foundation work is completed and backfilled. Sumps made for dewatering must be kept clear of the excavations / trenches required for further work. Method of pumping shall be approved by Engineer; but in any case, the pumping arrangement shall be such that there shall be no movement

of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction.

21.3 When there is a continuous inflow of water and quantum of water to be handled is considered in the opinion of Engineer, as large, well point system - Single stage or multi stage, shall be adopted. Contractor shall submit to Engineer his scheme of well point system including the stages, the spacing, number and diameter of well points, headers etc., and the numbers, capacity and location of pumps of approvals. Unless separately provided for in the Schedule of prices, the cost of dewatering shall be included in the item rate for excavation.

22.0 RAIN WATER DRAINAGE

22.1 SCOPE: This section covers the drainage of rain water in excavated areas.

22.2 Grading in the vicinity of excavation shall be such as to exclude rain/ surface water draining into excavated areas. Excavation shall be kept clean of rain and such water as the Contractor may be using for his work by suitably pumping out the same at no extra cost to the Owner. The scheme for pumping and discharge of such water shall be approved by the Engineer.

22.3 Contractor shall ensure that the surface runoff outside the excavated pit/ working area shall be collected through a catch drain excavated around the working area and led away to a natural stream, at no extra cost to the Owner. Contractor shall maintain the catch drains in proper condition during the construction period at no extra cost to the Owner.

PART - 4: PRE-CONSTRUCTIONAL ANTI-TERMITE TREATMENT

1.0 **SCOPE**

This specification covers the general requirements for Anti-termite Constructional Measures, chemical treatment of soils for the protection of buildings from attack by subterranean termites, chemicals to be used with their minimum rates of application and procedure to be followed while the building is under construction.

2.0 **APPLICABLE CODES**

The following codes, standards and specifications are made a part of this specification. All specifications, standards, codes of practices referred to herein shall be the latest edition including all applicable official amendments and revisions. In case of discrepancy between this specification and those referred to herein, this specification shall govern:

2.1 IS: 6313 Part - I - Code of Practice for Anti-termite Measures in Buildings Constructional Measures

2.2 IS: 6313 Part - II - Pre-constructional Chemical Treatment Measures

2.3 IS: 8944 - Specification for Chloropyrifos Emusifiable Concentrates

2.4 IS: 4015 Part - I - Guide for Handling cases of Pesticide Poisoning First Aid Measures

2.5 IS: 4015 Part - II - Symptoms, Diagnosis and Treatment

3.0 **GENERAL**

3.1 Contractor shall furnish all tools, plants. instruments, qualified supervisory personnel, labour, materials, any temporary works, consumables, any and everything necessary whether or no such items are specifically stated herein for completion of the job in accordance with specification requirements.

3.2 All work shall be done in the order of progress required by Owner's construction programme.

3.3 Contractor shall take all necessary precautions to prevent any accident in connection with the performance of the work.

3.4 On final completion of all work, Contractor shall leave the entire premises within the site of his operation clean and free from all rubbish resulting from his operation.

3.5 Owner reserves the right to inspect, check and direct any or all operations at any stage of the work and to require unsatisfactory work to be remedied at Contractor's expense.

3.6 No work shall be carried out under unsuitable weather conditions viz. when raining or when the soil is wet due to rain or sub-soil water.

3.7 Chemicals shall be brought to site of work in sealed original containers. The materials shall be brought in, at a time, in adequate quantity to suffice for the work. The material shall be kept in cool and locked stores. The empties shall not be removed from the work site till the relevant item of work has been completed and permission granted by Owner/ Engineer.

3.8 Chemicals available in concentration forms with concentration indicated on the sealed containers only shall be used. Chemicals shall be diluted with water in required quantity before use, using graduated containers to achieve the desired percentage of concentration:

Examples:

Chloropyrifos 20 1 litre is diluted to 20 litres to give 1.0% emulsion.

4.0 PRE-CONSTRUCTIONAL CHEMICAL TREATMENT

4.1 ESSENTIAL REQUIREMENTS

4.1.1 Hand operated pressure pump with graduated containers shall be used to ensure uniform spraying of the chemical. Continuous check shall be kept to ensure that the specified quantity of chemical is used for the required area during the operation.

4.1.2 Condition of Formation

The treated soil barrier shall be complete and continuous under the whole of the structure to be protected. All foundations shall be fully surrounded by and in close contact with the barrier of treated soil. Each part of the area treated shall receive the specified dosage of chemical.

4.1.3 Time of Application

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

4.1.4 Disturbance

The treated soil barriers shall not be disturbed after they are formed. If by chance, treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

4.2 CHEMICALS, METHOD AND RATE OF APPLICATION

4.2.1 (a) Mound Treatment

Termite mounds within the plinth and contingent apron area shall be destroyed by means of insecticides in the form of water suspension or emulsion which shall be poured into the mounds at several places after breaking open the earthen structure and making holes with crow bars. For a mound volume of about one (1) cum., four (4) litres of an emulsion in water of one of the following shall be used:

0.50 percent Chloropyrifos

(b) Soil Treatment

Any one of the following chemicals (conforming to Indian Standards) in water emulsion shall be applied uniformly over the area to be treated.

Chemical	Concentration by weight percent
Chloropyrifos	1.0

4.2.2 Treatment of Column-pits, Wall-trenches and excavations

(a) The bottom surface and the sides (up to a height of about 300 mm) of the excavations made for column pits, wall trenches and shall be treated with the chemical at the rate of 5 litres per sq.m of the surface area.

(b) After the column foundations and the retaining walls come up, the backfill in immediate contact with the foundation structure shall be treated at the rate of 15 litre per sq.m of the vertical surface of the sub-structure for each side. If water is used for ramming the earth fill, the chemical treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemical with the above dose.

The earth shall be returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete or masonry surfaces of the columns and walls so that the earth in contact with these surfaces is well treated with the chemical.

c) In the case of R.C.C. framed structures with columns and plinth beams with concrete mix 1:2:4 or richer, the treatment shall start at the depth of 500 mm below ground level for columns and plinth beams. From this depth the back-fill around the columns, beams and shall be treated at the rate of 15 litres/sq.m of vertical surface. The other details of treatment shall be as laid down in clause (b) above.

4.2.3 Treatment of Top Surface of Plinth Filling

The top surface of the filled earth within plinth beams/walls shall be treated with chemical emulsion at the rate of 5 litres per sq.m of the surface before the sand bed/subgrade is laid. Holes up to 50 to 70 mm deep at 150 mm centres both ways shall be made with 12 mm dia. crow-bar on the surface to facilitate saturation of the soil with chemical emulsion.

4.2.4 Treatment of Junction of Wall and Floor

To achieve continuity of vertical chemical barrier to inner wall surfaces from the ground level, small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor (before laying the subgrade) and rod holes made in the channel up to ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 15 litres / sq.m of the vertical wall or column surface so as to soak the soil right to the bottom. The soil shall be tamped back into place after this operation.

4.2.5 Treatment of Soil Under Apron Along External Perimeter of Building

The top surface of the consolidated earth over which the apron is to be laid shall be treated with chemical emulsion at the rate of 5 litres / sq.m of the surface before the apron is laid, by making rod holes 75 mm deep at 150 mm centres both ways.

4.2.6 Treatment of Soil Along External Perimeter of Building

After the building is complete, holes shall be made in the soil with iron rods along the external perimeter of the building at interval of about 150 mm and depth 300 mm and these holes filled with chemical emulsion at the rate of 7.5 litres/metre of perimeter of the external wall. If the earth outside the building is graded on completion of building, this treatment shall be carried out on completion of such grading. If the filling is more than 300 mm the external perimeter treatment shall extend to the full depth of filling up to the original ground level so as to ensure continuity of chemical barrier.

4.2.7 Treatment for Expansion Joints

Anti-termite treatment shall be supplemented by treating through the expansion joint after the sub-grade has been laid at the rate of 2 litres per linear meter of expansion joint.

4.2.8 Treatment of Soil Surrounding Pipes and Conduits

When pipes and conduits enter the soil inside the area of the foundations, the soil surrounding the points of entry shall be loosened around each such pipe or conduit for a distance of 150 mm and to a depth of 75 mm before treatment is commenced. When they enter the soil external to the foundations, they shall be similarly treated

for a distance of over 300 mm unless they stand clear of the walls of the building by about 75 mm.

5.0 SAFETY PRECAUTIONS

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

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

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

5.4 The concentrates are oil solutions and present a fire hazard owing to the use of petroleum solvents. Flames shall not be allowed during mixing.

5.5 Care shall 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.

PART – 5: CONCRETE AND ALLIED WORKS

1.0 SCOPE

1.1 This Specification covers the general requirements for ready mixed concrete and for concrete using on-site production facilities including requirements in regard to the quality, handling, storage of ingredients, proportioning, batching, mixing, transporting, placing, curing, protecting, repairing, finishing and testing of concrete; formwork; requirements in regard to the quality, storage, bending and fixing of reinforcement; grouting as well as mode of measurement and payment for completed works.

1.2 It shall be very clearly understood that the specifications given herein are brief and do not cover minute details. However, all works shall have to be carried out in accordance with the relevant standards and codes of practices or in their absence in accordance with the best accepted current engineering practices or as directed by ENGINEER from time to time. The decision of ENGINEER as regards the specification to be adopted and their interpretation and the mode of execution of work shall be final and binding on CONTRACTOR and no claim whatsoever will be entertained on this account.

2.0 APPLICABLE CODES AND SPECIFICATIONS

The following specifications, standards and codes, including all official amendments/ revisions and other specifications & codes referred to therein, should be considered a part of this specification. In all cases the latest issue/ edition/ revision shall apply. In case of discrepancy between this specification and those referred to herein below or other specifications forming a part of this bid document, this specification shall govern.

2.1 MATERIALS

2.1.1 IS: 269 Specification for 33 grade ordinary portland cement

2.1.2 IS: 455 Specification for portland slag cement

2.1.3 IS: 1489 Specification for portland pozzolana cement (Parts 1 & 2)

2.1.4 IS: 8112 Specification for 43 grade ordinary portland cement

2.1.5 IS: 12330 Specification for sulphate resisting Portland Cement

2.1.6 IS: 383 Specification for coarse and fine aggregates from natural sources for concrete

2.1.7 IS: 432 Specification for mild steel and medium tensile (Parts steel bars and hard drawn steel wires for 1 & 2) concrete reinforcement

2.1.8 IS: 1786 Specification for high strength deformed steel bars and wires for concrete reinforcement

2.1.9 IS: 1566 Specification for hard drawn steel wire fabric for (Parts II) concrete reinforcement

2.1.10 IS: 9103 Specification for admixtures for concrete

2.1.11 IS: 2645 Specification for integral cement waterproofing compounds

2.1.12 IS: 4900 Specification for plywood for concrete shuttering work

2.1.13 IS: 4926 Ready mixed concrete

2.1.14 IS: 12269 Specification for 53 grade ordinary portland cement

2.1.15 IS: 8041 Specification for rapid hardening cement

2.1.16 IS: 12600 Specification for low heat cement

2.1.17 IS: 6909 Specification for supersulphated cement

2.1.18 IS: 12089 Specification for granulated ground blast furnace slag

2.1.19 IS: 6699 Specification for granulated ground blast furnace slag

2.1.20 IS: 6073 Specifications for precast concrete masonry units (Part 1)

Methods for specifying precast concrete masonry (Part 2)

2.2 MATERIAL TESTING

2.2.1 IS: 4031 Methods of physical tests for hydraulic cement (Parts 1 to 15)

2.2.2 IS: 4032 Method of chemical analysis of hydraulic cement

2.2.3 IS: 650 Specification for standard sand for testing of cement

2.2.4 IS: 2430 Methods for sampling of aggregates for concrete

2.2.5 IS: 2386 Methods of test for aggregates for concrete (Parts 1 to 8)

2.2.6 IS: 3025 Methods of sampling and test (physical and chemical) water used in industry (Part 1 to 51)

2.2.7 IS: 6925 Methods of test for determination of water soluble chlorides in concrete admixtures

2.3 MATERIAL STORAGE

2.3.1 IS: 4082 Recommendations on stacking and storing of construction materials at site

2.4 CONCRETE MIX DESIGN

2.4.1 IS: 10262 Recommended guidelines for Concrete Mix Design

2.4.2 SP: 23 Handbook on Concrete Mixes

2.5 CONCRETE TESTING

2.5.1 IS: 1199 Method of sampling and analysis of concrete

2.5.2 IS: 516 Method of test for strength of concrete

2.5.3 IS: 9013 Method of making, curing and determining compressive strength of accelerated cured concrete test specimens

2.5.4 IS: 8142 Method of test for determining setting time of concrete by penetration resistance

2.5.5 IS: 9284 Method of test for abrasion resistance of concrete

2.5.6 IS: 2770 Methods of testing bond in reinforced concrete

2.6 EQUIPMENT

2.6.1 IS: 1791 Specification for batch type concrete mixers

2.6.2 IS: 2438 Specification for roller pan mixer

2.6.3 IS: 4925 Specification for concrete batching and mixing plant

2.6.4 IS: 5892 Specification for concrete transit mixer and agitator

2.6.5 IS: 7242 Specification for concrete spreaders

2.6.6 IS: 2505 General Requirements for concrete vibrators: Immersion type

2.6.7 IS: 2506 General Requirements for screed board concrete vibrators

2.6.8 IS: 2514 Specification for concrete vibrating tables

2.6.9 IS: 3366 Specification for pan vibrators

2.6.10 IS: 4656 Specification for form vibrators for concrete

2.6.11 IS: 11993 Code of practice for use of screed board concrete vibrators

2.6.12 IS: 7251 Specification for concrete finishers

2.6.13 IS: 2722 Specification for portable swing weigh batchers for concrete (single and double bucket type)

2.6.14 IS: 2750 Specifications for steel scaffoldings

2.7 CODES OF PRACTICE

2.7.1 IS: 456 Code of practice for plain and reinforced concrete

2.7.2 IS: 457 Code of practice for general construction of plain and reinforced concrete for dams and other massive structures

2.7.3 IS: 3370 Code of practice for concrete structures for storage of liquids (Parts 1 to 4)

2.7.4 IS: 3935 Code of practice for composite construction

2.7.5 IS: 2204 Code of practice for construction of reinforced concrete shell roof

2.7.6 IS: 2210 Criteria for the design of reinforced concrete shell structures and folded plates

2.7.7 IS: 2502 Code of practice for bending and fixing of bars for concrete reinforcement

2.7.8 IS: 5525 Recommendation for detailing of reinforcement in reinforced concrete works

2.7.9 IS: 2751 Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction

2.7.10 IS: 9417 Specification for welding cold worked bars for reinforced concrete construction

2.7.11 IS: 3558 Code of practice for use of immersion vibrators for consolidating concrete

2.7.12 IS: 3414 Code of practice for design and installation of joints in buildings.

2.7.13 IS: 4326 Code of practice for earthquake resistant design and construction of buildings

2.7.14 IS: 4014 Code of practice for steel tubular scaffolding. (Parts 1 & 2)

2.7.15 IS: 2571 Code of practice for laying in situ cement concrete flooring

2.7.16 IS: 7861 Part1 - Recommended practice for hot weather concreting

Part2 – Recommended practice for cold weather concreting

2.7.17 IS: 3370 Code of practice for concrete structures for the storage of liquid (Part I to IV)

2.8 CONSTRUCTION SAFETY

2.8.1 IS: 3696 Safety code for scaffolds and ladders (Parts 1 & 2)

2.8.2 IS: 7969 Safety code for handling and storage of building materials

2.8.3 IS: 8989 Safety code for erection of concrete framed structures

2.9 MEASUREMENT

a) IS: 1200 Method of measurement of building and engineering works (Parts 2 and 5)

(Part 1 to 12)

3.0 **GENERAL**

3.1 ENGINEER shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and ENGINEER's approval obtained, prior to starting of concrete work. This shall, however, not relieve CONTRACTOR of any of his responsibilities. All materials, which do not conform to this specification, shall be rejected.

3.2 Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes/standards shall only be used. Other materials may be used after approval of the ENGINEER and after establishing their performance suitability based on previous data, experience or tests.

4.0 **MATERIALS**

4.1 CEMENT

4.1.1 Unless otherwise specified or called for by ENGINEER/OWNER, cement shall be ordinary portland cement conforming to IS: 269, IS: 8112 or IS: 12269.

4.1.2 The portland pozzolana cement shall conform to IS: 1489 and it shall be used as directed by ENGINEER. Where portland pozzolana or slag cements are used, it shall be ensured that consistency of quality is maintained and there will be no adverse interactions between the materials and the finish specified is not marred.

4.1.3 Only one type of cement shall be used in any one mix unless specifically approved by ENGINEER. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without prior approval from ENGINEER.

4.1.4 Cement, which is not used within 90 days from its date of manufacture, shall be tested at a laboratory approved by ENGINEER and until the results of such tests are found satisfactory, it shall not be used in any work.

4.2 AGGREGATES

4.2.1 Aggregates shall consist of naturally occurring stones and gravel (crushed or uncrushed) and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/silt/organic impurities/deleterious materials and conform to IS: 383. Aggregates such as slag,

crushed over burnt bricks, bloated clay ash, sintered fly ash and tiles shall not be used.

4.2.2 Aggregates shall be washed and screened before use where necessary or if directed by the ENGINEER.

4.2.3 Aggregates containing reactive materials shall be used only after tests conclusively prove that there will be no adverse affect on strength, durability and finish, including long term effects, on the concrete.

4.2.4 The fineness modulus of sand shall neither be less than 2.2 nor more than 3.2. If use of sand having fineness modulus more than 3.2 is unavoidable then it shall be suitable blended with crusher stone dust.

4.2.5 The maximum size of coarse aggregate shall be as stated on the drawings, but in no case greater than 1/4 of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of the form. For most work 20mm aggregate is suitable. Where there is no restriction to the flow of concrete into sections, 40mm or larger size is permitted.

4.2.6 In concrete elements with thin sections, closely spaced reinforcements or small cover, consideration should be given to the use of 10mm nominal maximum size.

4.2.7 Plums 160 mm and above of a reasonable size may be used where directed. Plums shall not constitute more than 20% by volume of concrete unless specified by ENGINEER.

4.3 WATER

4.3.1 Water used for both mixing and curing shall conform to IS: 456. Potable water is generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used.

4.3.2 The pH value of water shall not be less than 6.

4.3.3 Seawater shall not be used for concrete mixing and curing.

4.3.4 The proposed admixtures shall comply with requirements of Specification for Admixtures for Concrete.

4.4 REINFORCEMENT

4.4.1 Reinforcement bars shall conform to IS: 432 and/ or IS: 1786 and welded wire fabric to IS: 1566 as shown on the drawing.

4.4.2 All reinforcement shall be clean, free from pitting, oil, grease, paint, loose mill scales, rust, dirt, dust or any other substance that will destroy or reduce bond.

4.4.3 Special precaution like coating of reinforcement may be provided with the prior approval of ENGINEER.

4.5 – Not Used

4.6 SAMPLES AND TESTS

4.6.1 All materials used for the works shall be tested before use. The frequency of such confirmatory tests shall be decided by ENGINEER.

4.6.2 Manufacturer's test certificate shall be furnished for each batch of cement/steel and when directed by ENGINEER samples shall also be got tested by the CONTRACTOR in a laboratory approved by ENGINEER at no extra cost to OWNER. However, where material is supplied by OWNER, all testing charges shall be borne by OWNER, but transportation and preparation of material samples for the laboratory shall be done by CONTRACTOR at no extra cost.

4.6.3 Sampling and testing of aggregates shall be as per IS: 2386 under the supervision of ENGINEER. The cost of all tests, sampling, etc. shall be borne by CONTRACTOR. For coarse aggregate crushing value shall be tested.

4.6.4 Water to be used shall be tested to comply with clause 5.4 of IS: 456.

4.6.5 CONTRACTOR shall furnish manufacturer's test certificates and technical literature for the admixture proposed to be used. If directed, the admixture shall be got tested at an approved laboratory at no extra cost.

4.7 STORING OF MATERIALS

4.7.1 All material shall be stored in a manner so as to prevent its deterioration and contamination, which would preclude its use in the works. Requirements of IS: 4082 shall be complied with.

4.7.2 CONTRACTOR will have to make his own arrangements for the storage of adequate quantity of cement even if cement is supplied by OWNER. If such cement is not stored properly and has deteriorated, the material shall be rejected. Cost of such rejected cement, where cement is supplied by OWNER, shall be recovered at issue rate or open market rate whichever is higher. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Not more than 15 bags shall be stacked in any tier. Storage arrangement shall be approved by ENGINEER**. Storage under tarpaulins shall not be permitted**. Each consignment of cement shall be stored separately and consumed in its order of receipt. CONTRACTOR shall maintain record of receipt and consumption of cement.

4.7.3 Each size of coarse and fine aggregates shall be stacked separately and shall be protected from dropping leaves and contamination with foreign material. The stacks shall be on hard, clean, free draining bases, draining away from the concrete mixing area.

4.7.4 CONTRACTOR shall make his own arrangements for storing water at site in tanks of approved capacity. The tanks shall be cleaned at least once a week to prevent contamination.

4.7.5 The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground/ water. Each type and size shall be stacked separately.

5.0 CONCRETE

5.1 GENERAL

5.1.1 Concrete grade shall be as designated on drawings. Concrete in the works shall be “DESIGN MIX CONCRETE” OR “NOMINAL MIX CONCRETE”. All concrete works of up to grade M15 shall be NOMINAL MIX CONCRETE whereas all other grades, M20 and above, shall be DESIGN MIX CONCRETE.

5.2 DESIGN MIX CONCRETE

5.2.1 Design Mix Concrete are classified in three categories, viz. "Normal Concrete (M)", "Heavy Concrete (H)", "Super Heavy Concrete (SH)". Each class of concrete shall be identified by a prefix and two numbers. Prefix "M" would denote Normal Concrete, prefix "H" would denote heavy concrete and prefix "SH" would denote super heavy concrete. The two numbers e.g. 25 - 40 would denote the crushing strength of cube at 28 days in N/sq.mm and maximum size of the coarse aggregates in millimetres respectively.

5.2.2 Normal concrete shall have a net dry unit weight of not less than 25 kN/cum, for the finished structure after curing, Heavy concrete shall have a net dry unit weight of not less than 36.30 kN/cum, for the finished structure after curing and special heavy concrete shall have a net dry unit weight of not less than 41 kN/cum for the finished structure after curing.

5.2.3 Mix Design & Testing

For Design Mix Concrete, the mix shall be designed as per any of four methods given in SP: 23 to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS: 456. The design mix shall in addition be such that it is cohesive and does not segregate during placement and should result in a dense and durable concrete capable of giving the specified finish. For liquid retaining structures, the mix shall also result in watertight concrete. The CONTRACTOR shall exercise great care while designing the concrete mix and executing the works to achieve the desired result.

5.2.4 The minimum grade of concrete shall be as per Table 5 of IS: 456 for various exposure conditions of concrete. For various environmental conditions, refer Table 3 of IS: 456.

5.2.5 The minimum cementitious content for Design Mix Concrete shall be as per Table 5 of IS: 456 or as given below, whichever is higher. In case of PPC or OPC with fly ash addition at site the fly ash content shall not exceed 30%. For concrete with such cement the minimum cementitious content (C+F) shall be as given in table below.

Grade of Concrete, M	**Minimum Cement Content in kg/cum. of Concrete**
20	300
25	320
30	340
35	360
40	360
45	400

The minimum cement content stipulated above shall be adopted irrespective of whether the CONTRACTOR achieves the desired strength with less quantity of cement. The CONTRACTOR's quoted rates for concrete shall provide for the above eventuality and nothing extra shall become payable to the CONTRACTOR on this account. Even in the case where the quantity of cement required is higher than that specified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the CONTRACTOR.

5.2.6 It shall be CONTRACTOR's sole responsibility to carry out the mix designs at his own cost. He shall furnish to ENGINEER for approval at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS: 516 shall comply with the requirements of IS: 456.

Grade of Concrete M	**Minimum Compressive Strength N/Sq.mm at 7 days**	**Specified Characteristic compressive strength N/sq.mm at 28 days**
15	10.0	15.0
20	13.5	20.0
25	17.0	25.0

30	20.0	30.0
35	23.5	35.0
40	37	40.0
45	30	45.0

5.2.7 A range of slumps recommended for various types of construction, unless otherwise instructed by the ENGINEER, shall be as given below:

Structure/Member	**Slump in millimeters**	
	Maximum	**Minimum**
Reinforced foundation walls and footings	75	25
Plain footings, caissons and substructure walls	75	25
T. G. and massive compressor foundations	50	25
Slabs, Beams and reinforced walls	50	25
Pumps & miscellaneous Equipment Foundations	75	25
Building columns	50	25
Pavements	50	25
Heavy mass construction	50	25
Liquid retaining/ conveying structures	50	25

(NOTE: These values are not meant for pumped concrete placed using slip formed technique.)

5.2.8 Where single size graded coarse aggregate are not available, aggregates of different sizes shall be properly combined. The contractors mix design shall show that combined grading of coarse aggregate meets the requirements of Table 2 of IS: 383 for graded aggregates.

5.3 BATCHING & MIXING OF CONCRETE

5.3.1 Proportions of aggregates and cement, as per approved concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within ±2% for cement and ±3% for aggregate. The batching equipment shall be calibrated at the frequency decided by ENGINEER.

5.3.2 Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water- cement ratio specified for use by ENGINEER shall be maintained. Each time the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional sand and cement to allow for sticking in the drum.

5.3.3 Arrangement should be made by CONTRACTOR to have the cubes tested at his own expense in an approved laboratory or in field with prior consent of ENGINEER. Sampling and testing of strength and workability of concrete shall be as per IS: 1199, IS: 516 and IS: 456. It is preferable to cast additional cubes (minimum 3 specimens) for testing at 7 days and 14 days.

6.0 NOMINAL MIX CONCRETE

6.1 MIX DESIGN & TESTING

Mix Design and preliminary tests are not necessary for Nominal Mix Concrete. However works tests shall be carried out as per IS: 456. Proportions for Nominal Mix Concrete and w/c ratio may be adopted as per Table 9 of IS: 456. However, it will be CONTRACTOR's sole responsibility to adopt appropriate nominal mix proportions to achieve the specified characteristic strength.

6.2 BATCHING & MIXING OF CONCRETE

Based on the adopted nominal mixes, aggregates shall be measured by volume. However cement shall be by weight only. Appropriate correction shall be made for bulking of sand after testing.

7.0 READY MIXED CONCRETE

7.1 All specification as per IS: 4926 – "Specification for ready mixed concrete" shall be used.

7.2 The Contractor shall identify at least two sources of ready mix concrete supplier and get it approved by ENGINEER prior to start of the Works. Any change in the source of the RMC, shall be got approved by the ENGINEER.

7.3 The design mix prepared by the RMC supplier shall be the responsibility of the Contractor. The testing of concrete as per Codal provisions and the specifications shall be done by the Contractor same as the normal concreting works.

8.0 PRECAST CONCRETE

8.1 GENERAL

Precast concrete shall comply with the preceding Sections relating to Concrete as far as they are applicable. Precast concrete blocks shall comply with the requirements and recommendations of BS 6073.

8.2 PRECASTING BED

All precast units shall be cast on, or their shutters supported from a suitably prepared level unyielding paved area.

8.3 MARKING

All units shall be suitably marked in a clean and legible manner with a reference number and the date of casting, which information shall be clearly visible when units are stacked. Reinforced precast members shall be clearly marked to indicate the upper face.

8.4 FORMWORK

The formwork shall be either steel or lined with steel, waterproof / laminated board or such other material as directed and approved by the ENGINEER. Forms shall be strongly constructed, closely jointed and smooth and shall be such as to ensure true sharp arises and a perfect surface. Forms shall be so designed that they can be taken apart and reassembled readily.

8.5 CASTING TOLERANCE

The casting tolerance, unless otherwise ordered or directed, shall be within +3mm of true dimensions.

8.6 STRIKING FORMS

The method and time of striking the side shutters after casting the units will normally be left to the discretion of the CONTRACTOR, but the ENGINEER may specify minimum time in which case the CONTRACTOR must comply with the ENGINEER'S directions. In the event of any damage resulting from premature removal of shutters, or from any other cause, the unit will be liable to rejection and replacement by the Contractor at his own cost, whether the Engineer has specified a minimum striking time or not.

8.7 LIFTING, STACKING AND REMOVAL

8.7.1 Precast units shall not be lifted, transported or used in the Works until they are sufficiently mature. The crushing tests on the test cubes, which are to be kept along with relevant the precast units, will be used to assess the maturity of the units.

8.7.2 Lifting, stacking and removal of precast units shall be undertaken without causing shock, vibration or undue stress to or in the units. The CONTRACTOR shall satisfy the ENGINEER that the methods he proposes for lifting, transporting and setting precast units will not overstress or damage the units in any way. In the event of overstress or damage due to whatever cause, the unit or units concerned will be liable to rejection. Rejected units shall be immediately broken up and removed from the site. The CONTRACTOR shall replace such rejected units at his own cost.

8.8 CURING

The top and sides of all precast units shall be kept covered constantly and in a damp condition with clean, potable fresh water for at least seven days after casting or for such further period as the ENGINEER may direct. It is preferable to have a curing pond for this purpose.

8.9 PRECASTING RECORDS

Complete records shall be maintained of all precast work. Every unit shall have a reference number, date of casting, date of removal from bed and date and position of placing shall be recorded together with corresponding test cube reference number and results.

8.10 CONTRACTOR shall submit a method statement to ENGINEER for approval, furnishing details of each stage of operation.

9.0 FORMWORK

9.1 Formwork shall be all inclusive and shall consist of but not limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs, etc. including ties, anchors, hangers, inserts, false work, wedges, etc.

9.2 The design and engineering of the formwork as well as its construction shall be the responsibility of CONTRACTOR. However, if so directed by ENGINEER, the drawings and calculations for the design of the formwork shall be submitted to ENGINEER for approval.

9.3 Formwork shall be designed to fulfill the following requirements:

9.3.1 Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.

9.3.2 Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.

9.3.3 Capable of withstanding without deflection the worst combination of self weight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, wind and weather forces.

9.3.4 Capable of easily striking without shock, disturbance or damage to the concrete.

9.3.5 Soffit forms capable of imparting a camber if required.

9.3.6 Soffit forms and supports capable of being left in position if required.

9.3.7 Capable of being cleaned and/or coated if necessary immediately prior to casting the concrete; design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.

9.4 The formwork may be of lined timber, waterproof / plastic coated plywood, steel, plastic depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of ENGINEER. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and formwork and between formwork and structure shall be sufficiently tight to prevent loss of slurry from concrete using foam and rubber seals.

9.5 The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces, dust etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost.

9.6 Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of ENGINEER. CONTRACTOR shall equip himself with enough quantity of shuttering to allow for wastage so as to complete the job in time.

9.7 Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.

9.8 Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves may be used. Formwork spacers left in situ shall not impair the desired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture.

9.9 For liquid retaining structures sleeves shall not be provided for through bolts nor shall through bolts be removed if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

9.10 Where specified or shown on drawings all corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size.

9.11 Forms for substructure may be omitted when, in the opinion of ENGINEER, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavation shall be slightly larger, as directed by ENGINEER, than that required as per drawing to compensate for irregularities in excavation.

9.12 CONTRACTOR shall provide adequate props of adjustable steel pipes carried down to a firm bearing without overloading any of the structures.

9.13 The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering

for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.5 m or as directed by ENGINEER. CONTRACTOR shall temporarily and securely fix items to be cast (embedment/inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

9.14 Formwork showing excessive distortion, during any stage of construction, shall be removed. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at CONTRACTOR's cost.

9.15 The striking time for formwork shall be as per IS: 456 and shall be determined based on the following requirements:

9.15.1 Development of adequate concrete strength;

9.15.2 Permissible deflection at time of striking form work;

9.15.3 Curing procedure employed - its efficiency and effectiveness;

9.15.4 Subsequent surface treatment to be done;

9.15.5 Prevention of thermal cracking at re-entrant angles;

9.15.6 Ambient temperatures; and Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete). Before removing formwork of soffit of slabs/ beams compressive strength at 7/14/21 days shall be checked. The contractor shall obtain permission from the Engineer before deshuttering.

9.16 Under normal circumstances (generally where temperatures are above 20 Deg. C) forms may be struck after expiry of the period given in IS: 456 unless directed otherwise by ENGINEER. For Portland Pozzolona/slag cement the stripping time shall be suitably modified as directed by the ENGINEER. It is the CONTRACTOR's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resists surface damage and any stresses arising during the construction period.

10.0 REINFORCEMENT FABRICATION AND PLACEMENT

10.1 Reinforcing bars supplied in the form of bent coils shall be straightened cold without damage at no extra cost. No bending shall be done when ambient temperature is below 5 Deg.C. Suitable preheating may be permitted if steel bar bending is to be done at below 0 Deg.C. Bars supplied in bent coils shall be straightened only by machine.

10.2 All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings/ schedules or as directed by ENGINEER. Bar bending machines shall be used to achieve desired accuracy.

10.3 Re-bending or straightening incorrectly bent bars shall not be done without approval of ENGINEER.

10.4 Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire, etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be approved by ENGINEER prior to concrete placement. Spacers (PVC or Concrete) shall be of such material and design as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.

10.5 Binding wire shall be 16 gauge soft annealed wire. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.

10.6 Substitution of reinforcement, laps/splices not shown on drawing shall be proposed by CONTRACTOR and approved by ENGINEER.

10.7 If permitted by ENGINEER, welding of reinforcement shall be done in accordance with IS: 2751, IS: 9417 and SP: 34 as applicable.

10.8 Tolerance on placement of reinforcement shall be as per Cl. 12.3 of IS: 456.

11.0 TOLERANCES

11.1 Tolerance for formed and concrete dimensions shall be as per IS: 456 and/ or ACI-117-90, ACI- 347 unless specified otherwise.

11.2 Tolerance specified for horizontal or vertical building lines or footings shall not be construed to permit encroachment beyond the legal boundaries.

11.3 Tolerance for top of concrete of equipments and structural steel foundations shall be as under:

11.3.1 Where grout thickness is less than or equal to 25mm: +5mm and –10mm.

11.3.2 Where grout thickness is more than 25mm: ±15mm.

12.0 PREPARATION PRIOR TO CONCRETE PLACEMENT

12.1 Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provided.

12.2 All arrangements-formwork, equipment and proposed procedure, shall be approved by ENGINEER. CONTRACTOR shall maintain separate Pour Card for each pour as per the format enclosed.

13.0 **TRANSPORTING, PLACING AND COMPACTING CONCRETE**

13.1 Concrete shall be transported from the mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water.

13.2 In all cases concrete shall be deposited as nearly as practicable directly in its final position. To avoid segregation, concrete shall not be rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms, CONTRACTOR shall provide suitable drops and “Elephant Trunks”. Concrete shall not be dropped from a height of more than 1.5 m as stipulated in clause 9.13.

13.3 Concrete shall not be placed in flowing water. Under water concrete shall be placed in position by tremie or by pipeline from the mixer and shall never be allowed to fall freely through the water.

13.4 While placing concrete the CONTRACTOR shall proceed as specified below and also ensure the following:

13.4.1 Continuously between construction joints and predetermined abutments

13.4.2 Without disturbance to forms or reinforcement

13.4.3 Without disturbance to pipes, ducts, fixings and the like to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits, etc

13.4.4 Without dropping in a manner that could cause segregation or shock

13.4.5 In deep pours only when the concrete and formwork is designed for this purpose and by using suitable chutes or pipes.

13.4.6 Do not place if the workability is such that full compaction cannot be achieved.

13.4.7 Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary. In supported excavations, withdraw the linings progressively as concrete is placed.

13.4.8 If placed directly onto hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.

13.4.9 Ensure that there is no damage or displacement to sheet membranes.

13.4.10 Record the time and location of placing structural concrete.

13.5 Concrete shall normally be compacted in its final position within thirty minutes (Initial setting time) of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids, thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork.

Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers. Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set. Over-vibration leads to segregation and shall be avoided.

13.6 Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by ENGINEER. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

13.7 CONTRACTOR shall submit a method statement to ENGINEER for approval, furnishing details of pour sequence, thickness of each layer, mixing and conveying equipments proposed etc. preferably with a sketch.

13.8 Except when placing with slip forms, each placement of concrete in multiple lift work shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction and it shall be resumed before concrete takes initial set but not until it has had time to settle as determined by ENGINEER. Concrete shall be protected against damage until final acceptance.

14.0 PLACING OF CONCRETE BY PUMPING METHODS

14.1 GENERAL

14.1.1 Placing of concrete by pumping will be as specified or authorised by Engineer to achieve the required speediness of construction and maintain targeted schedules.

14.1.2 Pumping of concrete shall be done only after conducting pumpability trials to ascertain the performance of fresh concrete on pumping in presence of the Engineer as per approved procedure. During pumping, concrete shall be conveyed either through rigid pipe or through flexible hose and discharged directly into the desired area. A steady supply of pumpable concrete is necessary for satisfactory pumping. Pumpable concrete requires properly graded aggregates, material uniformity, consistent batching and thorough mixing. Concrete pumps used shall be able to deliver concrete over a horizontal distance of about 400 m or of about 100 m in a vertical direction, (with intermediate figures for a combination of horizontal

and vertical movements). They shall be used for concreting densely reinforced structures, internal structural elements of buildings and for large pours of concrete.

14.1.3 Placement of normal concrete by pumping will be permitted as specified or authorised by the Engineer. The decision, whether or not to pump any particular mix shall rest entirely with the Engineer and no extra claims for payment on this account will be entertained. The pumping equipment, pipe lines and accessories as well as proportioning of pumpable concrete shall generally confirm to the recommendations of ACI-304.2 (latest revision) – Placing of concrete by pumping method - Proportioning of pumpable mixes gives certain guide lines on concrete mix. However, final selection of mix shall be as instructed by the Engineer.

14.2 PUMPING EQUIPMENT

14.2.1 Requisite numbers of modern dependable concrete pumps capable of pumping concrete of specified quality at a rate required to meet the construction schedules, together with a balanced complement of pipelines, accessories, spare parts, power controlled placing booms, and experienced pump operators and maintenance staff shall be provided at locations and in a manner approved by the Engineer.

14.2.2 The pumping plant shall be completely installed on each occasion, with preliminary mock operation for a sufficient length of time prior to scheduled placement of a particular concrete pour, to enable the Engineer to conduct pumpability tests and necessary adjustments for the concrete mix, prior to use of the pumping for placement of concrete.

14.3 TYPE OF PUMP

14.3.1 The selection of the concrete pump shall be done as per the project requirement. The Contractor shall submit the concrete pump data sheets proving the suitability for the given project to ENGINEER for approval.

14.3.2 The concrete pump shall be selected on its best pumping capacity and the speediness to be achieved in the project. The piston pumps of a net horizontal pumping capacity of 30 m3/ hr or 20 m3/ hr or 15 m3/ hr or 10 m3/ hr can be utilised. The combination of various pumps to be used shall be decided by Contractor and shall submit the necessary documents and targeted progress to be achieved in line with the Time Period and Milestones.

14.3.3 These pumps shall have capacity to pump the concrete up to at a horizontal distance of 400 m and capable of generating a minimum pressure of 80 bar. These parameters shall depend upon the building sizes, manoeuvrability and other construction features. These pumps shall consist of a receiving hopper with a bolted grill at top of capacity not less than 600 litres. The hoppers shall be provided with hydraulically driven re-mixing blades or other agitating devices to keep the concrete mixed continuously and maintain consistency and uniformity. The pumps shall be provided with two cylinders with max. diameter not less than 150 mm, stroke of about 1200 mm and the number of strokes not exceeding 25 per minute.

The outlet valves shall be located on the discharge lines. Type of inlet and outlet valves may vary depending on the manufacturer, but they shall preferably be of sliding-rod-flat-gate type. The piston shall be hydraulically driven. Primary power shall be supplied by gasoline, diesel or electric motor of requisite power rating. Care shall be taken by the Contractor to ensure uninterrupted operation of the pumps during the entire period of concreting by providing adequate standby arrangements. The primary power and pump equipment shall be either truck or trailer mounted, and not skid mounted.

14.4 PIPELINES AND ACCESSORIES

14.4.1 Rigid pipelines

Concrete transported to the placement area by pumping methods shall be pumped thorough rigid pipes or a combination of rigid and heavy-duty flexible hoses. Rigid pipe shall be made available in minimum 125 mm diameter size. Aluminum alloy lines shall not be used for delivery of concrete. Rigid pipes shall be furnished in such lengths as can be manually handled by a single person.

14.4.2 Flexible conduit (hose)

Flexible conduit shall be made of rubber, or spirally wound flexible metal, and plastic flexible conduits generally present greater resistance to movement of concrete and their performance is not the same as that of a rigid pipe and also larger sizes (100 mm to 123 mm) have a tendency to leak. Flexible conduits provided, shall be interchangeable with rigid pipes and their use restricted to curves, difficult placement areas, and as connection to moving cranes or to water borne lines.

14.4.3 Couplings

The couplings provided to connect both flexible and rigid pipe sections shall be adequate in strength to withstand handling during erection of the pipe system, misalignments, and poor support along the lines. They should be nominally rated for at least 3.45 Mpa and greater for rising over 30 mtr. The strength and tightness of joints shall be guaranteed. Couplings shall be designed to allow replacement of any pipe section without moving other pipe sections, and shall provide a full internal cross-section with no obstructions or crevices to disrupt the smooth flow of concrete.

14.4.4 Accessories

The pump and the distribution system for a particular concreting job shall use the accessories as listed below and they shall be approved by the Engineer.

(a) Rigid and flexible pipes in varying lengths, such as 3, 1.5, 0.9, 0.6 and 0.3 m lengths.

(b) Curved sections of rigid pipes such as large radius elbows at angles of 90 deg., 45 deg., 22 deg. 30 min. and 11 deg. 15 min.

(c) Swivel joints and rotary distributors.

(d) Pin and gate valves to prevent back-flow in the pipe line.

(e) Switch valve to direct flow into another pipe line.

(f) Connection devices to fill forms the bottom up.

(g) Temporary supports, rollers and other devices for protection of conduit over rock, concrete, reinforcement steel and forms. Lifting and leashing points.

(h) Extra strong coupling for vertical runs in inaccessible areas.

(i) Transition for connecting different sizes of pipes.

(j) Air vents for downhill pumping.

(k) Clean-out equipment.

(l) Adequate numbers of separate placement booms of various radius and reach, either stationary steel column mounted or tower crane mast mounted moving on rail tracks, or truck mounted shall be provided by the Contractor to match within concrete placement schedule and pumps. For maximum flexibility of operation the separate placement boom shall be such that they can be easily lifted by the tower cranes provided. Their mounting arrangements shall be quick connecting type and interchangeable between tower crane masts, steel columns and truck mountings etc. The placement booms shall consist of three hinged parts incorporating a concrete pipe line with articulated inserts at boom joints and ending in a flexible hose. The boom shall be remote controlled.

14.5 THE PUMPING PLANT AND THE PIPE DISTRIBUTION SYSTEM

14.5.1 The concrete pumping plant apart from the receiving hopper and the pump shall also be provided with a water pressure valve, connecting pipes with needle valve, cleaning rods, outlets for drainage water and a high pressure pumps for flushing out the concrete in pipe line.

14.5.2 The shortest way shall be selected in planning the direction of the concrete pipeline, and the number of bends (elbows) shall be as small as possible. Should a change be made of the direction in plan of the pipe lines or a change of their vertical profile, these shall be arranged witheasy transitions.

14.5.3 Before the pipeline is assembled all pipe flanges shall be tested and carefully cleaned, packing rings cleaned or replaced, and the internal surfaces of all pipe section cleaned. Horizontal lengths of concrete pipe lines shall be laid on supports, wooden trestles, scaffolding, staging etc. Vertical and inclined lengths of pipe shall

be fastened by clamp irons or stirrups to masts, or to the frame of the structure being erected. It is recommended to replace vertical sections of the pipeline by inclined sections where possible. Sharp turns and bends at an angle of 90 deg. shall be avoided. Pipes shall be supported in such a manner that they do not disturb the forms during concreting.

14.5.4 A vertical section of the concrete pipeline shall not be arranged closer than 8 to 9 m from the concrete pump. Before a vertical section a valve shall normally be placed, to prevent back flow of the concrete when the pump stops or when the pipe is cleaned or replaced. When pumping vertically through the placer boom, a thrust block shall be provided at the base of the vertical riser to resist the forces in the pipeline due to the pumping of concrete.

14.5.5 When pumping downwards, 15 m or more, it is desirable to provide an air release valve at the middle of the top bend.

14.6 LINE RESISTANCE AND LUBRICATION

14.6.1 When concrete is pumped through a straight section of a pipe or hose, it moves as a cylinder riding on a thin lubricant film of a grout or mortar. At changes in direction or cross-section some re-mixing occurs. In all cases at the start of pumping operation lubricating mortar is required, and this shall be a properly designed mortar of cement-sand grout (1:1) or a batch of the regular concrete with the coarse aggregate omitted. Except for a small portion of this mortar which may be used for bedding at the construction joint, it shall be wasted and not used in the concrete placement. It can be assumed that about 0.35 cu. m of mortar will lubricate a 125 mm diameter horizontal pipeline of about 300 m length and the lubrication shall be maintained as long as the pumping continues. For vertical or smaller lines less mortar will be required. The mortar shall have the same cement content as that of the concrete. The water cement ratio shall be determined by the placing condition and finally decided by the Engineer. In order to ensure that only minimum quantity of grout mortar is used to lubricate the pipeline, a rubber sponge ball shall be allowed to pass through the pipeline immediately before the first batch of grout mortar is pumped. This rubber ball shall be pushed by the following mortar along the pipeline slowly and allowed to emerge at the open end. The cost of the lubricating mortar to be used, shall be deemed to have been included in the general rate structure for works in the schedule of items and nothing extra shall be payable.

14.6.2 It shall be taken into account when planning the pipeline that, in straight horizontal and vertical section of pipe and at bends, the resistance to the movements of concrete differ. For convenience in calculating the resistance of a concrete pipeline experimental co-efficient of equivalent length shall be used by means of which the equivalent length of a horizontal concrete pipeline is to be obtained. In absence of the pump manufacturer’s data, equivalent lengths of concrete pipeline as indicated in Table–8 may be used.

Table –8

EQUIVALENT LENGTH OF CONCRETE PIPELINES

Characteristics of a length of concrete pipeline	**Equivalent length of horizontal concrete pipeline in meter**
Bend in pipeline at an angle of 90 deg	12
Bend in pipeline at an angle of 45 deg	7
Bend in pipeline at an angle of 22 deg. 30 min	4
1 m of vertical concrete pipeline	8

The equivalent length of the concrete pipeline must be less than or equal to the range of feed in horizontal direction as specified by the pump manufacturer for the same rate of pumping. To obtain the least line resistance, the layout of the pipeline system shall contain a minimum number of bends and preferably with no change in pipe size. If two sizes of pipes are required to be used, the smaller diameter shall be used at the pump end and the larger at the discharge end. The contractor shall exercise care in handling of the pipeline, during assembly, cleaning and dismantling so as to lower the line resistance by preventing the formation of rough surfaces, dents in pipe section and crevices in couplings. If any pipe, bend, coupling and other accessories are considered to be defective or damaged by the Engineer, the same shall not be used in the concrete pipeline till such time the defect has been removed and the damage repaired to the entire satisfaction of the Engineer. Qualified chemical admixtures shall be used effectively to get workable concrete.

14.7 PROPORTIONING PUMPABLE CONCRETE

14.7.1 Basic Consideration

(a) Although the ingredients of concrete to be placed both by pumping and by other means are the same, more emphasis shall be laid on the quality control and proportioning of a dependable pumpable mix. Dependability is affected by the equipment and the operator, with the control of all of the ingredients in the mixture, the batching and mixing operations, and the knowledge and experience of all the personnel from beginning to end.

(b) Concrete mixes for pumping shall be “plastic” at all times. Stiff mixes shall not be used for pumping as they do not pump well. Particular attention shall be given to the mortar (cement, sand and water) and the amounts and sizes of coarse aggregates.

14.8 NORMAL WEIGHT AGGREGATES

14.8.1 Coarse Normal Weight Aggregates

The maximum size of angular coarse aggregate shall be limited to one-third of the smallest inside diameter of the hose or pipe based on simple geometry of cubical shape aggregates. For well-rounded aggregates, the maximum size shall be limited to 40% of the pipe or hose diameter. Adequate provisions shall be made to eliminate over size particles in the concrete by screening or by careful selection of aggregate. Gradation of sizes of coarse aggregates shall correspond to Grades A and B of Table–9 and shall meet IS: 2386 requirements. If required certain fractional sizes shall be combined and blended to produce the required gradation. Greater emphasis shall be laid on uniformity of gradation throughout the entire job. The maximum size of the coarse aggregate has a significant effect on the volume or amount of coarse aggregate that may be effectively used in a mix. As will be seen from Table–10 the quantity of coarse aggregate must be substantially reduced as the maximum size become smaller. Mixes consisting of too large a portion of coarse aggregate with less cement shall be avoided.

Table –9

Grading Requirement of Coarse Aggregates for Pumped Concrete

Grade - A (Maximum Size 40 mm)		**Grade –B** (Maximum Size 20 mm)	
Sieve Size	**Percent Passing By weight**	**Sieve Size**	**Percent Passing By weight**
50 mm	100	25 mm	100
40 mm	95 to 100	20 mm	90 to 100
20 mm	35 to 70	12.5 mm	20 to 55
10 mm	10 to 30	10 mm	0 to 15
4.75 mm	0 to 5	4.75 mm	0 to 5

Table –10

Volume of coarse Aggregate per unit of volume of concrete

Max. Size	**Volume of Dry-rodded Coarse Aggregate per unit volume of aggregates of concrete for different fineness modulii of sand**			
	FMS = 2.40	**FMS = 2.60**	**FMS = 2.80**	**FMS = 3.00**
10	0.50	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.60

Max. Size	Volume of Dry-rodded Coarse Aggregate per unit volume of aggregates of concrete for different fineness modulii of sand			
	FMS = 2.40	FMS = 2.60	FMS = 2.80	FMS = 3.00
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.70
50	0.78	0.76	0.74	0.72

Note:

- Volumes are based on aggregates in dry-rodded condition.
- These volumes are selected from empirical relationships to produce concrete with a degree of workability suitable for usual reinforced construction. When placement is to by pump, they shall be reduced by about 10 percent.
- FMS = Fineness Modulus of Sand.

14.8.2 Fine Normal Weight Aggregates

Fine aggregate shall consist of natural sand, manufactured sand or a combination thereof and shall be graded within the following limits.

Sieve Size	Percent passing by weight
9.5 mm	100
4.75 mm	950 to 100
2.36 mm	80 to 100
1.18 mm	50 to 85
600 microns	25 to 60
300 microns	10 to 30
150 microns	2 to 10

Fine aggregates shall conform to the requirements of IS: 2386. Particular attention shall be given to those passing through finer screen sizes. For small line system (less than 150 mm) 15 to 30 percent shall pass 300 micron sieve and 5 to 10 percent shall pass 150 micron sieve. Sands which are deficient in either of these two sizes shall be blended with selected finer sands or inert material such as quarry dust to produce these desired percentages. The fineness modulus of sand meeting the above grading limits will fall between 2.13 and 3.37 with the median being 2.75. Pumpability of mixes will generally improve with a decrease in the

fineness modulus value or in other words with the use of finer sands. Sands having a fineness modulus between 2.40 and 3.00 are generally satisfactory provided that the percentages passing 300 micron and 150 micron sieves meet the previously stated requirements. It shall also be emphasized that for uniformity, the fineness modulus of the sand shall not vary more than 0.20 from the average value used in proportioning. Table–10 is suggested as a guide to determine the amounts of coarse aggregate to be combined with sand of different fineness modulus. The foot note of Table–10 requires a reduction in the volume of coarse aggregate by 10 percent for pumping. This margin shall be considered as a safety margin for variations in sand gradation to reduce pumping pressure. Under conditions of good materials control and uncomplicated line systems, this reduction may not be required. Although in practice it may not be possible to duplicate this recommended sand gradation exactly, sands having a gradation closer to the upper limit (fine sand) are more desirable for pumping than those near the lower limit (coarse sand). The fineness modulus of sand according to the recommended curve is 2.68 and the gradation meets all the requirements stated earlier.

14.9 WATER AND SLUMP

14.9.1 Water requirements and slump control for pumpable normal weight concrete are interrelated and extremely important considerations. The mixing water requirements for a particular mix shall be determined by the Engineer and modified to suit the fineness of sands, quality of admixtures, additives, cement replacements or other special materials being used in the concrete.

14.9.2 The Contractor shall establish the optimum slump jointly with the Engineer for a pumpable mix at the discharge hose end and shall maintain control of that particular slump throughout the course of a job. Excess water shall not be added in the receiving hopper to make the concrete mix pumpable; instead attempt shall be made to obtain ‘truly plastic mix’ by proper proportioning.

14.9.3 Slump of concrete may undergo change between initial mixing and final placement. If the slumps at the discharge hose end are to be maintained within specified limits, it will be necessary for the concrete to enter the pump at a higher slump to give the required mobility during transport. Slump adjustments by re-proportioning of the constituents as may be required shall be carried out by the Contractor jointly in consultation with the Engineer for every type of mix and for every new placement and set up of pump and pipelines.

14.10 CEMENT CONTENT

14.10.1 The determination of the cement content for a normal weight pump mix shall follow the same basic principles used for conventionally placed concrete. The water cement ratio shall be established by the Engineer on the basis of exposure conditions, strength requirements or minimum cement consumption, whichever governs. However, because of slightly higher ranges of slump and ratios of fine to coarse aggregates, the pump mix may require an increase in the amount of cement

above those pumpable concrete mass. The total quantity of fines passing through the 300 micron sieve including cement, fine sand, stone dust etc. shall be in the range of 380 to 450 kg/cu.m of concrete.

14.10.2 Cement content in case of M-50 shall be maximum of 425 kg/m3, and shall be a mix with high range of workability i.e. 175 mm +/- 25 mm. All the contents shall be mixed based on the mix design & trial studies.

14.10.3 While establishing the cement content for normal weight trial mixes, it will be necessary to take into account the capabilities of the particular pump and its operator for over strength proportioning in the laboratory to provide for field variations.

14.10.4 In case of pumping difficulties, it is desirable and economical to correct any deficiencies in the aggregates, especially in the sand instead of using extra quantities of sand. With well graded coarse and fine aggregates properly combined, the cement requirement for pumpable mixes shall closely resemble to those used in conventially placed concrete.

14.11 ADMIXTURES

The use of poor aggregate grading or aggregate with continuous change in overall grading of the 'combinations' during concreting operation will make special admixtures quite useful in overcoming the main difficulty like blockage in pumping. These admixtures shall be incorporated in pumpable concrete to aim the following:

14.11.1 Increase in the range of mix designs which may be successfully pumped using water reducing admixtures/Super plasticizers with the approval of the Engineer.

14.11.2 Reducing the risk of pipeline blockages by preventing segregation of concrete mix.

14.11.3 To have satisfactory/specified performance both in fresh and hardened state.

Any admixture that increases workability in normal weight concrete may usually improve pumpability. The choice of type of admixture and the advantage gained from its use in concrete to be pumped will depend on the characteristics of the pump mix and will be finally decided by the Engineer in consultation with the admixture manufacturer.

For improvement of pumpability the following admixtures are generally recommended. Such admixtures used shall be conforming to ASTM C-494/IS 9103.

(a) Water Reducing Admixtures/ Super Plasticizers

These cause reduction in water requirements at constant slump or an increase in slump at constant water-cement ratio. They can be designed to have no apparent effect on setting time, or alternately to achieve varying degrees of acceleration or retardation in rate of hardening of the mixture.

Most water reducing admixtures increase the pumpabillity of the concrete mix through plasticising action.

(b) Air Entraining Admixtures

Air entrained concrete is considerably plastic and more workable than non air entrained concrete. It can be pumped with less coarse aggregate segregation and has less tendency for concrete to bleed. Start-up after shut down is also generally easier due to reduced bleeding. For pumped concrete these limits shall be obtained at the point of placement in the structure. To compensate for air content loss in the air entrained concrete higher entrainment of air may be required at the batching plant. The required adjustment of admixture dose shall be carried out by the Engineer after carrying out necessary air loss tests. An air content in the range of 3 to 5 % shall be preferred as higher ranges reduces the delivery capacity of pump systems due to increased compressibility of the concrete and also reduces strength of concrete. If air-entraining plasticizer is used, typically 13 % minimum water reduction is possible. Therefore, strength loss due to air entrainment will be compensated by using such air-entraining plasticizer.

(c) Finely Divided Mineral Admixtures

Contractor, if specifically approved by the engineer, can use mineral admixture. In concrete mixtures deficient in fines, the addition of a finely divided inert mineral admixture generally improves workability, pumpability, reduces the amount of bleeding and increases the strength. The effect on strength depends on the type of mineral admixture used, conditions under which the concrete is cured, and the amount of admixture used. Water soluble polymers obtained from cellulose derivations may also be used as an admixture with a small dose of 60 to 150 gms/cu.m to increase viscosity of the mixing water and reduce the frictional resistance to flow and bleeding in the pipe system.

14.12 TRIAL MIXES

The trial mixes for pumping shall be prepared and tested in the Site laboratory by contractor in accordance with clause 14.13 of this specification. The ingredients, particularly the coarse and fine aggregates shall also be checked for the conformance to the desired properties described, by the contractor. Table –10 may be used to select the volume of coarse aggregate per cu. m. of concrete. In using this table it is recommended that the highest probable fineness modulus of sand be used rather than the average fineness modulus to ensure consistent performance during pumping. For additional plasticity, 10% reduction in coarse aggregate quantities shall be considered. Experience with the use of local aggregate and their uniformity shall also be considered in the proportioning concepts.

14.13 MIX DESIGN FOR PUMPABLE CONCRETE

Taking the above factors into account, the concrete shall first be designed for normal placement conditions and then modified as necessary to suit pumping. The following procedure shall be adopted:

14.13.1 Design the mix for specified characteristic strength and workability.

14.13.2 Check and ensure combined grading of aggregates i.e. as uniform grading as possible. This requirement is vital as gaps or partial gaps are the basic reasons for poor water retention property and segregation under pressure.

14.13.3 Determine the optimum sand content for the required workability and increase sand content by reducing volume of coarse aggregate per unit volume of concrete by about 10% as a degree of protection against under sanding due to batch variations.

14.13.4 Recheck the minimum cement content for durability.

14.13.5 Examine the total fines content i.e. cement and fine aggregates passing through 300 micron sieve and readjust the mix, if necessary. A very rich mix with fine sand will be as problematic as coarse sand with lean mix.

14.13.6 Re-appraise the grading if the particle shape of any particular fraction is such as may cause excessive voids. Re-adjust as required, if necessary examining the void ratio of various combinations, using void meter to achieve minimum voids at the expense of 'sufficient fines' content.

14.13.7 If dissatisfied with Cl. 14.13.1 to Cl. 14.13.6 as above, consider what remedial action may be taken to overcome the troublesome factor. For example, the following two situations may occur

14.13.8 If the sand has more coarser fraction it is worth considering the addition of a proportion of finer sand, or alternately if the sand has more finer fraction, the addition of coarse fraction may be considered. Addition or reduction of cement may help, but the correct solution is to overcome the gap in overall grading as stated above.

14.3.9 In a 20 mm aggregate max. size, if there is an excess of 10 to 4.75 mm fraction, and this fraction is flaky with unduly large surface area, either increase the sand content to reduce the possibility of segregation and to reduce the inter-practical stresses, or (better) re-grade using single sized aggregates.

14.3.10 At the trial mix stage small variations can be made preferably in the light of the pressures registered and observed performances through the pump. In certain cases admixtures may be economically and beneficially used to improve or eliminate circumstances that cannot readily be overcome by other means.

14.14 TESTING FOR PUMPABILITY

No mix shall be accepted for use on a pumping job until an actual test under field condition has been completed. Testing a mix for pumpability involves duplication of

the anticipated job condition from beginning to end. The batching and conveying by truck mixers shall be the same as will be used; the same pump and operator shall be present. The pipe and hose layouts shall simulate the actual condition as far as practicable. Prior use of a mix on another job may furnish evidence of pumpability but only if conditions are duplicated. Before commencing a new concreting job, the contractor shall carry out pumpability tests in consultation with the Engineer. Concrete used in such tests shall not be used in the actual construction, unless specifically permitted by the Engineer.

Following parameter shall be established by pumpability trials:

14.14.1 Insitu compressive & split tensile strength of concrete by

a) Curing the sample at Site by sprinkling water.

b) Curing the sample at Laboratory in curing tanks.

14.14.2 Wet sieve analysis of concrete to ensure that proportions of ingredients before and after pumping are same.

14.15 FIELD PRACTICES

14.15.1 Proper planning of concrete supply, pump location, line layout, placing sequence and the entire pumping operation shall be done by the Contractor and got approved by the Engineer on every occasion before commencement of concreting job. The pump shall be as near the placing area as practicable, and the entire surrounding area must have adequate bearing strength to support the concrete delivery trucks, thus assuring a continuous supply of concrete. For important concrete placements and large jobs, adequate standby power and pumping equipment shall be provided as replacement, should break down occur.

14.15.2 Direct communications shall be maintained between the pump operator, concrete placing crew and batching plant. The placing rate shall be estimated so that concrete can be operated at an appropriate delivery rate. As a final check, the pump shall be started and operated without concrete to ascertain that, all moving parts are operating properly. As stated previously, the grout mortar shall be pumped into the line to provide initial lubrication for the concrete. As soon as concrete is received, the pump shall be run slowly until the lines are completely full and the concrete is slowly moving. Once the pumping is started, the operator shall ensure that the hopper of the pump is not emptied beyond a certain level, as air may enter the pipeline and cause choking. Continuous pumping should be ensured. If a delay occurs because of concrete delivery, form repairs, or other factors, the pump shall be slowed down to maintain some movement of the concrete till normal supply is resumed. For longer delays, the concrete in the receiving hopper shall be made to last as long as possible by moving the concrete in the lines occasionally with one stroke of the pump. In confined areas, attempt shall be made by the Contractor to run a return line back to the pump, so that concrete can be re-circulated during delays.

14.15.3 The Contractor shall ensure that obstructions are not found in the pipe due to interruption in the feed of the concrete by more than 30 to 45 minutes.

14.15.4 Minor blockages shall be cleared by operating a few strokes of the pump in reverse momentarily and then by returning to normal forward pumping. If this fails, a succession of reverse and forward strokes shall be carried out to remove the blockage. Should this fail also, the blockage may be due to air-lock and the entrapped air has to be removed.

14.15.5 Attempt to push through the obstructions by repeatedly starting the pump will result in compaction of the concrete and complicate the removal of the concrete in the pipe. Blockages in the pipe are usually discovered by the sound when the pipe is struck. To remove the obstruction, the concrete pipe shall be taken apart at the assured position and cleaned. Then the pumping process shall be started all over again.

14.15.6 This method of checking the blockage and setting it right shall be done with great speed as excessive delay will cause setting of concrete in the pipeline downstream of the choke and will lead to further blockage. When the blockage is being found out and remedied, the pump shall periodically be given one or two strokes forward to keep the concrete in motion. If blockage occurs in the placer boom, a pipe joint near the base of the placer boom shall be opened and the boom made vertical to drain the pipeline by gravity.

14.15.7 Cleaning blockages are time consuming and as such major blockages shall best be avoided by ensuring a pumpable mix. Concrete that is either under or over sanded, short of fines, gap graded, has an excess of a particular size, or excessively wet or dry will be rejected by the pump either by blockage or by hard pumping involving excessive pressures.

14.15.8 The termination of pumping operations shall be carefully planned to utilize the concrete dormant in the pipeline and the hopper when the pump is stopped and to avoid wastage.

14.15.9 When the form is nearly full, and there is enough concrete in the line to complete the placement, the pump shall be stopped and a go-devil be inserted and forced through the line to clear it out. Water under pressure shall be used to push the go-devil. The go-devil shall be stopped about one metre from the end of the line, so that the water in the line will not spill over into the placement area. After flushing, water in the pipe shall be removed by drain cock which shall be located for this purpose in the lowest part of the line. After all concrete has been removed from the lines, all lines and equipment shall be immediately cleaned thoroughly.

14.16 QUALITY CONTROL

14.16.1 Contractor shall ensure that workmanship and plant shall be maintained at peak efficiency. Degree of control on all the concrete operation from selection of the ingredients to the final testing of specimen shall be in line with the assumptions

made in mix design with respect to the standard deviation and co-efficient of variation.

14.16.2 The Contractor shall ensure that any compromise in quality is not done for the pumped concrete. To be pumpable, a high level of quality control for the assurance of uniformity must be maintained. Sampling at both the truck discharges and point of final placement shall be done by the Contractor and the Engineer jointly, as frequently as the Engineer desires to determine, if any change in the slump air content, and other significant mix characteristics occur take necessary corrective actions.

14.16.3 The Contractor shall engage experienced supervision at all levels. The placing crew shall be experienced and qualified and each operation shall be well planned and properly scheduled.

14.16.4 All the crew engaged in each of the concrete activities shall demonstrate in the presence of the Engineer, their skills and capabilities to produce the final product as specified.

15.0 MASS CONCRETE WORKS

Sequence of pouring for mass concrete works shall be as approved by ENGINEER. CONTRACTOR shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

16.0 PLACING TEMPERATURE OF CONCRETE

16.1 Placing temperature of concrete should be maintained as specified in Bill of Quantities or as directed by ENGINEER, to avoid shrinkage cracking

16.2 Mixing water shall be kept cool by storing it under cover. Chilled water or crushed ice as part of the mixing water to achieve the specified placing temperature shall be used. For chilled water, it is recommended that the contractor install and maintain refrigeration facility of required capacity. The contractor shall also build and maintain well insulated adequate capacity storage tank for cold water with insulated connected piping. To supplement this refrigeration facility, the contractor will have to have ice plant or use commercial ice subject to approval of the ENGINEER. The full quantity of crushed ice shall be stored in cold storage 24 hours in advance of the start of concreting. The temperature in cold storage shall not be more than –2oc. The contractor should study the placing temperature condition and work out plant capacity commensurate with the construction schedule requirements and submit his scheme along with the tender.

16.3 Ice when used as replacement for a portion or all the mixing water shall be produced from water which meets the requirements of clause 4.3. Ice when used shall be in flakes of size 3mm or below or crushed condition and the crushed ice shall be such as to pass completely, 10mm sieve.

17.0 **CURING**

17.1 Curing and protection shall start immediately after the compaction of the concrete to protect it from:

17.1.1 Premature drying out, particularly by solar radiation and wind;

17.1.2 Leaching out by rain and flowing water;

17.1.3 Rapid cooling during the first few days after placing;

17.1.4 High internal thermal gradients;

17.1.5 Low temperature or frost;

17.1.6 Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

17.2 All concrete, unless directed otherwise by ENGINEER, shall be cured by use of continuous sprays or ponded water or continuously saturated coverings of sacking, canvas, hessian or other absorbent material for the period of complete hydration with a minimum of 7 days. The quality of curing water shall be the same as that used for mixing.

17.3 Where a curing membrane is directed to be used by the ENGINEER, the same shall be of a non wax base and shall not impair the concrete finish in any manner. The curing compound to be used shall be got approved from the ENGINEER before use and shall be applied with spraying equipment capable of a smooth, even textured coat.

17.4 Curing may also be done by covering the surface with an impermeable material such as polyethylene, which shall be well sealed and fastened.

17.5 Extra precautions shall be exercised in curing concrete during cold and hot weather as per Clause no. 8.3 of IS: 7861(Part II) and Clause no. 8.2 of IS: 7861(Part I) respectively.

17.6 Curing arrangement shall be subjected to ENGINEER’s approval.

18.0 **CONSTRUCTION JOINTS AND KEYS**

18.1 Construction joints (location and type) shall be as shown on the drawing or as approved by ENGINEER. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of ENGINEER.

18.2 Dowels for concrete work, not likely to be taken up in the near future, shall be coated with cement slurry and encased in lean concrete as indicated on the drawings or as directed by ENGINEER.

18.3 Before resuming concreting on a surface which has hardened all laitance and loose aggregates shall be thoroughly removed by wire brushing and/ or hacking, the surface washed with high pressure water jet and treated with thin layer of cement slurry for vertical joints and a 15 mm thick layer of cement sand mortar for horizontal joints, the ratio of cement and sand being the same as in the concrete mix.

18.4 When concreting is to be resumed on a surface, which has not fully hardened, all laitance shall be removed by wire brushing, the surface wetted, free water removed and a coat of cement slurry applied. On this a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way.

18.5 Approved epoxy Bonding agent, for bond between old (say 28 days or more) and new concrete may also be used as per manufacturer's specifications.

19.0 FOUNDATION BEDDING

19.1 All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or spongy area shall be cleaned out and back filled with either soil-cement mixture, lean concrete or clean sand compacted as directed by ENGINEER. The surfaces of absorptive soils shall be moistened.

19.2 Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The rock surface shall be kept wet for 2 to 4 hours before concreting.

20.0 BASE CONCRETE

20.1 The thickness and grade of concrete and reinforcement shall be as specified in the item of work.

20.2 Before placing the blinding concrete of 1:4:8 mix, 50/75mm thick as per the item of work, the sub base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly tamped and the surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

21.0 FINISHES

21.1 GENERAL

The formwork for concrete works shall be such as to give the finish as specified. The CONTRACTOR shall make good as directed any unavoidable defects consistent with the type of concrete and finish specified; defects due to bad

workmanship (e.g. damaged or misaligned forms, defective or poorly compacted concrete) will not be accepted. CONTRACTOR shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

21.2 INTEGRAL CEMENT FINISH ON CONCRETE FLOOR

In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screeded off to proper level and tamped with tamper having conical projections so that the aggregate shall be forced below the surface. The surface shall be finished with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface. Where specified, a floor hardener of appropriate thickness as approved by the ENGINEER shall be supplied and used as recommended by the manufacturer.

22.0 REPAIR AND REPLACEMENT OF UNSATISFACTORY CONCRETE

22.1 Immediately after the shuttering is removed, all the defective areas such as honeycombed surfaces, rough patches, etc. shall be brought to the notice of ENGINEER who may permit patching of the defective areas or reject the concrete work. ENGINEER'S decision on rejection of concrete work shall be final.

22.2 All through holes for shuttering shall be filled with cement mortar for full depth and neatly plugged flush with surface.

22.3 Rejected concrete shall be removed and replaced by CONTRACTOR at no additional cost to OWNER.

22.4 For patching of defective areas all loose materials shall be removed and the surface shall be prepared as directed by the ENGINEER.

22.5 Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the ENGINEER as to be the method of repairs to be adopted shall be final and binding on the CONTRACTOR and no extra claim shall be entertained on this account. The surface shall be saturated with water for 24 hours before patching is done with 1:5 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as directed by ENGINEER.

22.6 CONTRACTOR shall submit a method statement for such repairs to ENGINEER for approval.

23.0 VACUUM DEWATERING OF SLABS

Where specified floor slabs, either on grade or suspended, shall be finished by vacuum dewatering including all operations such as poker vibration, surface vibration, vacuum processing, floating and trowelling as per equipment

manufacturer's recommendation. The equipment to be used shall be subject to ENGINEER'S approval.

24.0 HOT WEATHER REQUIREMENT

24.1 Concreting during hot weather shall be carried out as per IS: 7861 (Part I).

24.2 Adequate provisions shall be made to lower concrete temperatures which shall not exceed 40 °C at the time of placement of fresh concrete.

24.3 Where directed by ENGINEER, CONTRACTOR shall spray non-wax based curing compound on unformed concrete surface at no extra costs.

25.0 COLD WEATHER REQUIRMENTS

25.1 Concreting during cold weather shall be carried out as per IS: 7861 (PART 2).

25.2 The ambient temperature during placement and up to final set shall not fall below 50°C. Approved anti-freeze/accelerating additive shall be used where directed.

25.3 For major and large scale concreting works the temperature of concrete at times of mixing and placing, the thermal conductivity of the formwork and its insulation and stripping period shall be closely monitored.

26.0 LIQUID RETAINING STRUCTURES

26.1 The CONTRACTOR shall take special care for concrete of liquid retaining structures, underground structures and those other specifically called for to guarantee the finish and water tightness.

26.2 The minimum level of surface finish for liquid retaining structures shall be of smooth type. All such structures shall be hydro-tested.

26.3 The CONTRACTOR shall include in his price hydro-testing of structure, all arrangements for testing such as temporary bulk heads, pressure gauges, pumps, pipe lines, etc.

26.4 Any temporary arrangements that may have to be made to ensure stability of the structures shall also be considered to have been taken into account while quoting the rates.

26.5 Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/epoxy pressure grouting, guniting or such other method as may be approved by the ENGINEER. All such rectification shall be done by the CONTRACTOR to the entire satisfaction of the OWNER/ENGINEER at no extra cost to the OWNER.

27.0 TESTING CONCRETE STRUCTURES FOR LEAKAGE

27.1 Hydro-static test for water tightness shall be done at full storage level or soffit of cover slab, as may be directed by ENGINEER, as described below:

27.1.1 In case of structures whose external faces are exposed, such as elevated tanks, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry during the period of observation of seven days after allowing a seven day period for absorption after filling with water.

27.1.2 In the case of structures whose external faces are submerged and are not accessible for inspection, such as underground tanks, the structures shall be filled with water and after the expiry of seven days after the filling; the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hrs. over period of seven days. Backfilling shall be withheld till the tanks are tested. The total drop in surface level over a period for seven days shall be taken as an indication of the water tightness of the structure. The ENGINEER shall decide on the actual permissible nature of this drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has on evaporation losses. Unless specified otherwise, a structure whose top is covered shall be deemed to be water tight if the total drop in the surface level over a period of seven days does not exceed 40 mm.

27.1.3 Each compartment/segment of the structure shall be tested individually and then all together.

27.2 For structures such as pipes, tunnels, etc. the hydrostatic test shall be carried out by filling with water, after curing as specified, and subjecting to the specified test pressure for specified period. If during this period the loss of water does not exceed the equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

28.0 OPTIONAL TESTS

28.1 If ENGINEER feels that the materials i.e. cement, sand, coarse aggregates, reinforcement and water are not in accordance with the specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the ENGINEER, as per relevant IS Codes. OWNER shall pay only for the testing of material supplied by the OWNER, otherwise CONTRACTOR shall have to pay for the tests. Transporting of all material to the laboratory shall however be done by the CONTRACTOR at no extra cost to OWNER.

28.2 In the event of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strength, ENGINEER reserves the right to order the CONTRACTOR to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, as per relevant IS specifications. All these tests shall be carried out by CONTRACTOR at

no extra cost to the OWNER. Alternately ENGINEER also reserves the right to ask the CONTRACTOR to dismantle and re-do such unacceptable work at the cost of CONTRACTOR.

28.3 If the structure is certified by ENGINEER as having failed, the cost of the test and subsequent dismantling/reconstruction shall be borne by CONTRACTOR.

28.4 The quoted unit rates/prices of concrete shall deemed to provide for all tests mentioned above.

29.0 **GROUTING**

For details of grouting, refer GROUTING specification.

30.0 **QUALITY CONTROL**

30.1 Alternatively, if CONTRACTOR has his own QC formats he may adopt them subjected to such modifications considered necessary by ENGINEER.

30.2 In either case CONTRACTOR shall submit his detailed Quality Assurance Plan. along with the bid. This would be reviewed, appropriately modified and approved by CONSULTANT after the award of contract.

31.0 **INSPECTION**

All materials, workmanship and finished construction shall be subject to continuous inspection and approval of ENGINEER. Materials rejected by ENGINEER shall be expressly removed from site within 3 working days and shall be replaced by CONTRACTOR immediately at no extra cost to OWNER.

32.0 **CLEAN-UP**

Upon the completion of concrete work, all forms, equipment, construction tools, protective coverings and any debris, scraps of wood, etc. resulting from the work shall be removed and the premises left clean.

33.0 **ACCEPTANCE CRITERIA**

33.1 Any concrete work shall satisfy the requirements given below individually and collectively for it to be acceptable.

33.1.1 Properties of constituent materials;

33.1.2 Characteristic compressive strength;

33.1.3 Specified mix proportions;

33.1.4 Minimum cement content;

33.1.5 Maximum free-water/cement ratio;

33.1.6 Workability;

33.1.7 Temperature of fresh concrete;

33.1.8 Density of fully compacted concrete;

33.1.9 Cover to embedded steel;

33.1.10 Curing;

33.1.11 Tolerances in dimensions;

33.1.12 Tolerances in levels;

33.1.13 Durability;

33.1.14 Surface finishes;

33.1.15 Special requirements such as:

a) Water tightness

b) Resistance to aggressive chemicals

c) Resistance to freezing and thawing

d) Very high strength

e) Improved fire resistance

f) Wear resistance

g) Resistance to early thermal cracking

33.2 ENGINEER's decision as to the acceptability or otherwise of any concrete work shall be final and binding on the CONTRACTOR.

33.3 For work not accepted, ENGINEER may review and decide whether remedial measures are feasible so as to render the work acceptable. ENGINEER shall in that case direct the CONTRACTOR to undertake the remedial measures. These shall be expeditiously and effectively implemented by CONTRACTOR. Nothing extra shall become payable to CONTRACTOR by OWNER for executing remedial measures.

CONCRETE POUR CARD

(a) CLIENT: DATE: POUR NO:

(b) PROJECT: STRUCTURE:

(c) CONTRACTOR:

(d) MAX AGGREGATE SIZE: mm SLUMP: mm

(e) DRG. NO:

(f) START/COMPLETION TIME:

(g) CONCETE GRADE/QUANTITY: M / M3 MIXING TIME:

PART – 6: STRUCTURAL STEEL WORKS

1.0 **SCOPE**

1.1 This specification covers the general requirements for supply of all steel items where specified, fabrication, inspection, testing and delivery at site of all fabricated structural steel items.

1.2 This specification also covers design of all connections and substituted members, preparation of all shop fabrication drawings, inspection of fabricated items and the general requirements for erection of structural steel.

1.3 The scope of work also includes, but is not limited to proper stacking and storage of fabricated materials, transport from place of storage to place of erection, wherever required. All the works shall be carried out as per approved Quality Assurance procedures.

2.0 **APPLICABLE CODES, STANDARDS & SPECIFICATIONS**

2.1 The pertinent clauses of the following Indian Codes, Standards and Specification (latest editions including all applicable official amendments, reaffirmations and revisions) shall apply to the material and workmanship covered by this specification. In the event of the conflict of certain requirements between this specification and the codes referred herein, this specification shall govern.

2.2 It is not the intent to specify herein all the codes and standards required for the satisfactory completion of work. The list of codes and standards indicates certain primary codes & standards and not all the codes required for the work under the contract. It is understood that all the following codes and standards shall form the part of this specification whether explicitly indicated or not.

IS: 800: Code of Practice for General Construction in Steel.

IS: 801: Code of practice for use of Cold formed light gauge steel structural members in general building construction.

IS: 803: Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded oil storage tanks.

IS: 806: Code of practice for use of steel tubes in general building construction.

IS: 808: Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections.

IS: 813: Scheme of symbols for welding.

IS: 814: Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel – Specification.

IS: 816: Code of Practice for use of Metal Arc Welding for General construction in Mild Steel.

IS: 822: Code of Procedure for Inspection of Welds.

IS: 1024: Code of Practice for use of welding in bridges and structures subjected to dynamic loading

IS: 1161: Steel Tubes for structural purposes – Specification.

IS: 1182: Recommended Practice for Radiographic examination of Fusion - Welded Butt Joints in Steel Plates

IS: 1200: Method of Measurement in Building Civil Engineering Works.

IS: 1239: Mild steel tubes, tubulars and other Wrought steel fittings

Part 1 - Mild steel tubes

Part 2 - Mild steel Tubulars and other wrought steel pipe fittings

IS: 1363: Hexagon Head Bolts, Screws and Nuts of product (Parts 1 to 3) Grade C (Size range M5 to M64)

IS: 1367: Technical Supply Conditions for Threaded Fasteners (All Parts)

IS: 1395: Low and medium alloy steel covered electrodes for manual metal arc welding

IS: 1852: Rolling and Cutting Tolerances for Hot Rolled Steel Products.

IS: 2062: Hot Rolled low, medium and high tensile structural steel

IS: 2074: Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming

IS: 2595: Code of Practice for Radiographic Testing

IS: 3502: Steel Chequered Plate

IS: 3600: Method of testing fusion welded joints and weld metal in steel (All parts)

IS: 3658: Code of Practice for Liquid Penetrant Flaw Detection

IS: 3757: Specification for High Strength Structural Bolts

IS: 4000: High strength bolts in Steel Structures - Code of Practice

IS: 4260: Recommended practice for ultrasonic testing of butt welds in ferritic steel

IS: 4353: Submerged arc welding of mild steel and low alloy steel – Recommendations

IS: 5334: Code of Practice for Magnetic Particle Flaw Detection of Welds

IS: 5369: General Requirements for Plain Washers and Lock Washers

IS: 5372: Taper Washers for Channels

IS: 5374: Taper Washer for I Beams

IS: 6610; Heavy Washers for Steel Structures

IS: 6639: Specification for Hexagonal Bolts for Steel structures

IS: 7205: Safety Code for Erection of Structural Steel Work

IS: 7215: Tolerances for Fabrication of Steel Structures

IS: 8500: Structural Steel-microalloyed (medium and high strength qualities)

IS: 9595: Recommendations for Metal Arc Welding of Carbon and Carbon Manganese Steel

SP: 6(1): Structural Steel Sections

IS: 12843: Tolerances for Erection of Steel Structures

AISC: Specifications for Design, Fabrication and Erection of Buildings

AWS D1.1: Structural Welding code: Steel

3.0 REGULATORY REQUIREMENTS

The work covered in this specification, shall comply with all relevant government and local laws, regulations and standards. For subjects not covered by regulations, codes, standards or specifications, the materials and construction shall be based on good engineering practice, subject to approval by Engineer/ Engineer's Representative.

4.0 SUPPLY AND FABRICATION OF STRUCTURAL STEEL

SL.NO.	CONTENTS
4.1	STEEL MATERIALS
4.2	DRAWINGS
4.3	FABRICATION
4.4	TESTING, INSPECTION AND REPORTS
4.5	TEST FAILURE

4.1 STEEL MATERIALS

Steel materials shall comply with the specifications laid down under clause 2.0 and/or as called for on the design drawings. All materials used shall be new, unused and free from defects.

4.1.1 Steel Supply by the Contractor

All steel and other materials shall be procured and supplied by the Contractor, from the reputed manufactured like SAIL, TATA STEEL, ESSAR and JINDAL. Steel proposed to be procured from other sources shall have prior approval from the Owner before placement of procurement order. However Owner reserves the right to accept material from other manufacturers. Steel procured shall conform to the following.

The contractor shall furnish to the Engineer/ Engineer's Representative duplicate copies of all purchase order copies covering the material ordered by him for the project under reference and also test reports.

Contractor shall furnish the mill/ manufacturer's test reports, along with the materials and satisfactorily demonstrates the specific grade and quality. Material test certificate shall be original.

All materials required for the work shall be correlated with manufacturers test certificates. In the absence of test certificates, Contractor shall test materials through reputed laboratory approved by Engineer/ Engineer's Representative for establishing quality at Contractor's cost and as directed by the Engineer/ Engineer's Representative.

Material supplied against this Test Certificates (TC) should have identification stamped or stencilled on them. All such identification markings shall be authenticated by the inspection agency, which has inspected and approved the material.

The Engineer/ Engineer's Representative shall have the right to test random samples to prove authenticity of the test certificates produced by the contractor at

the contractor's cost. Any material found not meeting the required specification would be rejected.

Contractor shall use materials for fabrication as specified in the approved drawings. All materials supplied by the contractor shall be in sound condition, of recent manufacture, free from defects such as mill scales, slag intrusions, laminations, pitting, flaky, rust etc. and be of full weight and thickness as specified.

Whenever the contractor desires to substitute structural members/shapes, plates for the sizes shown on the drawings, for want of availability of requisite materials, such substitutions shall be made only after authorization in writing by the Engineer/ Engineer's Representative. Engineer/ Engineer's Representative may also direct that substitution be made, when he considers such substitution to be necessary.

4.2 DRAWINGS

4.2.1 Engineer's Drawings (Owner's Drawings)

(a) Engineer will issue to the Contractor such drawings and data as specified in the Contract which may include, depending on Contract:

(i) Preliminary Drawings and Data along with the Tender / Enquiry,

(ii) Any additional basic engineering details to enable detailed engineering by Contractor as required by Contract,

(iii) Interface particulars with other Contracts, and

(iv) Detailed engineering drawings in Owner's scope.

(b) Not Used.

(c) Not Used.

(d) Not Used.

(e) Not Used.

(f) In case of variations in drawings and specifications, the decision of the Engineer shall be final. Should the Contractor during the execution of his work, find discrepancies in the information furnished by the Engineer, he shall refer such discrepancies to the Engineer before proceeding with such work.

(g) Unless otherwise specified, the drawings and specifications are intended to include everything obviously requisite and necessary for proper and entire completion of the work and shall be carried out accordingly for completeness as required.

4.2.2 Contractor's Drawings

(a) Fabrication drawings shall be prepared by the Contractor or through an agency approved by Owner at his own cost based on the Engineer's/ Engineer's Representative's approved design drawing "Released for Construction" and their subsequent revisions. All the drawings for the entire work shall be prepared in metric units. Drawings shall be prepared in AUTOCAD and the details shall be drawn to the minimum scale as specified under:

(i) Marking Plan: 1:75

(ii) Joint Details: 1:5, 1:10, 1:15

(iii) Elevations: 1:20

(b) Contractor shall not commence detailing unless Engineer's approvals on Contractor's design drawings are officially released for preparation of shop drawings. The contractor shall be responsible for the correctness of all fabrication drawings. Fabrication drawings shall be revised by the Contractor to reflect all revisions in design drawings as and when such revisions are made by the Engineer.

(c) Key plan prepared by the contractor shall indicate the fabrication / erection marking of each members and a table showing the corresponding fabrication drawing number where these members are detailed. Also each drawing prepared by Contractor shall indicate corresponding Engineer's/ Engineer's Representative's drawing number with revisions.

(d) Each member shall be detailed separately unless members are identical in all respects with no deviation whatsoever. Shop detail drawings shall show all shearing, punching, drilling, bevel cutting, blending, and all welding in complete detail. All connections and splices shall be designed and detailed by the Contractor and clearly shown on the drawings. Bill of material shall show number, size, length, weight and assembly work of each erection piece. Bill of material for each drawing shall include fasteners/bolts, nuts, washers and other accessories complete with specification, size, length, numbers, etc for each erection mark and proper identification for each joint. Bill of materials shall be prepared erection mark wise, showing weight of each component part and total weight of each erection mark. All revisions after initial issue of a drawing shall be clearly indicated with issue number and date of revision.

(e) Each drawing prepared by the Contractor shall clearly indicate Names of Engineer, Engineer's Representative, Contractor, Project Title, Title of drawing, Scale, Notes, Details of revisions carried out etc. All titles, noting, marking and writings on the drawing shall be in English and all dimensions shall be in metric units. Before the commencement of preparation of fabrication drawings, Contractor shall discuss with the Owner's

Representative any specific requirement to be followed for fabrication drawing preparation.

(f) No detailed shop drawings will be accepted by the Engineer unless they are complete and checked and approved by Contractor's qualified structural engineer and accompanied by an erection plan showing the location of all pieces detailed.

(g) Contractor should check for erection clearance and ensure that the detailing of connections is carefully planned to obtain ease in erection of structures including field-welded connection and bolting. Field connections/splices may be welded or bolted type.

(h) Contractor shall submit design calculations for each and every connection detail proposed by him and also for any substitution for members, desired by him and approved by the Engineer. Fabrication drawings not accompanied by calculation for connection details are liable for rejection.

(i) Each lot of drawings sent by Contractor for approval shall contain a limited number of drawings and shall be in an order and manner which follows erection sequence or as required by Engineer based on priorities allocated. Engineer will return one copy of Contractor's drawing marked with Engineer's approval/comments. Contractor shall furnish the Engineer the required number of prints of all approved drawings for field use and record purpose.

(j) Engineer or Engineer's Representative may review / approve the fabrication drawing at his option some, all or none of the fabrication drawings. Wherever such reviews are carried out the same shall be restricted to the following.

(i) Review/ approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.

(ii) Correctness of overall dimensions, centre to centre distance, elevations. Important / typical connection details (adequacy of number of bolts / weld length for few connections only will be checked), working points for bracing members and orientations and sizes / sections of members.

(iii) Sequence of erection in the light of project requirements.

(iv) Whether the fabrication drawings broadly conform to details shown on design drawings and comply with technical specifications, general notes, any specific notes made on design drawings and generally with the requirement of good engineering practice.

k) It shall be clearly noted by the contractor that even where review is done by the Engineer or Engineer's Representative, the following shall be the sole responsibility of the Contractor.

(i) Provision for erection,

(ii) Marking of members,

(iii) Cutting lengths of members,

(iv) Matching of joints and holes,

(v) Provision kept in the member for all other interconnected members,

(vi) Bill of materials,

(vii) Gusset sizes.

(l) Approval by Engineer or Engineer's Representative of any of the fabrication drawings shall not relieve the Contractor from the responsibility for correctness of engineering, design of connections, workmanship, and fit of parts, details, material, errors or omissions of any and all work shown thereon. Engineer's approval shall not invalidate any claim for damages of any kind for incorrectly detailed / fabricated steel, notwithstanding any approval of such drawings by Engineer.

(m) On completion of fabrication and erection, the contractor shall update his fabrication drawings, incorporating all site changes and substitutions and shall submit two (2) sets of hard copies of such "as-built" drawings to Owner for record purpose. The Contractor shall also furnish two sets of soft copies of all final approved Contractor's drawings in the form of CDs.

(n) Time consumed by the Contractor in securing approval of drawings should not be added to the time allowed for completion of contract. A period of four (4) weeks from the dates of receipt of drawings by the Engineer or Engineer's Representative should be anticipated for this item of procedure in the schedule.

(o) All these drawings submitted by the contractor will remain the property of the Owner. Owner reserves the right to use them in any manner whatsoever.

(p) The drawings prepared by the Contractor and all subsequent revisions etc. shall be at the cost of the Contractor for which no separate payment will be made.

4.3 FABRICATION

4.3.1 General

(a) Fabrication shall not be started until Contractor has received copies of such drawings upon which Engineer has endorsed his approval. Any work done prior to approval of Contractor's fabrication drawings will be at the Contractor's risk. The Contractor shall make such changes in the design when so directed, which are considered necessary to make the structures

conform to the provisions and intent of the specifications, without any additional cost to the Owner.

(b) All workmanship and finish shall be of the best quality and shall conform to good engineering practice and the best approved method of fabrication. All materials shall be finished straight and shall be machined/ ground smooth true and square where so specified.

(c) All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Standard fabrication clearances as detailed in the American institute of Steel Construction Manual / BIS Codes shall generally be followed unless otherwise directed/ approved.

(d) Material at the shops shall be kept clean and protected from weather. Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant Codes and Standards. In addition the Contractor shall strictly adhere to the following.

i) All care should be taken to avoid undue welding distortions

ii) Complete layout shall be prepared and got approved by the Engineer before actual fabrications are started. If needed mock-ups may also be prepared.

iii) All fit ups shall be got approved from the Engineer.

4.3.2 Connections

(a) All shop connections shall be welded unless otherwise specified in Engineer's/ Engineer's Representative's drawing. Field connections can be either welded or bolted and as shown in design drawings. Bolts used for erection shall conform to IS: 6639 and as specified in the design drawings.

(b) All connections shall be designed for forces indicated on the design drawings. The contractor shall be responsible for selection of standard connections from AISC Manual of Steel Construction or any other standards approved by Engineer.

(c) In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers are used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that at least one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be at least three times the pitch of the thread.

(d) In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be

provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.

(e) Not more than one shop splice shall be provided to make up the full length of a member. Shop splices to make the full member lengths shall be of full penetration butt welded type and radiographically tested.

(f) Transportation or the Contractor's erection methods may require additional splices not shown on the drawings. The contractor shall be responsible for the design and detailing of such splices or joints, and shall submit these for the Engineer's approval.

(g) All bolts, nuts, washers, electrodes, screws etc. shall be supplied/ brought to site 10% in excess of the requirement in each category and size. Rates shall cover the cost of this extra quantity and no additional payment will be made for this extra quantity supplied.

(h) All members likely to collect rain water shall have drain holes provided.

4.3.3 Straightening

(a) Rolled materials, before being worked, shall be straightened, unless otherwise specified. If straightening or flattering is necessary, it shall be done by methods that will not injure the material. Long plates shall be straightened by passing through a mandrel or levelling rolls and structural shapes by the use of mechanical or hydraulic bar/ section straightening machines. Heating or forging shall not be resorted to without the prior approval of the Engineer in writing. In case of site fabrication, Contractor shall obtain Engineer's approval in writing on the straightening method proposed to be adopted before commencing the work.

(b) Checking of the straightness of the structural members like angles, channels, beams etc. shall be done by using the thread. For checking of the straightness of the column sections piano wire shall be used. The sections, which are twisted beyond repairs, shall not be used for fabrication. Heating or hammering shall not be permitted. After removal of bends structural members shall be submitted for inspection and approval of Engineer.

4.3.4 Cutting

(a) Cutting may be done by shearing, cropping, sawing or machine flame cutting. All re-entrant corners shall be shaped notch free to a radius of at least 12-mm. Sheared or cropped edges shall be dressed to a neat workmanlike finish and shall be free from distortions and burrs.

(b) Hand flame cutting shall be undertaken, only if so permitted by the Engineer and shall only be carried out by an expert in such work. Hand flame cut edges shall be ground smooth and straight.

(c) Edges of flange cover plates and plates used to form any sections shall be ground smooth.

4.3.5 Punching and Drilling

(a) Holes in secondary members such as Purlins, grits, lacing bars etc. may be punched full size through material not over 12mm thick. Holes should be clean cut, without burr or ragged edges. Holes for all other connections shall be drilled accurately and the burrs removed effectively. Where several parts are to be connected to very close tolerances, such parts shall be first assembled, tightly clamped together and drilled through.

(b) Sub-punching may be permitted before assembly, provided the holes are punched 3mm smaller in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall not in such cases exceed 16mm.

(c) When match drilling is carried out in one operation through two or more separate parts, these parts shall be separated after drilling and the burrs removed.

(d) Holes for turned and fitted bolts shall be drilled to a slightly smaller diameter and reamed to a diameter equal to the nominal diameter of the shank or barrel subject to tolerance specified in IS: 919.

(e) Where reamed members are taken apart for transporting or handling, the respective pieces reamed together shall be so marked that they may be reassembled in the same position in the final setting up. No interchange of reamed parts will be permitted. Poor matching, over drilling and ovality in holes shall be a cause for rejection. Burning holes with gas is strictly prohibited.

(f) Holes may be required to be drilled by the Contractor at no extra cost at site for installing equipment or steel furnished by other agencies. The information for this will be supplied to the Contractor by the Engineer before or after erection of the steel. Holes should be by drilling or other machining process and not by gas cutting sets.

4.3.6 Rolling and Forming

Plates, Channels, Rolled Steel Joists etc., for circular bins, bunkers, hoppers, gantry girders, etc., shall be accurately laid off and rolled or formed to required profile/ shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

4.3.7 Grinding

Column ends bearing on each other, resting on base plates, compression joints designed for bearing, base plates coming in contact with column end and cap plate

shall be ground smooth to ensure 90% contact with local gap not exceeding 0.10 mm (filler gauge shall be used to check this gap). All ground surfaces shall be protected from dirt and mechanical damages till the assembly is completed. However the underside of base plate bearing on grout need not be machined.

4.3.8 Welding

(a) Before the start of the work, welding procedure shall be submitted to Engineer for approval. Welding shall be entrusted to only qualified and experienced welders who shall be periodically tested and graded as per relevant standards. Approval of the welding procedure by the Engineer shall not relieve the Contractor of his responsibility for correct and sound welding without undue distortion in the finished structure.

(b) Welding Procedure Specification (WPS) shall be established and Qualification of weld procedure (QWP) shall be done as per approved standards. Welders employed shall be qualified as per above standards prior to taking up fabrication. Contractor shall obtain approval from Engineer before the start of the work.

(c) Following pre-qualified welding process shall be employed for fabrication, erection and repair and the same shall have the approval of Engineer before adopting the welding process on the job.

(i) Submerged Arc Welding (SAW)

(ii) Shield Metal Arc Welding (SMAW)

(iii) Gas Metal Arc Welding (GMAW)

(iv) Gas Tungsten Arc Welding (GTAW)

(d) All welds shall be free from defects like blowholes, lack of penetration, undercutting, cracks etc. All welds shall be cleaned of slag or flux and show sections, smoothness of weld metal, featheredges without overlap and freedom from porosity.

(e) 50mm on either side of the surfaces on which weld metals is to be deposited shall be smooth, uniform, free from fins, tears, burrs, cracks and absolutely free from grease, paint, loose scale, moisture or any other substance which would adversely affect quality and strength of weld.

(f) Machining, thermal cutting or grinding may be employed for joint preparation or removal of unacceptable work or metal. The weld edges shall be smooth & regular surface, free from cracks & notches. Flame cut material above 50mm thick shall be pre-heated as per relevant standards prior to flame cutting and shall be subjected to Engineer’s approval.

(g) All weld fit-up shall comply with tolerances specified in the relevant standards. The parts to be joined by fillet welds shall be brought into close contact as practicable and within the tolerable limits as per relevant codes & standards.

(h) All tack welds shall be made using qualified procedure and qualified welders. Any preheat requirement specified in the welding procedure shall also apply to tack welds. All tack welds shall be examined visually for defects and if found defective, shall be removed and re-welded. Throat thickness, leg length and length of tack weld shall be as per IS: 9595.

(i) Welding of temporary attachments/ fixtures to retain fit up is permitted in case the parts have a nominal thickness of at least 10mm. Temporary attachments are welded at the minimum distance of at least 50mm from the weld seam. Welding of temporary attachments/ fixtures into the joint slot is not allowed. All temporary fixtures shall be removed after welding, by grinding then to weaken the welded portion and hammering thereafter followed by grinding the portion of any weld remaining on the base metal. A dye check at the discretion of the quality surveyor shall be done to detect any crack/ defect at the point of fixture temporary weld.

(j) It is not allowed to turn over and carry over heavy assemblies in tacking condition in order to control the geometric dimensions to the requirements of the drawings. The work shall be positioned for flat welding wherever practicable and overhead weld shall be avoided as far as possible.

(k) In the joints of the parts with dissimilar thickness smooth transition of one part to the other must be provided by way of the gradual decreasing of the thickness of the thicker part with the slope of the surface not exceeding 15 degree.

(l) Welding shall not be done when the surface of the members are wet or exposed to rain, or high wind velocities unless the welding operator and the work are properly protected.

(m) In joints connected only by fillet welds, the minimum size of fillet weld to be used shall be as per IS: 9595.

(n) Welds shall be defect free and surfaces shall be thoroughly cleaned to remove all visible weld defects and extra material.

(o) For all built up sections such as Columns, Crane Grinders etc welding between web and flange plates shall be carried out by SAW process. Especially for crane girders full penetrations of weld between top of web plate and top flange shall be ensured. Welding shall be continuous and shall be on both sides of the connecting member. One side fillet weld is not acceptable.

(p) While fabricating plated beams and built up members, all shop splices in each component part shall be made before such component part is welded to other

parts of the members. Wherever weld reinforcement interferes with proper fit-up between components to be assembled for welding, these welds shall be ground flush prior to assembly.

(q) Each layer of a multiple layer weld except root and surfaces runs may be moderately peened with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from overpeening.

(r) No welding shall be done on base metal at a temperature below -5 Deg.C. Base metal shall be preheated to the temperature as per relevant IS codes.

(s) In general all welding shall be performed as per the recommendations specified in IS: 9595.

(t) Pre-heating and Post weld Heat treatment shall be carried out as per the acceptable standards and procedure and shall have prior approval from the Engineer. The pre-heat and inter pass temperature shall be checked just prior to initiating the arc for each pass. The weld joint details and procedure for Pre-heating and Post heating shall be submitted by the Contractor for approval from Engineer.

4.3.9 Welding Consumables

(a) Electrodes, filler wires and flux used for welding shall be from approved manufacturers/ Suppliers. Contractor shall submit the list of Electrode manufacturers proposed to be procured to the Engineer for approval. The contractor shall furnish certification that electrode or electrode flux combination will meet the requirements of classification. The classification and size of electrode, arc length, voltage & amperage shall be suited to type and thickness of material, type of groove, welding positions and other circumstances attending work.

(b) Only low hydrogen electrodes shall be used for welding. All electrodes having low hydrogen covering shall conform to relevant acceptable standards. These electrodes shall be purchased in hermetically sealed containers or baked by the user as recommended by electrode manufacturer. Electrode flux coating shall be sound and unbroken. Broken or damaged coating shall cause the electrodes to be discarded. Before welding, the electrodes shall be dried in a holding oven at 120°C at least for one (1) hour or as per manufacturer's recommendations. Only limited quantity shall be issued to the welders. The electrodes shall be kept in "carry ovens" and shall not be exposed to the atmosphere.

(c) Welding plants and accessories shall have capacity adequate for welding procedure laid down and shall satisfy appropriate standards and be of approved make and quality. Contractor shall furnish and obtain approval from Engineer the details of equipment he proposes to deploy for the works. All the electrical plant in connection with the welding operation shall be properly and

adequately earthed and adequate means of measuring the current shall be provided. Proper safety rules shall be strictly followed.

4.4 TESTING, INSPECTION & REPORTS

4.4.1 General

(a) Contractor shall give due notice to the Owner/ Owner's Representative in advance of the materials or workmanship getting ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the Engineer/ Engineer's Representative's approval/ inspection. The fact that certain material has been accepted at Contractor's shop shall not invalidate final rejection at site by the Engineer/ Engineer's Representative, if it fails to conform to the requirements of these specifications, be in proper condition or has fabrication inaccuracies which prevents proper assembly nor shall it invalidate any claim which the Engineer/ Engineer's Representative may make because of defective or unsatisfactory materials and/or workmanship.

(b) No materials shall be painted or dispatched to site without the inspection and approval by the Engineer/ Engineer's Representative unless such inspection is waived in writing by the Engineer/ Engineer's Representative.

(c) Shop inspection by Engineer/ Engineer's Representative or submission of test certificates and acceptance thereof by Engineer/ Engineer's Representative shall not relieve Contractor from the responsibility of furnishing material conforming to the requirements of these specifications, nor shall it invalidate any claim which the Engineer/ Engineer's Representative may make because of defective or unsatisfactory material or workmanship.

(d) Contractor shall provide all the testing and inspection services and facilities for shop work except where otherwise specified. Contractor's inspection work shall be under the control of competent Chief Inspector whose primary responsibility is inspection (reporting to Management) and not to production department.

(e) High Strength Friction Grip Bolting: Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method of tightening and the type of bolt used.

(f) For fabrication work carried out in the field, the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the Engineer/ Engineer's Representative. Inspection and tests on structural steel members shall be as set forth below:

4.4.2 Material Testing

(a) All materials conforming to a particular Indian or any other standard as called for shall be tested as required by such standard. Proof in the form of certified test reports or mill certificates indicating the required tests have been carried out as per specification at the source is acceptable.

(b) If mill test reports are not available for any steel materials, the same shall be got tested by Contractor to Engineer's/ Engineer's Representative's satisfaction to demonstrate conformity with the relevant specification at his own cost.

(c) Raw material with cracks, seams, laps, lamination and heavy pitting are not acceptable. Ultrasonic testing of plates above 50 mm thick shall be carried out for the soundness of materials.

(d) Engineer has option to specify additional inspection or testing as he deems necessary and the additional cost of such testing shall be borne by the Contractor.

(e) The Contractor shall maintain records of all inspection and tests, which shall be made freely available to the Engineer/ Engineer's Representative and shall be submitted to the Engineer/ Engineer's Representative on completion of each stage of work.

4.4.3 Tests on Welds

(a) All welds shall be tested for flaws by any of the methods described under. The choice of the method adopted shall be determined by the Engineer/ Engineer's Representative. Following methods are generally recommended for the quality control of welded joints.

(b) Magnetic Particle Test (MPT): All fillet welds in general structural steel work shall have their final passes fully tested by MPT. However, for fillet welds of size 10mm and above and/or critical areas, the root and final passes shall be tested using MPT. The Engineer shall however decide the requirements of this additional testing. For Complete penetration butt welds, the root and final passes shall be tested using MPT. All MPT shall be as per relevant acceptable standards. Defects if found, shall be repaired and retested. MPT shall be carried out using alternating current only. Direct current may be used with the permission of the ENGINEER. The cost of demagnetizing after testing is deemed to be included in the quoted rates of the Contractor.

(c) Liquid Penetrant Test (LPT): MPT may be substituted by Liquid Penetrant Inspection where the former is not feasible due to configuration. The testing should be in accordance with relevant acceptable standards. All defects shown shall be repaired and rechecked.

(d) Radio-graphic Inspection (RT): All completed full penetration butt welds shall be fully or selectively (say 10%) shall be radio-graphed as per Engineer's directive in accordance with the relevant acceptable standards.

(e) Ultrasonic Testing (UT): Wherever built up sections for crane runways girders are fabricated, the T-joints of the sections shall be subjected to ultrasonic testing.

(f) Acceptance Standard: The acceptable standards for various weld tests shall be as per ASME Sec VIII- Div I or relevant acceptable standards.

4.4.4 Inspection of Welds

(a) Welding shall be carried out as per approved WPS and QWS by qualified welders.

(b) The correction of defective welds shall be carried out as directed by the Engineer without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means as prescribed by the Engineer shall be used to ensure that the whole of the crack and material up to 25mm beyond each end of the crack has been removed. Cost of all such tests and operations incidental to correction shall be to the Contractor's account.

(c) Contractor shall perform the following minimum tests on welds with no cost implication to the Owner. Contractor's quoted rate is deemed to have included the cost of such tests.

Sl. No:	**Location & Type of weld**	**Type of Test**	**Extent of test**	**Remarks**
1	All fillet welds in general other than those covered under the SI. No: 2, 3, 5, 7 & 8	LPT	1% of fillet weld with minimum of one test on each	
2	Fillet welds for plate thickness greater than 25 mm and fillet size more than 10 mm	MPT/DPT	10%	
3	Flame cut edges of plates more than 38 mm for fillet weld	MPT/LPT	100%	
4	Flame cut edges of plates greater than 25 mm for	MPT/LPT	100%	

	butt weld			
5	Fillet welds between tension flanges and webs	MPT/LPT	100%	
6	Full penetration butt welds	DPT	100%	DPT shall be carried out after back gouging before second side welding.
7	Fillet weld greater than 12 mm on flame cut edges of low alloy steel	MPT	100%	
8	Fillet welds for built up girders, columns and other heavy structures for penetration	Macro etch test	One (1) test per structure for penetration	
9	Butt welds of thickness greater than 25 mm and less than 32 mm	MPT/DPT	100%	
10	Butt welds of thickness greater than 32 mm	RT	100%	
11	Butt welds of rolled sections having depth greater than 600 mm	RT	100%	

(d) In addition to the minimum tests to be conducted by the Contractor, Engineer reserves his right to direct the Contractor to conduct additional tests. The extent, type and location of test shall be decided by the Engineer. These additional tests shall be conducted by the Contractor or through an approved agency in presence of the Engineer. If the test fails, the cost of that test shall not be payable to the Contractor. The tests which when successful will be paid for at the rates specified in the schedule.

(e) Weld defects and acceptable criteria

Type of defect	**Acceptance criteria**	**Remarks**
Cracks	Not acceptable	
Incomplete or lack of	Not acceptable	

Type of defect	Acceptance criteria	Remarks
fusion		
Mis-alignment of butt welds	0.25 x T (Maximum of 3mm)	T: thickness of thinner plate
Reinforcement	Max reinforcement of 2 mm for t <10 mm 3 mm for t >10 mm < 15 mm 4 mm for 15 mm and greater	
Undercut	0.25 mm deep max	
Sharp edges	Min radius of 2mm	

f) Weld repairs

Whenever weld repair is required, Contractor shall give prior intimation to the Engineer and obtain permission before the repair is taken up. When a defect is detected in a weld, it shall be removed by cutting/ grinding and smooth blending of the area with parent metal without sharp edges, corners. If welding is required, the same shall be done using the qualified procedure/ welder and stage inspection as per the original weld. Correction of defect in the same portion of the weld shall not be allowed more than two (2) times. The portion of the welding seams, which have been subjected to repair, must be indicated in the weld inspection reports.

4.4.5 Inspection And Tests On Structural Steel Fabricated Members

Inspection and tests on Structural Steel Fabricated Members shall be as set forth below:

a) All the fabricated parts of Structural Steel members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment and surface finish are in accordance with the requirements shown on the approved Contractor's shop drawings and/or Engineer's drawings.

b) Fit ups shall be examined by the quality surveyor as per the approved QA plan prior to welding the joint. All welds shall be inspected for flaws by the method described under "Inspection of welds".

c) The dimensions of the fit ups shall be maintained as specified in the fabrication drawings.

d) Dimensions of all assembles and sub-assemblies shall be as per fabrication drawings within the tolerances specified in IS: 7215.

4.5 TEST FAILURE

4.5.1 In the event of any failure of welding, structural steel members to meet inspection or test requirements, the Contractor shall notify the Owner or his authorised representative. A design concession request has to be made and got approved from the Engineer or his representative before repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the Engineer.

4.5.2 Contractor shall maintain records of all inspection and testing which shall be made available to the Engineer or his authorized representative, for three years from the date of completion of the contract.

4.5.3 The Engineer has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the Owner, only in case of successful testing.

4.6 TOLERANCES

The dimensional and weight tolerance for rolled shapes shall be in accordance with IS: 1852 for indigenous steel and equivalent applicable codes for imported steel. The tolerances for fabrication of structural steel shall be as per IS: 7215.

4.7 SHOP MATCHING

For structures like bunkers, tanks, etc. shop assembly is essential. For other steel work, such as columns along with the tie beams/ bracings may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc., if so desired by the Owner or his authorized representative. All these shop assemblies shall be carried out by Contractor at no extra cost to the Owner.

4.8 DRILLING HOLES FOR OTHER WORKS

As a part of this Contract, holes in members required for installing equipment or steel furnished by other manufacturers or other contractors shall be drilled by the Contractor at no extra cost to the Owner. The information for such extra holes will be supplied by the Owner or his authorized representative.

4.9 MARKING OF MEMBERS

4.9.1 After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.

4.9.2 All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

4.9.3 Erection marks on like pieces shall be in identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends.

4.10 ERRORS

Any error in shop fabrication which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the Owner or his authorized representative as defective workmanship. In case Owner or his authorized representative rejects such material or defective workmanship, the same shall be replaced by the materials and workmanship conforming to the Owner or his authorized representative's requirements by Contractor free of cost at site.

4.11 SHOP PAINTING

Surface preparation and painting of steel surfaces shall be in accordance with specifications provided in **Clause 8.0**. All surfaces inaccessible after erection shall receive two coats of the approved paint before erection. All fabricated steel material, except those galvanised shall receive protective paint coating as specified in **Clause 8.0** of this specification. Galvanising of fabricated steel wherever specified, shall be as per approved detailed specification.

4.12 QUALITY SURVEILLANCE

4.12.1 General

(a) The Engineer shall subject all works and materials covered by this specification to Inspection.

(b) The Contractor shall provide free access in his shop during working hours for the inspection staff, designated by the Engineer, at all phases of the work and assist them where necessary in conducting the inspection. The Contractor shall expeditiously furnish all gauges, instruments and other necessary measuring equipment required for inspection of the work in the shop. The shop inspection by the inspector is intended to ensure that the material and the workmanship are in accordance with this specification, but it will be not relieve the Contractor of any of his responsibilities for the product. The inspector’s inspection will include, but not be limited to, the following:

4.12.2 Material

The inspector will ascertain that only materials conforming to the requirements of this specification are used.

4.12.3 Dimension and Tolerance

(a) The Engineer will ensure and check that the structural members conform to the dimensions and tolerances as set out on the drawings and as required by the specification.

(b) Members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements shown in the Contractor's approved fabrication drawings and the Owner's requirements.

4.12.4 Welding Procedure

The Engineer will witness the welding and testing of any procedure qualification tests that are required by this specification. The Engineer will also check that welding procedure (including the electrode, flux, current, arc voltage, speed of travel) used are in accordance with the approved welding procedures.

4.12.5 Welding Equipment

The Engineer will check the welding equipment to be used for the work to ensure that it is in such condition as to enable qualified welders to follow the procedures.

4.12.6 Welder & Welding Operator Qualifications

(a) The Engineer will permit welding to be performed only by welders and welding operators who are qualified by tests in accordance with relevant standards.

(b) When the quality of a welder or welding operators work, appears to be below the requirements, the Engineer may require testing of his qualifications by necessary tests.

4.12.7 Welds

(a) The Engineer will ascertain that the sizes, length and the location of all welds conform to the requirements of this specification and the approved fabrication drawings. Temporary welds used for the works shall be removed and ground flush with the original surface.

(b) The Engineer will identify with a distinguishing mark of all parts of the joints that he has inspected and accepted.

(c) The Contractor shall comply with all the demands of the Engineer to correct improper workmanship and to remove and replace, or correct as instructed, all welds found defective or deficient.

(d) In the event of faulty welding or its removal for rewelding results in damage to the base metal in the judgment of the Engineer, or its retention is not in

accordance with the intent of the plans and specification, the Contractor shall remove and replace the damaged material at his own cost.

5.0 ERECTION OF STRUCTURAL STEEL

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5.11	PAINTING

This specification covers the general requirements for erection of structural steel. In addition to provision of erection and transport equipment, the scope of work includes supply of tools and tackles, consumables, materials, labor and supervision and shall cover the following:

(a) Storing and staking of all fabricated structural components/ units/ assemblies at site storage yards till the time of erection.

(b) Transportation of structures from storage yard to site of erection, including multiple handling, if required.

(c) All minor rectifications/ modifications such as, removal of bends, kinks, twists etc for parts damaged during transportation and handling, reaming of holes which do not fit properly or which are damaged, for use of next higher size bolt, plug-welding and re-drilling of holes which do not register and which cannot be reamed for use of next higher size bolt, drilling of holes which are either not drilled at all or are drilled in incorrect position during fabrication.

(d) Fabrication of minor missing items as directed by the Owner or his authorized representative.

(e) Verification of the position of embedded anchor bolts and inserts with respect to lines and levels, installed by others based on Geodetic Scheme/ Bench Mark/ Reference co-ordinates to be furnished by Owner or his authorized representative.

(f) Verification of actual dimensions of structures (erected by others) which would have bearing on the cutting lengths, end connections etc of those members which are to be erected under this scope of work.

(g) Assembly of steel structural components at site wherever required, including temporary supports and staging.

(h) Erection of structures including making connections by bolts/ High strength Friction Grip bolts/ welding as per drawing.

(i) Alignment of all structures true to line, plumb and dimensions within specified limits of tolerance.

(j) Making arrangements for providing all facilities for conducting Ultrasonic Testing (UT) by reputed testing laboratories approved by Owner or his authorized representative and making available test films / graphs, with reports / interpretation.

(k) Rectifying at site, damaged portions of shop primer by cleaning and application of touch-up paint. Application at site after erection required number of coats of primer and finishing paint as per specification.

(l) Rectification of structures as per preliminary acceptance report and Final acceptance report.

(m) All necessary items of work required for satisfactory completion of job on schedule.

5.1 ERECTION SCHEME

5.1.1 Contractor after the award of work shall submit a detailed erection scheme covering the period of completion of all the works covered under the specification for Owner or his authorized representative's approval. The erection scheme shall include but not limited to the following.

(a) Methods proposed to be employed for transporting his equipments, tools, tackles, gas cylinders, electrodes and all that is necessary to site.

(b) Type, capacity and quantity of equipment that the Contractor proposes to bring to site for unloading, transporting within the site, handling, assembling, hoisting and erecting of the structural steel components for all these operations.

(c) Strength and trade wise composition of the work force and supervisory personnel that will be deployed by the Contractor for the various operations.

(d) Any special specific scheme being adopted for erection of special / complicated structural elements.

5.1.2 A brief write-up covering the above activities shall be submitted along with the bid document by the bidder during submission of his bid.

5.1.3 Engineer reserves the right to direct the Contractor either at the start or during the contract period, to mobilize additional resources in terms of labour, material ,equipment, tools and plant etc at no cost to the Owner if in his opinion that the resources employed by the Contractor does not meet the schedule of completion.

5.2 ERECTION PROGRAMME

5.2.1 Within two (2) weeks of acceptance of bid, the Contractor shall submit a detailed erection programme with dates and estimated completion time for various parts of the work for Engineer's approval. This programme shall broadly comprise the following:

(a) Layout plan identifying the areas proposed for unloading, main storage, subsidiary storage and assembly.

(b) Transportation of fabricated material between the storage and work areas.

(c) Layout to indicate the points at which proposed erection begins, direction in which it is proposed to progress, the deployment of equipment, access route for cranes to reach work areas, etc.

(d) The locations and extent of site offices and stores, labor quarters if any.

(e) Layout of electrical cables and water pipes from the tap-off points.

(f) Details of the method of handling, transport, hoisting and erection including false work/ staging, temporary bracing, guying, etc. along with complete details of the quantity and capacity of the various items of erection equipment that will be used.

(g) Site organization chart showing the number of supervisory personnel, and the number and composition of the various gangs.

5.2.2 Any modifications to the erection programme directed by Engineer for reasons of inadequacy of

(a) The quantity and/or capacity of the erection equipment.

(b) Erection personnel and supervisors, temporary bracing, guying etc.

(c) Safety of the erection methods, or stability of the erected portions of structures, or unsuitability of the erection sequence due to interference with the work of other agencies.

(d) Any other unforeseen events which may delay the schedule. shall be incorporated by Contractor and the work shall be carried out in accordance with the revised programme. Approval by Engineer shall not relieve the Contractor from the responsibility for the safe, sound, accurate and timely erection of structural steel work as required by the Engineer/ Owner. Contractor shall also make no extra claims for bringing additional equipment to site for erection, if so directed by Engineer. Contractor shall be deemed to have visualized all erection problems while bidding for the work and no additional compensation shall be claimed on this account.

5.3 SITE OPERATIONS

5.3.1 Contractor shall employ an experienced and qualified Engineer who shall be in full time charge of the job and responsible for all site activities.

5.3.2 Contractor shall complete all preliminary works at site well before the arrival of structural steel, such as establishment of a well equipped and adequately staffed site office, stores, unloading gantry, unloading and pre-assembly yard, labour quarters if any, electrical and water connections, electrical winches, derricks, cranes, compressors, all tools and tackles, rivet guns, welding sets, torque wrenches, spud wrenches, staging, etc. as well as experienced erection and supervisory personnel as part of this contract and any other work that may be necessary so as to start erection immediately after the arrival of the first batch of steel at site.

5.3.3 Contractor shall furnish at his own expense, the necessary non-inflammable staging and hoisting materials or equipment required for the erection work and shall remove and take them away after completion of the job. Contractor shall also provide necessary passageways, fences, safety belts, helmets, lights and other fittings to the satisfaction of Owner / Engineer and to meet the rules of local authorities and for protection to his men and materials. A licensed electrician shall be kept on the job for the entire duration of the work to maintain Contractor's electrical equipment and connections.

5.3.4 Contractor shall protect all existing plant, structures, piping, conduits, equipment and facilities against damage during erection. Any damage caused by Contractor shall be rectified entirely at Contractor's cost, to the satisfaction of Owner / Engineer. If work has to be carried out adjacent to existing switch yards or electrical installations which are live, Contractor must ensure suitable safety precautions in consultation with Engineer.

5.3.5 If a portion of the work of the project area cannot be made available to Contractor for his activities due to operations being carried out by other agencies, he shall

suitably modify his sequence of operations so as to continue work without interruption. Contractor shall work in coordination with other agencies working on the project site and plan his work suitably so as not to hinder the progress of construction at site.

5.4 ACCEPTANCE OF STEEL, ITS HANDLING & STORAGE

5.4.1 The fabricated material received at erection site shall be verified with respect of marking on the key plan / marking plan or shipping list.

5.4.2 Any material found damaged or defective shall be stacked separately and the damaged or defective material shall be painted in distinct color for identification and the same shall be brought to the notice of Engineer.

5.4.3 No dragging of steel shall be permitted. All fabricated items shall be stored 300mm above ground on suitable packing to avoid damage. It shall be stored in the order required for erection, with erection marks visible. All storage areas shall be prepared and maintained by Contractor. Steel shall not be stored in the vicinity of areas where excavation or grading will be done and, if so stored temporarily, this shall be removed by Contractor well before such excavation and/or grading commences to a safe distance to avoid burial under debris.

5.4.4 Scratched or abraded steel shall be given a coat of primer in accordance with the specification after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/corrosion by suitable coating and also from getting damaged.

5.5 ANCHOR BOLTS, EMBEDDED PARTS & FOUNDATIONS

5.5.1 Contractor shall carefully check the location and layout of anchor bolts embedded in foundations constructed by others, to ensure that the structures can be properly erected as shown on the drawings. Any discrepancy in the anchor bolts/foundation shall be reported to Engineer.

5.5.2 Contractor shall carefully check the actual dimensions of structures and also the location, level and sizes of embedded parts, a) in the RC beam /column and/ or b) cleats / plates provided in steel beam /column constructed by others to receive structures covered under this scope of work. Contractor shall take note of discrepancies if any, shall be reported to Engineer and fabricate the structures covered under this contract suitably before the commencement of erection.

5.5.3 Leveling of column bases to the required elevation may be done either by providing shims or three nuts on the upper threaded portion of the anchor bolt. All shim stock required for keeping the specified thickness of grout and in connection with erection of structures on foundations, crane brackets or at any other locations shall be of good M.S. plates and shall be supplied by Contractor at his cost.

5.5.4 A certain amount of cleaning of foundations and preparing the area is considered normal and shall be carried out by Contractor at no extra cost.

5.5.5 Where beams bear in pockets or on walls, bearing plates shall be set and levelled as part of the work. All grouting under column base plates or beam bearing plates will be carried out by Contractor, unless the grouting is specifically excluded from the Contractor's scope.

5.6 ASSEMBLY & CONNECTIONS

5.6.1 Field connections may be effected either by bolting, welding or by use of high strength friction grip bolts as shown in the design and erection drawings.

5.6.2 All bolts, nuts, washers, rivets, electrodes required for field connections shall be supplied by Contractor free of cost. The materials shall have prior approval from the Owner /Engineer and necessary test certificates shall be furnished to Engineer's approval. Materials shall be procured from the reputed manufacturers with prior approval from Owner /Engineer

5.6.3 All assembling shall be carried out on a level platform.

5.6.4 Drifts shall be used only for drawing the work to proper position and must not be used to such an extent as to damage the holes. Size of drifts larger than the nominal diameter of hole shall not be used. Any damaged holes or burrs must be rectified to the satisfaction of Engineer.

5.6.5 Corrections of minor misfits and reasonable amount of reaming shall be considered as a part of erection. Any error in the shop, which prevents proper fit on a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to Engineer.

5.7 ERECTION

5.7.1 Erection work shall be taken up after receipt of clearance from the Engineer.

5.7.2 Erection shall be carried out with the help of maximum mechanization possible.

5.7.3 Prior to commencement of erection, all the erection equipment, tools, tackles, ropes etc shall be tested for their load carrying capacity. Such tests may be repeated at intermediate stages also if considered necessary. Frequent visual inspection shall be done of all vulnerable areas and components to detect damages or distress in the erection equipments, if any.

5.7.4 All structural steel shall be erected as per approved Design / fabrication drawings. Proper size steel cable slings, etc., shall be used for hoisting. Guys shall not be anchored to existing structures, foundations, etc. unless so permitted by Engineer in writing. Care shall be taken to see that ropes in use are always in good condition.

5.7.5 For safety requirements during erection, provisions of IS: 7205, IS: 7969 and other relevant codes shall be strictly followed.

5.7.6 Steel columns, if any, are to be lowered and erected carefully with the help of a crane and/or derrick without damaging the walls steel or floor.

5.7.7 Structural steel frames shall be erected plumb and true. Frames shall be lifted at such points that they are not liable to buckle and deform. Trusses shall be lifted only at node points. In the case of trusses, roof girders, all of the purlins and wind bracing shall be placed simultaneously and the columns shall be erected truly plumb on screed bars over the pedestals. All steel columns and beams shall be checked for plumb and level individually before and after connections are made.

5.7.8 Temporary bracing, whenever required, shall be provided to sustain forces due to erection loads and equipment etc. Erected parts of the structure shall remain stable during all stages of erection when subjected to action of wind, dead weight and erection forces etc. Such bracings shall be left in place as long as may be required for safety and stability. Specified sequence of erection of vertical and horizontal structural members shall be followed

5.7.9 Erected members shall be held securely in place by bolts to take care of dead load, wind / seismic load and erection load.

5.7.10 All structural members shall be erected with erection marks in the same relative position as shown in the appropriate erection and shop drawings.

5.7.11 All connections shall achieve free expansion and contraction of structures wherever provided.

5.7.12 No final bolting or welding of joints shall be done until the structure has been properly aligned and approved by Engineer.

5.7.13 For positioning beams, columns and other steel members, the use of steel sledges is not permitted.

5.7.14 Instrumental checking of correctness of initial setting out of structures and adjustment of alignment shall be carried out in sequence and at different stages as required. The final leveling and alignment shall be carried out immediately after completion of each section of a building.

5.7.15 The Contractor shall design, manufacture, erect and provide false work, staging temporary support etc., required for safe and accurate erection of structural steelwork and fully responsible for the adequacy of the same.

5.7.16 The Contractor shall also provide facilities such as adequate temporary access ladders, gangways, tools & tackles, instruments etc. to Owner for his inspection at any stage during erection.

5.7.17 Chequered plates shall be fixed to supporting members by welding or by countersunk bolts as shown/ specified in relevant drawings and/or as directed by Engineer. The edges shall be made smooth and no burrs or jagged ends shall be left. While splicing, care should be taken so that there is continuity in pattern between the two portions. Care should also be taken to avoid distortion of the plate while welding. The erection of chequered plates shall include:

(a) Welding of stiffening angles/ vertical stiffening ribs as per drawings,

(b) Cutting to size and making holes to required shape wherever necessary to allow service lines such as piping, cables etc to pass through,

(c) Splicing as shown in relevant drawings,

(d) Smoothening of edges,

(e) Fixing of chequered plates by welding and/or countersunk bolts,

(f) Providing lifting hooks for ease of lifting.

5.7.18 Cutting, heating or enlarging holes may be carried out only with prior written approval from the Engineer.

5.7.19 Test certificates as specified in Data Sheet A shall be furnished by CONTRACTOR.

5.8 FIELD CONNECTIONS

5.8.1 Assembly by Permanent Bolts:

(a) The number of washers on permanent bolts shall not be more than two (2) and not less than one (1) for the nuts and one (1) for the bolt head.

(b) Only wooden rams or mallet shall be used in forcing members into position in order to protect the metal from injury or shock.

(c) Where bolting is specified on the drawing, the bolts shall be tightened to the maximum limit. The threaded portion of each bolt shall project through the nut by at least one thread. Tapered washers shall be provided for all heads and nuts to achieve uniform bearing on sloping surface.

(d) To prevent loosening of nuts, spring washers or lock-nuts shall be provided as specified in the design / shop drawings.

(e) All machine fitted bolts shall be perfectly tight and the ends shall be checked to prevent nuts from becoming loose. No unfilled holes shall be left in any part of the structure.

5.8.2 Assembly by Welding:

(a) All field assembly by welding shall be executed in accordance with the requirements for shop fabrication. Where the steel has been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints to be welded.

(b) All other requirements of welding and its acceptance standards shall be in accordance with clauses specified in Section-5 above.

5.8.3 Assembly By High Strength Friction Grip Bolts (HSFG Bolts):

(a) Assembly of structures with HSFG bolts shall conform to IS: 4000.

(b) The mating surface shall be prepared in accordance with the requirements of design in order to achieve required properties to develop adequate friction between the surfaces.

(c) The mating surfaces shall be absolutely free from grease. lubricant, dust, rust etc and shall be thoroughly cleaned before assembly.

(d) The nuts shall be tightened up to the specific torque with the help of torque-wrench or by half-turn method with the help of pneumatic wrench lever.

(e) The direction of tightening of the nuts shall be from the middle towards the periphery of assembly.

(f) After desired tightening the bolt heads, nuts and edges of the mating surfaces shall be sealed with a coat of paint to obviate entry of moisture.

5.9 INSPECTION

Engineer or their authorised representatives shall have free access to all parts of the job during erection and all erection shall be subjected to their approval. In case of faulty erection, all dismantling and re-erection required will be at Contractor's cost. No paint shall be applied to rivet heads or field welds or bolts until these have been approved by Engineer.

5.10 TOLERANCES

Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb. The tolerances specified below do not apply to steel structures where the deviations from true position are intimately linked with and directly influence technological process. In such cases, the tolerances on erected steel structures shall be as per recommendations of process technologists/ suppliers which will be indicated in the drawings.

5.10.1 Columns

a) Deviation of column axes at foundation top level with respect to true axes

i)	In longitudinal direction	:	± 5 mm
ii)	In lateral direction	:	± 5 mm
b)	Deviation in the level of bearing surface of columns at foundation top with respect to true level	:	± 5 mm
c)	Out of plumbness (verticality) of column axis from true vertical axis, as measured at column top:		
i)	For columns up to and including 15 meters in height	:	± 1/1000 of column height in mm or ±15 mm whichever is less
ii)	For columns exceeding 15 meters in height	:	± 1/1000 of column height in mm or ± 20 mm whichever is less
d)	Deviation in straightness in longitudinal and transverse planes of column at any point along the height	:	± 1/1000 of column height in mm or ± 10 mm whichever is less
e)	Difference in erected position of adjacent pairs of columns along length or across width of building prior to connecting width of building prior to connecting trusses/ beams with respect to true distance	:	± 10 mm
f)	Deviation in any bearing or seating level with respect to true level	:	± 5 mm
g)	Deviation in differences in bearing levels of a member on adjacent pair of columns both across and along the building	:	± 10 mm

5.10.2 Trusses And Beams

a)	Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord	:	± 1/250 of height of truss in mm or ± 15 mm whichever is less
b)	Lateral shift of top chord of truss at the centre of span from the vertical plane whichever passing through the centre of supports of the truss	:	± 1/1500 of span of truss in mm or ± 15 mm is less
c)	Lateral shift in location of truss from its true vertical position	:	± 10 mm

d)	Lateral shift in location of purlin true position	:	± 5 mm
e)	Deviation in difference of bearing levels of trusses or beams from the true difference		
	i) For trusses	:	±20 mm
	ii) For beams		
	Depth < 1800 mm	:	±6 mm
	Depth > 1800 mm	:	±10 mm
f)	Deviation in sag in chords and diagonals of truss between node points	:	1/1500 of length in mm or 10 mm whichever is smaller
g)	Deviation in sweep of trusses, beams etc in the horizontal plane	:	1/1000 of span in mm subject to a maximum of 10 mm

5.10.3 Crane Girders & Rails

a)	Shift in the centre line of crane rail with respect to centre line of web of crane girder	:	± 5 mm
b)	Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point	:	± 5 mm
c)	Difference in alignment of crane rail in plan measured between any two points 2 meters apart along rail	:	± 1 mm
d)	Deviation in crane track with respect to time gauge		
	i) For track gauges up to and including 15 meters	:	± 5 mm
	ii) For track gauges more than 15 meters	:	± [5 + 0.25 (S-15)] where S in meters is true gauge
e)	Deviation in the crane rail level at any distance point from true level	:	1/1200 of the gauge or ± 10mm whichever is less
f)	Difference in the crane rail actual levels between any two points 2 meters apart along the rail length	:	± 2 mm

g)	Difference in levels between crane track rails at		
	i) Supports of crane girders	:	± 15 mm
	ii) Mid span of crane girders	:	± 20 mm
h)	Relative shift of crane rail surfaces at a joint in plan and elevation	:	2 mm subject to grinding of surfaces for smooth transition.
i)	Relative shift in the location of crane stops (end buffers) along the crane tracks with track gauge S in mm	:	1/1000 of track gauge S in mm subject to maximum of 20 mm

5.10.4 Chimneys And Towers

a)	Out of plumbness (verticality) from the true vertical axis	:	1/1000 of the height of the chimney or tower in mm

5.10.5 Bunkers

a)	Deviation in length of bunker from true length	:	± 1/1000 of length in mm
b)	Deviation in width of bunker from true width	:	± 1/1000 of width in mm
c)	Deviation in height of bunker from true height	:	± 1/500 of height in mm
d)	Deviation in diagonal length in any horizontal cross section from the true diagonal length	:	± 1/500 of diagonal length in mm

5.11 PAINTING

After steel has been erected, all bare and abraded spots, field welds, bolt heads and nuts shall be spot painted. Before paint is applied, the surface shall be dry and free from dust, dirt, scale and grease. Surface preparation and painting of steel surfaces shall be in accordance with specifications provided in **section 8.0**.

6.0 **CLEAN UP OF WORK SITE**

During erection, the Contractor shall without any additional payment, at all times keep the working and storage areas used by him, free from accumulation of waste materials or rubbish. Before completion of erection, he shall remove or dispose of in a satisfactory manner all temporary structures, waste and debris and leave the premises in a condition satisfactory to Owner/ Engineer.

7.0 **METHOD OF MEASUREMENT –**

SL.No:	DESCRIPTION	ALTERNATIVE

1.0	DELIVERY OF FABRICATED STEEL (REFER CLAUSE 5.4.1)	AT SITE RAILWAY SIDING LOCATED AT / OWNER'S STORE LOCATED AT / FABRICATOR WORKSHOP LOCATED AT / DELIVERED TO TRANSPORT CONTRACTOR AT .
2.0	PAINTING OF SCRATCHED OR ABRADED STEEL WITH PRIMER COAT FOR PROTECTION AFTER UNLOADING AND HANDLING PRIOR TO ERECTION (REFER CLAUSE 5.4.4)	RED OXIDE / RED OXIDE ZINC CHROMATE / RED LEAD / ZINCPHOSPHATE/ / EPILUX 610 PRIMER / ANTISALINE METALLIC PRIMER / .
3.0	TYPE OF FIELD CONNECTIONS (REFER CLAUSE 5.6.1)	❖ REVETTING ❖ BOLTING WITH ➢ M.S.BOLTS TO CLASS 4.6 ➢ H.T.BOLTS TO CLASS 6.6/8.8/10.9 /12.9 ➢ H.S.F.G.BOLTS TO CLASS 8 G/10 K ➢ H.S.F.G.BOLTS TO CLASS ASTM 325/ 490 ❖ WELDING
4.0	TESTS AND TEST CERTIFICATES (REFER CLSE 5.7.19)	

	a LABORATORY TESTS	❖ <u>BOLTS AND RIVETS</u>: PULL OUT/ SHEAR/ PULL OUT AND SHEAR ❖ <u>WELDS</u>: RADIOGRAPHY/ ULTRASONIC/ MAGNETIC PARTICLE/ DYE PENETRATION ❖ <u>BOLTS, RIVETS AND WELDS</u>: VISUAL/ DIMENSIONAL/ VISUAL AND DIMENSIONAL
	b SITE TESTS	❖ <u>WELDS</u>: RADIOGRAPHY/ ULTRASONIC/ MAGNETIC PARTICLE/ DYE PENETRATION ❖ <u>BOLTS, RIVETS AND WELDS</u>: VISUAL/ DIMENSIONAL/ VISUAL AND DIMENSIONAL
5.0	PAINTING OF STEEL AFTER ERECTION WITH A PRIMER COAT FOR ALL ABRADED	RED OXIDE / RED OXIDE ZINC CHROMATE / RED LEAD / ZINCPHOSPHATE/ / EPILUX
	SPOTS, RIVET HEADS, FIELD WELDS, BOLT NUTS, ETC. (REFER CLAUSE 5.11)	610 PRIMER / ANTISALINE METALLIC PRIMER / .
6.0	GROUTING OF BASE OF COLUMNS, BEAMS ETC.	INCLUDES / NOT INCLUDED IN THE SCOPE GROUTING SHALL BE OF ❖ CM 1 : 1 ❖ CM 1 : 2 ❖ NON SHRINK GROUT

8.0 **<u>PAINTING OF STRUCTURAL STEEL</u>**

SL. NO:	**CONTENTS**
8.1	SCOPE
8.2	EXCLUSIONS

GUIDE FOR SELECTION OF CHOICE OF PAINTING SYSTEM

IMPORTANT NOTE:

(a) Not Used.

(b) Fill Data Sheet-B after selecting suitable painting system.

(c) Fill Data Sheet-C after selecting suitable painting system for each of the buildings and structures.

(d) Before issue of specification discuss with Owner or his authorized representative for the type of painting system.

8.1 SCOPE

8.1.1 This specification covers the general requirements for shop and field painting for Structural Steel works using hot/ cold rolled steel sections joined by using bolting and/or welding.

8.1.2 Briefly the scope of works covered under this specification are;

(a) Supply of all primers, paints and all other materials required for painting other than Owner's supply.

(b) Furnishing of all labor, materials, tools & equipment and the performance of all operations and incidentals necessary for surface preparation, painting, handling, storing, transporting, scaffolding etc.

(c) Testing of paints as per the relevant codes in the Standard Laboratory identified by the Owner and furnishing of required test certificates for Owner's approval.

(d) Repair work of damaged / pre-erection / fabrication shop primer and weld joints at field.

(e) Inspection of painting system after its application to conform to the specification requirement.

(f) Any other requirement as required for satisfactory completion of specified work.

8.2 EXCLUSIONS

This specification excludes paintings of the following structures/ equipment,

8.2.1 Mechanical & electrical equipment and parts.

8.2.2 Buried & Overhead piping works

8.2.3 Storage tanks

8.2.4 Insulated parts

8.2.5 Any other items of work specifically excluded in the scope of works.

8.3 APPLICABLE CODES, STANDARDS

8.3.1 The pertinent clauses of the following Indian / International Codes, Standards and Specification (latest editions including all applicable official amendments, reaffirmations and revisions) shall apply to the material and workmanship covered by this specification. In the event of the conflict of certain requirements between this specification and the codes referred herein, this specification shall govern.

8.3.2 It is not the intent to specify herein all the codes and standards required for the satisfactory completion of work. The list of codes and standards indicates certain primary codes & standards and not all the codes required for the work under the contract. It is understood that all the pertinent codes and standards shall form the part of this specification whether explicitly indicated or not.

INDIAN STANDARD CODES:

IS:5	Colours for ready mixed paints and Enamels.
IS:101	Methods of sampling and test for paints, varnishes and related products (all parts & all sections).
IS:104	Ready mixed paint, brushing, zinc chrome, priming.
IS: 110	Ready Mixed paint, brushing, grey filler for enamels for use over primers.
IS:158	Ready Mixed paint, Brushing, Bituminous, Black, Lead free, Acid, Alkali and heat resisting.
IS: 159	Ready Mixed paint, Brushing, Acid resisting.
IS: 341	Black Japan, Types A, B and C.
IS:1303	Glossary of Terms relating to paints.
IS:1477	Code of practice for painting of ferrous metals in Buildings (Parts 1 & 2).
IS: 2074	Ready Mixed paints, Red Oxide Zinc chrome priming.
IS: 2339	Aluminium paint for general purposes, in Dual container.
IS:2932	Specification for Enamel, synthetic, exterior, type-1: (a) Undercoating (b) Finishing.
IS:2933	Specification for Enamel, synthetic, exterior, type-2: (a) Undercoating (b) Finishing.
IS: 5905	Sprayed aluminium and zinc coatings on Iron and Steel.
IS: 6005	Code of practice for phosphating of Iron and Steel.
IS: 9862	Specification for ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water & chlorine resisting.
IS: 9954	Pictorial Surface Preparation Standards for Painting of Steel Surfaces.
IS:13183	Aluminium paint, Heat resistant-specification.
IS: 13607	Ready Mixed paint, Finishing, general purposes, to Synthetic specification.

INTERNATIONAL STANDARD CODES:

SIS-05-5900	Swedish Standard.
SSPC	Society for Protective Coatings (USA) Vol I & II.

NACE	National Association of Corrosion Engineers, USA (NACE).
ISO 8501	Preparation of Steel Substrates before application of paints and related products -Visual assessment of surface cleanliness (Part 1 & 2).
ISO 8502	Preparation of Steel Substrates before application of paints and related products -Tests for assessment of surface cleanliness (Part 1 to 4).
ISO 8503	Preparation of Steel Substrates before application of paints and related products - Surface roughness characteristics of blast-cleaned steel substrates (Part 1 & 2).
ISO 8504	Preparation of Steel Substrates before application of paints and related products -Surface preparation methods (Part 1 to 3).
ISO 12944	Paints & Varnishes - Corrosion Protection of Steel Structures by Protective Paint System.

8.4 HEALTH, SAFETY AND REGULATORY REQUIREMENTS

8.4.1 The work covered in this specification, shall comply with all relevant government and local laws, regulations and standards. For subjects not covered by regulations, codes, standards or specifications, the materials and construction shall be based on good engineering practice, subject to approval by Owner.

8.4.2 Contractor shall ensure that all health and safety regulations are observed for the erection of scaffolding and use of the selected paint material.

8.4.3 All necessary precautions shall be taken to ensure the safety of personal and property. Extreme caution shall be used when working with oil or oil-based paints, cleaning fluids etc., especially in close proximity to oxygen piping or oxygen equipment. Heavy concentrations of volatile or toxic fumes must be avoided and in confined areas, blowers or exhaust fans shall be used.

8.4.4 Rags and other waste material soiled with paints, thinners or solvents shall be kept in tightly closed metal containers while on the jobsite and not in use. Legal disposal of waste materials outside plant site premises is Contractor’s responsibility.

8.5 SURFACE PREPARATION OF STEEL

One or more of the following methods of surface preparation shall be followed, depending on condition of steel surface and as specified in data sheet. Engineer reserve the right to instruct the type of surface preparation depending upon the condition of material. Recommended methods of surface preparation of steel briefly are as under.

(a) Solvent cleaning.

(b) Manual or Hand tool cleaning

(c) Mechanical or Power tool cleaning.

(d) Abrasive Blast cleaning.

It is necessary that the Contractor may have to resort to any one or combination of the above method of surface preparation to achieve the required acceptable standard. Hence the rate quoted shall take into account for such preparation.

8.5.1 Solvent Cleaning:

All contaminants like oil, grease removal shall be carried out either by special solvents or by degreasing agents. Application and cleaning of solvents shall be as per manufacturer's instructions and shall be in accordance with SSPC-SP1.

8.5.2 Manual Or Hand Tool Cleaning:

This method of cleaning shall be used to remove all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter by use of non-powered hand tools. The minimum acceptable standards in case of manual or hand tool cleaning shall be in accordance with ISO 8501- St2 / SSPC-SP2.

8.5.3 Mechanical Or Power Tool Cleaning:

This method of cleaning shall be used to remove all mill scale, rust, paint and other detrimental foreign matter by use of power assisted hand tools. The minimum acceptable standards in case of power tool cleaning shall be in accordance with ISO 8501- St3 / SSPC-SP3.

8.5.4 Abrasive Blast Cleaning (Shot Blasting / Grit Blasting):

a) Shot / Grit blasting shall be resorted to only after removal of grease, oil and other contaminants as per SP-1. Special care shall be taken on weld areas to remove flux and spatter. Precautions shall be taken when grit or shot blasting of light gauge steel surfaces, to ensure that buckling does not occur due to continuous impingement of grit or steel shots under high velocity. Surface anchor profiles shall be measured by Testex tape – press-o-film and the finished surfaces shall conform to the requirements of ISO 8501- Sa 2½ / SSPC-SP10.

b) Blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceeding 85%.

8.5.5 Tests on Surface Preparations:

The following inspection and tests shall be performed on the steel surfaces subjected to surface preparation. Test / inspection reports shall be submitted to Engineer for his approval and acceptance.

a) Visual examination of surface preparation with comparators.

b) Profile check of the prepared surface with suitable “profilometer “eg. TESTEX method.

8.6 PAINT MATERIAL

8.6.1 Procurement:

All types of paint required for the work shall be procured from the reputed manufacturers. However contractor shall obtain the detailed list of approved paint manufacturers from the Engineer before initiating the procurement action.

8.6.2 Storage:

The Paint material shall be stored strictly in accordance with the instructions of the paint manufacture. In general painting materials should be stored in dry, cool, well ventilated and frost free area.

8.6.3 Packing:

All paints delivered to the fabrication shop / site shall be in original sealed container, as packed by the manufacturer. Paint containers shall clearly mark with paint manufacturer’s name, batch number, date of manufacture, shelf life and a clear indication of the type and color of the product.

8.6.4 Mixing:

a) Paint shall be thoroughly mixed prior to application. Mixing shall be done in a well-ventilated, clean and dust -free area. Paint shall be mixed by rotating power mixers or rolling rigs, until a uniform consistency is achieved.

b) Multiple pack paint materials shall be mixed in accordance and under the conditions as specified by the paint manufacturer. Pot life as specified by the paint manufacturer shall be strictly followed.

8.6.5 Thinner and Solvents;

Only additives, thinners, solvent etc as recommended by the paint manufacturer shall be used. A possible extension of the “pot life” by additions of thinners is prohibited.

8.6.6 Tests on Paint:

In order to ensure that the supplied paint meets the stipulations, samples of paint shall be tested in laboratories to establish quality of paint with respect to

(a) Viscosity,

(b) Adhesion/ bond of paint in steel surfaces,

(c) Adhesion / simulated salt spray test,

(d) Chemical analysis (percentage of solids by weight),

(e) Normal wear resistance as encountered during handling & erection,

(f) Resistance against exposure to acid fumes etc.

Alternatively manufacturer's test certificates shall be furnished by the Contractor in respect of above tests for Engineer's approval and acceptance. Engineer reserves the right to test the paint material either before the commencement of work or during the progress of work if in his opinion the paints supplied are of inferior quality and does not meet the codal requirements.

8.6.7 Paint Sample:

Before buying the paint in bulk, it is recommended to obtain sample of paint and establish "Control Area of Painting". On control area surface preparation, painting shall be carried out in the presence of Engineer and the Manufacturer of the paint.

8.6.8 Finishing Paint:

Color / Shade of the finishing paint shall be as per the choice of the Owner and Contractor shall obtain prior approval before procurement action is initiated.

8.7 PAINT APPLICATION

Painting shall be carried out by any one or the combination of the following method of application to suit the site condition and the type of paint being used. Manufacturer's recommended method of application shall be strictly followed.

(a) Brush Application.

(b) Roller Application.

(c) Spray Application.

8.7.1 Brush Application:

Brush application of paint shall be in accordance with the following,

(a) Brushes shall be of a style and quality that will enable proper application of paint

(b) Round, Oval or Wide flat brushes shall be used depending upon the surface irregularity, rough or pitted steel, large flat painting areas etc

(c) There shall be a minimum of brush marks left in the applied paint.

(d) Surfaces not accessible to brushes shall be painted by spray.

8.7.2 Roller Application:

Suitable rollers of different nap length to suit varying surface roughness shall be used. Rollers are not generally recommended for application of primers. Roller application shall only be used if the first or priming coat of paint has been applied by brush or other means. Manufacturer's recommendation shall be strictly followed for roller applied paints.

8.7.3 Spray Application:

(a) Airless or pneumatic spray application shall be in accordance with the following,

(i) Airless spray application shall be as per steel structure paint Manual Vol 1 & Vol 2 SSPC, USA.

(ii) Spraying shall be carried out keeping the spray gun at the minimum suitable distance from the work piece and consistently at 90 0 to the surface being painted.

(iii) Correct spray tips, air pressures etc as recommended by the equipment supplier shall be used.

(b) Air spray application shall be in accordance with the following,

(i) The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the paint to be applied, and shall be equipped with suitable pressure regulators and gauges.

(ii) Appropriate pressure and nozzles shall be those recommended by the manufacturer of the equipment for the material being sprayed. The equipment shall be kept in satisfactory condition to permit proper paint application.

(iii) Correct combination of air volume, air pressure and fluid flow to give good atomization shall be ensured to get a defect free painted surface.

(iv) Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators must be of adequate size and must be drained periodically during operations. The air from the spray gun impinging against the surface shall show no condensed water or oil.

(v) Ingredients shall be kept properly mixed in the spray pots or containers during application by continuous mechanical agitation.

(vi) Spray equipment shall be kept sufficiently clean so that dirt, dried paint and other foreign materials are not deposited in the paint film. Any solvents left in the equipment shall be completely removed before applying paint to the surface being painted.

(c) Selection of type of spray application shall depend upon the type of paint coating being used. At all time paint manufacturer's recommendation shall be strictly followed.

8.8 Coating Procedure

8.8.1 General Compatibility between primer, intermediate and top coats, as applicable for individual painting system shall be established through the paint manufacturer supplying the paints. Primer and finishing paint for the entire project shall preferably be procured from the same manufacturer. Mixing of material from different manufacturers is strictly prohibited

8.8.2 Surface shall not be coated in rain, wind, when steel surface temperature is less than 50 C, or when the relative humidity is greater than 85%.

8.8.3 Applied paint system shall be allowed to cure at ambient and surface temperatures between 10 ° C and 60 ° C with relative humidity below 85%. All paint shall be air curing.

8.8.4 A suitable test area (approx 0.5 m2) shall be painted with agreed paint system. The test area shall be fully coated with all coats of the agreed coating system using the tools and equipment to be used for the actual coating work. The painted test area shall be maintained for the duration of the project. Painting on test piece shall be carried out such that all the coats shall be made visible for reference at all time.

8.8.5 Structural steel shall be preferably prime coated at shop and subsequent finish coats shall be carried out at site after the alignment and erection is complete. Portions of structural steel members to be embedded into the concrete shall not be painted.

8.8.6 Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly.

8.8.7 Surfaces inaccessible after erection, including top surfaces of floor beams supporting grating / chequered plate / RC Slabs shall receive one additional coat of finish paint over and above the number of coats specified prior to erection.

8.8.8 Each coat of paint material shall be applied as continuous film of uniform thickness free of porous. Any spot or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

8.8.9 Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional coat can be applied without development of any detrimental film irregularities, such as lifting or loss of adhesion of the under coat. Manufacturer's instruction shall be strictly followed for intercoat intervals.

8.8.10 No paint shall be force dried under conditions which will cause checking, wrinkinling, blistering formation of pores or detrimentally affect the condition of the paint.

8.8.11 No drier shall be added to paint on the job unless specifically called for in the manufacturer's specification for the paint.

8.8.12 Paint shall be protected from rain, condensation, contamination, snow and freezing until dry to the fullest extent practicable.

8.8.13 Blast cleaned surface shall be coated with one coat of primer before surface degradation occurs but in no case later than 3hrs. Irrespective of the method of surface preparation, the first coat of primer shall be applied not later than 2-3 hours after preparation and on dry surface.

8.8.14 When the successive coat of the same color is specified, alternate coat shall be tinted as far as practicable; sufficiently to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life.

8.8.15 All field welded areas on shop painted item shall be mechanically cleaned (including the weld area proper, adjacent areas contaminated by weld spatter or fumes and areas where existing primer, intermediate / finishing paint is burnt). Subsequently, new primer and finishing coats of paint shall be applied as per painting specification.

8.8.16 Care shall be taken to protect adjacent equipment, piping, structures etc., from spillage and spatter during field painting by use of adequate temporary covers. If surfaces are accidentally spattered or sprayed, the paint shall be immediately and thoroughly removed. For cleaning of spillages an inert absorbent material shall be used

8.8.17 All structures shall receive appropriate number of primer, intermediate and finishing coats in order to achieve overall DFT as per the drawings / specifications/ data sheets.

8.9 PAINTING SYSTEM

The recommended painting system of all Structural Steel Works covering surface preparation, application of Primer coats, Intermediate coats (if specified) and Final coats to develop required minimum DFT shall be as per manufacturer’s detailed specification.

8.10 REPAIR OF COATED SURFACE

8.10.1 Wherever shop primer painting is scratched, abraded or damaged, the surfaces shall be thoroughly cleaned using emery paper and power driven wire brush wherever warranted, and touched up with corresponding primer. Touching up paint shall be matched and blended to eliminate conspicuous marks.

8.10.2 If more than 30% area of the painted surface of an item requires repair, the entire surface shall be repainted. In such an event no extra payment will be permitted.

8.11 TESTS ON PAINTING SYSTEM:

Following inspection and tests shall be performed during and after the application of paint system.

8.11.1 Wet film thickness (WFT) spot checks shall be carried out during the course of painting operation to ensure that film thickness is being maintained.

8.11.2 Dry film thickness (DFT) check of intermediate and final coating layers in accordance with the specification and /or paint manufacturer's recommendation.

8.11.3 Quality of adhesion between the coating system and the steel substrate and of the adhesion between the coatings layers shall not be less than those specified in the Codes/ Standards.

8.11.4 Porosity Check: Holiday detection test shall be carried out and all indications shall be repaired as per approved repair procedures.

8.12 FINAL INSPECTION

8.12.1 As part of the Quality Assurance, a final inspection in the presence of the representatives of Owner and Contractor shall be conducted prior to the final acceptance of the paintwork.

Part of this final inspection checks shall include:

(a) Visual check of the appearance,

(b) Checks on DFT's of the total applied coating system,

(c) Shade verification,

(d) Holiday Testing,

(e) Scratch Test,

(f) Adhesion test.

8.12.2 As part of acceptance procedure, a report shall be prepared that shall include:

(a) General:

- Names of the Painting Contractor and the responsible personal,
- Scope of work,
- Dates when the work was carried out,

- Copy of the work and quality plan,
- Deviations from this Specification and/or the quality plan.

(b) Inspection equipment

- Type and calibration of instruments used.

(c) Surface Preparation

- Condition of surface before preparation,
- Checks on the requirements as specified for cleaned surface.

(d) Coating application

- Information on coating systems being applied (i.e. product names, DFT's),
- Checks on requirements as specified for coating application,
- Check on dry film thicknesses of the total coating system applied.

(e) Conditions

- Checks on humidity, dew point and substrate temperature.

(f) Inspection reports

- Copy of the inspection reports of the Contractor,
- Inspection from an independent third party.

8.13 DOCUMENTATION:

Contractor shall keep records and furnish the following documents to the Owner:

8.13.1 A written quality plan with procedure for qualification trials and for the actual work,

8.13.2 Daily progress report with details of weather conditions, particular of applications, number of coats and type of material applied, anomalies, progress of work versus program,

8.13.3 Results of measurement of temperatures relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority,

8.13.4 Particulars of surface preparation and paint application during trials and during the work,

8.13.5 Details of non-compliance, rejects and repairs,

8.13.6 Type of testing equipments and calibration,

8.13.7 Code and batch numbers of paint materials used including shelf life,

8.13.8 Visual examination of surface preparation compared with the standards,

8.13.9 Profile check of the prepared surface with suitable “profilometer,

8.13.10 Dry film thickness check of intermediate and final coating layers, in accordance with the specification and/or paint manufacturer’s recommendation,

8.13.11 Checks/ tests carried out as per clauses above.

8.14 GUARANTEE:

8.14.1 The paint system shall provide sufficient protection of the underlying steel surface against the attack of the environment, other than mechanical damage, chemical spillage as result of operational activities or other unusual occurrences from the outside caused by others.

8.14.2 The Contractor is fully responsible for the quality of the work and for all related QA/QC activities as indicated in the specification.

8.14.3 The Contractor shall guarantee quality of their coating works for the period specified in Data Sheet-B and for the coating condition as specified below.,

8.14.4 The guarantee period starts from the date of acceptance of Contractor’s paint work.

8.14.5 Initial acceptance of any new coating work by Owner will not release the Contractor of his obligation under this section until final inspection has been carried out and acceptance of the completed work has been agreed in writing.

8.14.6 These guarantee clauses regarding coating specifications are prevailing and supersede the warrantee requirements in General Conditions of Contract.

DATA SHEET B

PAINT SYSTEM

Paint System	Surface Preparation	Primer Coat (µm)	Intermediate Coat (µm)	Top Coat (µm)	Dft (µm)

Paint System	Surface Preparation	Primer Coat (µm)	Intermediate Coat (µm)	Top Coat (µ	Dft (µm)

DATA SHEET C

RECOMMENDED PAINTING SYSTEM

Sl.	Structures in the scope of work	Recommended Painting System & surface preparation as per Data Sheet-A	Minimum Guarantee Period in Years.
1.			
2.			
3.			
4.			

Sl.	Structures in the scope of work	Recommended Painting System & surface preparation as per Data Sheet-A	Minimum Guarantee Period in Years.
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			

PART - 6: WATERPROOFING

1.0 **SCOPE**

1.1 This specification covers the general requirements of waterproofing treatments for various components of buildings/ structures. The works under this specification shall consist of furnishing of all tools, plants, labour, materials, and everything necessary for the complete work.

1.2 Work shall include design, supply, installation and testing of waterproofing systems, proprietary/ membrane to underground structures such as raft and retaining walls, landscaped courtyard spaces, terrace slabs with and without roof gardens, sunken wet areas in kitchen, pantry and toilets, underground and overhead water tanks, STP tanks etc.

(a) Not used

(b) Water proofing of terrace slab, balconies, canopies, chajja inclusive of grouting, sealing rainwater down take outlets, other services outlets, junctions of walls, slabs, beams, columns, parapet walls etc., expansion joints wherever required, all as per approved terrace proprietary treatment.

(c) Waterproofing of sunken portions in kitchen, pantry and toilets and water tanks inclusive of grouting, sealing outlet pipes of services, junctions of slabs, beams, walls and covering with protective cement sand plaster coat / screed.

1.3 The waterproofing systems shall be guaranteed for a minimum period of ten (10) years against all defects and liabilities thereof from the date of completion of project. The guarantee shall be on Stamp Paper of Rs.100/- in proforma approved by Owner or his authorized representative. (The contractor shall submit proforma for approval of Owner or his authorized representative before being written on Stamp Paper). The cost of Stamp Paper shall be borne by the Contractor.

1.4 Specialized agency executing waterproofing works shall be experienced in the installation of the offered waterproofing materials as demonstrated by previous successful installation, and shall be approved by the manufacturer in writing.

1.5 Contractor shall obtain prior written approval of the Owner or his authorized representative before appointing specialized waterproofing agency and the specialized waterproofing agency shall be from the List of Approved Makes.

1.6 Contractor shall propose the system/s for each of the application areas along with the technical bid, giving full descriptions.

1.6.1 The Contractor shall submit statement giving detailed brief of work he proposes to carry out.

(a) Name of agency with his experience certificate and quantum of work carried out.

(b) List of Projects completed and list of Projects in progress in India.

(c) Performance certificates from three different clients which are at least five years old.

(d) Technical Specifications.

(e) Product data sheets of material to be used.

(f) Shop drawings detailing;

i.) Sections coordinated with typical installation details,

ii.) Vertical termination and sealing,

iii.) Laps needed, if any,

iv.) Typical expansion, construction and control jointing details with minimum requirements,

v.) Horizontal fixing and laying details,

vi.) Typical finishing arrangement,

vii.) Flashings, if required.

(g) Protective measures to be taken.

(h) Installation guidance.

(i) Samples of each product in duplicate fixed over plywood boards or similar to enable proper cross sections.

(j) Manufacturer's certificate that product and material to be used is correct and shall give intended results when applied through authorized agency.

1.7 Contractor to provide for brick bat coba filling in terrace and toilet over the water proofing membrane as required and mentioned in the architectural specification. All terrace's without podium landscape to be provided with heat resistant tile flooring as per architectural specifications.

2.0 APPLICABLE CODES, STANDARDS & SPECIFICATIONS

2.1 The clauses of the following Indian Codes, Standards and Specification (latest editions including all applicable official amendments, reaffirmations and revisions) shall apply to the material and workmanship covered by this specification. In the event of the conflict of certain requirements between this specification and the codes referred herein, this specification shall govern. Any discrepancies or ambiguities seen shall be brought to the notice of the Owner or his authorized representative and clarification/ confirmation sought. Owner's or his authorized

representative's decision shall be final and binding on the contractor. However, as a general rule, more stringent specifications shall be followed.

2.2 It is not the intent to specify herein all the codes and standards required for the satisfactory completion of work. The list of codes and standards indicates certain primary codes & standards and not all the codes required for the work under the contract. It is understood that all the following codes and standards shall form the part of this specification whether explicitly indicated or not.

BS: 8102 - Protection of structures against water from the ground

IS: 712 - Specification for building limes

IS: 1200 - Method of measurement of building and civil engineering works

IS: 1203 - Determination of penetration of bitumen

IS: 1322 - Bitumen felts for waterproofing and damp proofing – Specification

IS: 1346 - Code of practice for water-proofing of roofs with bitumen felts

IS: 1580 - Bituminous compounds for water-proofing and caulking purposes – Specification

IS: 1609 - Damp proofing treatment using bitumen felts - Code of Practice

IS: 2645 - Integral water-proofing compounds for Cement mortar and Concrete – Specification

IS: 3036 - Laying lime concrete for a water-proofed roof finish - Code of practice

IS: 3037 - Specification for Bitumen Mastic for use in water proofing of roofs

IS: 3067 - Code of practice for general design details and preparatory work for damp proofing and water-proofing of buildings

IS: 3384 - Specification for bitumen primer for use in water-proofing and damp-proofing

IS: 4365 - Code of practice for application of bitumen mastic for water proofing of roofs

IS: 4911 - Glossary for terms relating to bituminous water proofing and damp-proofing of buildings

IS: 5871 - Specification for Bitumen Mastic for tanking and damp-proofing

IS: 6494 - Code of practice for water proofing of underground reservoirs and swimming pool

IS: 7193 - Glass fiber base bitumen felts – Specification

IS: 7198 - Code of practice for damp proofing using Bitumen Mastic

IS: 7290 - Recommendations for use of Polyethylene film for waterproofing of roofs

IS: 9918 - Code of practice for in situ water proofing and damp proofing treatment with glass fibre tissue reinforced bitumen

IS: 13182 - Water proofing and damp proofing of wet areas in building - Recommendations

IS: 13435 - Acrylic based polymer waterproofing materials – Methods of Test

IS: 13826 - Bitumen based felts - Method of Test

IS: 14695 - Glass fibre base coal tar pitch outerwrap – Specification

3.0 **GENERAL**

3.1 Work shall be carried out through approved specialist agency as per method of working approved in writing by the Owner or his authorized representative.

3.2 Waterproofing systems (membranes, protection board, water bar, joint fillers, sealants etc.) shall be as per specification and shall be used strictly in accordance with the manufacturer's instruction. Water bar shall be provided in all construction joints below ground level in addition to any joint which may be detailed on the drawings.

3.3 Waterproofing Work shall conform to minimum standards specified. Systems detailed hereunder are to clarify type of water proofing system expected and are to be referred as guidelines only. Contractor to study and ensure appropriateness for area under application and guarantee the performance. Contractor is at liberty to suggest and submit equivalent system with products meeting/ exceeding standards.

3.4 QUALITY ASSURANCE:

3.4.1 Manufacturer’s Qualification

(a) Not less than five years experience in manufacturing of waterproofing system.

(b) Obtain primary materials from single manufacturer. Manufacturer's name shall appear on containers and accessories.

(c) Provide secondary materials as required by manufacturer of primary materials.

3.4.2 Applicator’s Qualification

(a) Approved by manufacturer prior to execution of this Contract, with experience on at least five projects.

(b) Foreman of Field Crew: Minimum five years experience with system of waterproofing being installed.

3.4.3 Certifications

Manufacturer's certifications on manufacturer's letterhead:

(a) Certify system design; penetration, transition, and perimeter details; and system specifications are appropriate and satisfactory for this particular project.

(b) Certify products proposed for use comply with standards.

(c) Certify materials ordered and supplied are compatible with each other, suited for local and purpose intended and shipped in sufficient quantity to ensure proper timely installation.

(d) Certify materials have express warranty of merchantability and fitness for particular purposes of this Project.

(e) Certify manufacturer has reviewed Project and will issue warranty upon successful completion of installation.

(f) Certify materials shipped to site meet membrane manufacturer's published performance standards and requirements of this Specification.

(g) Membrane manufacturer's approval of insulation type and method of installation.

(h) Manufacturer's approval of installer.

3.5 SUBMITTALS:

3.5.1 Product Data

Contractor to submit along with his proposal product data for materials he proposes to use.

3.5.2 Informational Submittals

(a) Certifications specified in quality assurances.

(b) Manufacturer's instructions.

3.6 WATERPROOFING COMPOUNDS:

3.6.1 Waterproofing compounds shall be cementious (cement based), non-shrinking, self curing mixtures. These shall be -

(a) Free from sodium and chlorides,

(b) Free from material detrimental to concrete and reinforcement,

(c) Permeability, shear bond strength, compressive strength, volume changes meets minimum requirements of codes,

3.6.2 Mixing:

(a) Mixing of materials shall be in accordance with manufacturer's instructions.

(b) Mix in clear containers.

(c) Do not re-temper mix after initial set.

3.6.3 Accessories:

All other accessories/ materials such as primers, bonding agents, polymers, water stops or plugs etc. shall be used as recommended by waterproofing manufacturer meeting the minimum requirements of codes.

3.7 WARRANTY:

3.7.1 Warranty with attachments for full replacement value of completed installation signed by Manufacturer, Applicator and Contractor warranting against water infiltration and defects of materials and workmanship for a minimum period of ten (10) years.

3.7.2 Provide warranty that covers labour and workmanship, including labour for access to waterproofing, for watertight warranty.

(a) Warrant penetrations, terminations, changes of direction, and membrane.

(b) Warranty shall include removing and reinstalling superimposed work covering waterproofing.

4.0 MATERIALS

4.1 CEMENT**:** Cement shall be conforming to relevant IS Standards.

4.2 SAND**:** Sand shall be conforming to IS: 456 and relevant IS Standards.

4.3 BRICK BATS:

4.3.1 It shall be prepared from well-burnt bricks. In no case shall under-burnt bricks be used. Flaky and elongated pieces shall be avoided. Brick bats should be free from adherent coatings of soil or silt. It should also be free from alkalies, soft fragments, organic impurities, etc. in such quantities as not to affect strength and durability of concrete.

4.3.2 Water absorption for the bricks after 24 hours immersion in cold water shall not exceed 15%.

4.4 STONE TILES: Stone tiles such as kota/ shahbad shall be of best quality and free from any defects and of uniform thickness.

4.5 WATER:

4.5.1 Water used for mixing and curing shall be clean, reasonably clear and free from objectionable quantities of silt, oils, alkalies, acids, salts so as not to weaken mortar, or concrete or cause efflorescence or attack the steel in RCC while curing. It shall be free of elements, which significantly affects the hydration reaction.

4.5.2 Potable water is generally satisfactory, but it shall be tested prior to use in the works.

4.5.3 Water tested shall be in accordance with IS: 3025. Maximum permissible limits of deleterious materials in water should be as given in IS: 456.

4.6 ACCESSORIES: Primers, bonding agents, polymers, water stops or plugs etc. shall be used as per recommendations of the manufacturer meeting the minimum requirements of codes.

4.7 MEMBRANE:

4.7.1 The system proposed shall be suitable for the purpose and laid in accordance with the standards.

4.7.2 Membrane to be a purpose design and have proven application in India considering thermal expansion and contraction, dimensionally stable, durable, waterproof, puncture resistant and suited to the conditions of use.

4.7.3 The type of membrane selected shall meet standard codes of practice and samples and brochures of the product shall be submitted for review and acceptance by Owner or his authorized representative.

4.7.4 The thickness of membrane or number of coats/ layers shall be as recommended by manufacturer as required to achieve the performance requirements.

4.7.5 Reinforcement at angles, joints, etc.: Provide fillets to all changes of direction/ abutments, etc. formed from mortar or proprietary products as recommended by the tanking manufacturer to be compatible with the tanking coating system. In addition, provide reinforcement for tanking system at angles, joints, etc. using a reinforcement product of the appropriate grade and width as recommended by the tanking system manufacturer.

4.8 DELIVERY/ STORAGE:

4.8.1 All materials shall be delivered and stored at site conforming to following minimum requirements.

(a) Material received is approved by Owner or his authorized representatives.

(b) Material is in unopened container and labeled with manufacturer's name, brand name and instructions for use.

(c) Material received shall be along with manufacturer's certificate for quality and period of manufacture.

(d) Material shall be stored in dry, well ventilated and covered storage if so desired by manufacturer.

(e) Primers, adhesives etc. shall be as recommended by the membrane manufacturer.

5.0 **WORKMANSHIP**

5.1 The area where waterproofing system needs to be installed shall be made free from all other activities that could disrupt the installation of the system.

5.2 The substrate shall be rendered sound, free from contaminants such as fungus, algae, dust etc. by removing all weak layers and cleaning with up to 5% solution of Sodium Hypochlorite (to remove biological growth) and high pressure water jet.

5.3 The substrate or surfaces to receive the treatment shall be thoroughly cleaned of laitances, scales, loose material on surface. Grease, oil or other contaminants shall be removed by etching with 10-15% of solution of muriatic acid using commercial grade alkaline cleaner, flushing with clean water, drying and vacuuming.

5.4 The substrate shall be free of cracks, protrusions, undulations and damage to surface integrity. Should any defect be present in the substrates, the Contractor shall carryout all the necessary rectification works and preparatory works before the installation of the specified waterproofing system.

5.4.1 Any honeycombs shall be carefully cut and plugged, and cured well before treatment.

5.4.2 Cracks running through the sections shall be repaired using low viscosity, solvent free epoxy injection resin system.

5.4.3 Any surface cracks shall be chased open into a 'V' groove / notches, and filled with ready to use, non-shrink repair mortar and shall be cured and dried well before treatment.

5.4.4 Pipe joints shall be inspected for leakage before installation of waterproofing membrane and suitably repaired wherever required.

5.5 The substrate or surfaces to receive the treatment shall be examined carefully. Examination of surfaces shall account for the fact that,

5.5.1 Surfaces are cured for 14 days and no condensation has taken place.

5.5.2 Horizontal and vertical surfaces have smooth finish, free from defects.

5.5.3 Surfaces are dry, clean, free of grease, oil, dirt, rust, corrosion, other coatings and contaminants which could affect bond of water proofing system.

5.6 TREATMENT TO EXPANSION JOINTS:

The sides of the joint shall be finished properly. Filler board of required thickness and size shall then be installed flush between the finished surfaces leaving the required gap at the top of the board to be filled up with polysulphide sealant of approved manufacturer.

Filler board should be expanded Polyethylene board of approved make and of required thickness having the following characteristics

Water absorption: 0.20 %

Compressive strength: 0.7 – 0.10 Kg/sqm

Tear strength: 0.2 – 0.50 Kg/sqm

5.7 TANKING/ MEMBRANE TYPE WATERPROOFING SYSTEM:

Application areas: Raft and Retaining Walls

5.7.1 Performance Requirements:

(a) Not Used

(b) The installation shall ensure a waterproof tanking system application suitable to achieve a minimum service life as specified.

(c) The waterproofing system should be capable of protecting the structure by insulating it from any possible attacks from water, soil and gases thereby increasing the durability of the structure, without any leakage, and shall bridge over joints/ cracks due to minor settlements and shrinkage movement and shall accommodate movements in the substrate due to changes in moisture content.

Suggested Products

Profex Engage of Fosroc,

Preprufe 300 R of Grace,

Masterpren BG of BASF,

Dr. Fixit Flexshield Blue of Pidilite

Or equivalent

- Pile head treatment including reprofiling, encapsulation and sealing shall be as per manufacturer's instruction. Details shall be developed with potential suppliers.
- Contractor's proposal shall take into account the details shown on Architectural drawings.

5.7.2 Installation:

(a) General:

- Install materials carefully in accordance with the manufacturer's instructions and the recommendations of BS 8000: Part 4 to provide a completely waterproof, continuous membrane.
- All horizontal concrete surfaces receiving the membrane shall be treated in accordance with the membrane manufacturer's requirements. Voids and honeycombed areas shall be made good with a pre-bagged proprietary repair material. All vertical surfaces receiving the membrane shall be smooth shutter finished, and in accordance with the membrane manufacturer's requirements. All abrupt irregularities, voids and honeycombed areas shall be made good with a pre-bagged proprietary repair material.
- All surfaces shall be clean, smooth, free of laitance, dry and free of dust, frost, mould release agents, curing compounds and sharp protrusions at the time of installation.
- Where a hard-core bed is specified, Monolithic concrete blinding is preferred with not less than 50 mm thickness, which should be regular, smooth and free of loose aggregate and sharp protrusions.
- The primer coat shall be applied to all vertical and horizontal surfaces, strictly in accordance with the manufacturer's instructions.
- All wall/ base slab intersections and internal/ external angles shall be reinforced with a minimum 300 mm wide reinforcing strip of membrane. A chamfer shall be provided to all external angles prior to the application of the reinforcing strip.

- All edge laps shall be as per manufacture's recommendation. Continue main sheeting around angles, extending not less than 150mm on to adjacent surfaces. All laps shall be rolled to achieve a good seal and end laps staggered.
- Any areas damaged during the installation of the membrane shall be repaired with a minimum 300mm x 300mm patch.
- If application continues from one day to the next, all exposed edges shall be rolled to ensure a seal against water penetration.
- All vertical and exposed areas of the membrane shall be protected, with a protection board or screed supplied/ approved by the membrane manufacturer, prior to backfilling. This board shall be spot bonded with dabs of the waterproofing manufacturer's rubber bitumen sealant. Provide support as necessary to ensure protection remains fully in contact with tanking and does not move during backfilling operations.
- The membrane system shall be laid in accordance with the provisions of BS 8102.
- The membrane application shall take place within the temperature range specified by the manufacturer.
- Continuity of the membrane shall be maintained, in accordance with the manufacturer's instructions.
- Where the waterproof membrane is terminated on the concrete up stand adjacent to the external cladding, a continuous waterproof junction shall be formed with the cladding membrane, by lapping and sealing.
- All membranes shall be laid without folds and ripples.
- The membrane shall be formulated to suit local climatic conditions.
- Membrane to be inspected for damage before installation of protection board, reinforcement steel, shuttering and final placement of concrete. Repairs to be in accordance with manufacturers recommendations.

(b) Bonded Joints:

The works shall be bonded with the structural movement joints, within the construction, to form a watertight joint. Apply sheets adhesive side down,

smoothing out to exclude air. Roll laps to ensure good adhesion between sheets, in accordance with manufacturers recommendations.

(c) Dressing:

The works shall be terminated with the concrete. They shall be dressed into a 20mm x 20mm rebate formed within the concrete. The rebate shall be sealed, using liquid membrane, supplied by the waterproofing manufacturer.

d) Penetrations:

Particular attention shall be given to the workmanship around penetrations such as columns and drainage pipes. The following steps shall be carried out when the membrane is dressed around circular columns, drainage pipes, drainage channels and joints in accordance with the Engineer's Representative's details: Cover sheeting system with permanent overlying construction as soon as possible. Immediately prior to covering check for damage and repair as necessary.

- Form: 50mm x 50mm minimum angle fillets shall be formed at intersections between horizontal and vertical surfaces, using the membrane manufacturer's recommended liquid membrane.
- 300mm wide reinforcing strips (minimum) shall be applied at all changes of direction and transitions between horizontal and vertical planes.
- A star-cut panel of waterproofing membrane of the appropriate width shall be placed around the base of the column ensuring the star-cut edges are securely wrapped around the column, to achieve a minimum lap of 150mm.
- A 30mm x 30mm minimum angle fillet shall then be formed around the star-cut panel of the waterproofing membrane.
- The final 300mm minimum wide ring of waterproofing membrane shall be wrapped around the circumference of the column and chased into a 20mm x 20mm rebate sealed in accordance with the Engineer's Requirements.

(e) Primer(s):

The type(s) shall be as recommended for the purpose by the sheet manufacturer. The primer shall be applied according to the manufacturer's instructions to achieve an even and full cover of the surface. It shall be allowed to dry thoroughly before covering/ applying membrane.

(f) Jointing Tape:

The jointing of adjacent sheets of DPM, DPM to DPC, DPC to DPC, DPM to protection board, etc. shall be as per the manufacturer's recommended jointing system.

(g) Waterstops:

Shall be the membrane manufacturer's recommended range of passive or active Waterstops for expansion joints and additional protection at construction joints providing single point responsibility.

5.7.3 Testing:

Carry out tests in accordance with the following test methods and values and submit to the Engineer's Representative for review or provide existing certified data as required:

(a) Resistance to hydrostatic head (as per ASTM D5385): 60M

(b) Puncture Resistance (as per ASTM E154): 220 N

(c) Tear Resistance (as per ASTM D 624): 23N/mm

(d) Elongation (as per ASTM D412): 200%

(e) Adhesion to self (lap adhesion, as per ASTM D1876): 683N/m

5.8 MEMBRANE TYPE WATERPROOFING:

Application areas: Landscaped courtyard spaces, Terrace slab with sky garden, Terrace slab without sky garden, sunken wet areas in kitchen, pantry and toilets, underground and overhead water tanks, STP tanks.

Suggested Waterproofing Treatments

Application Area	**Suggested Products**
Landscaped spaces &	Polyurea WPE of Fosroc,
Terrace slab with roof gardens	Masterpren TGE of BASF,
	Dr. Fixit Flexshield Blue of Pidilite,
	Or equivalent
Terrace slab without roof gardens	Nitoproof 600 of Fosroc,
	Masterseal 550 EL of BASF,
	Dr. Fixit Torchshield of Pidilite,

Suggested Waterproofing Treatments

Application Area	**Suggested Products**
	Or equivalent
Toilet & Sunken wet areas	Brush bond RFX of Fosroc,
	PCI Lastogum of BASF,
	Dr. Fixit Pidifin 2K of Pidilite,
	Or equivalent

Contractor's proposal shall take into account the details shown on Architectural drawings.

5.8.1 Waterproofing work shall conform to the minimum requirements specified in relevant Indian/ International standards. Systems detailed above are to clarify type of water proofing system expected and are to be referred as guidelines only.

5.8.2 Contractor shall propose equivalent system with products meeting/ exceeding standards for each of the application areas and guarantee the performance.

5.9 INTEGRAL CEMENT WATER PROOFING:

Alternative to membrane waterproofing, integral cement waterproofing may be proposed by Contractors for review and acceptance of Owner or his authorized representative for the following application areas: Landscaped courtyard spaces, Terrace slab with sky garden, Terrace slab without sky garden, sunken wet areas in kitchen, pantry and toilets, underground and overhead water tanks, STP tanks.

5.9.1 Contractor's proposal shall take into account the details shown on Architectural drawings.

5.9.2 Contractor's shall submit detailed specifications for the selected waterproofing system.

5.9.3 Testing For Integral Cement Water Proofing System:

Carry out tests in accordance with the following test methods and submit to the Owner's Representative for review or provide existing certified data as required:

(a) Permeability to Water.

(b) Setting time.

(c) Compressive Strength.

(d) Determination of solid content.

(e) Determination of coarse particles.

(f) Determination of capillary water take-up.

(g) Determination of pH value.

(h) Determination of minimum film forming temperature and white point.

(i) Alkali resistance test.

6.0 **TESTING**

6.1 The waterproofing systems shall be tested in accordance with the relevant Indian/ International Standards and local site conditions, and the testing results shall meet or exceed the performance characteristics and testing requirements as specified in the relevant Indian/ International Standards.

6.2 On completion of installation and prior to next operation or as directed by the Owner or his authorized representative, work shall be tested by the Contractor. Required water shall be arranged and disposed off by the contractor at his cost.

6.2.1 All openings, drains etc. shall be plugged.

6.2.2 Water shall be flooded about 200 mm over the Sunk portion and kept ponded for 72 hours.

6.2.3 Surfaces shall be observed critically and incase any leakage is observed, those areas shall be treated again and tests to be carried out again to the satisfaction of the Owner or his authorized representative.

6.3 Approval of water test does not relieve the contractor of his obligation of providing installed water proofing guaranteed for 10 years as per contract.

6.4 All arrangement of material, labour etc. required including preserving and maintaining areas flooded shall be carried out by the Contractor at his cost.

PART – 8: MASONRY WORKS

1.0 SCOPE

These specifications cover the use of Brick Masonry for the structural purposes

2.0 GENERAL

The provision of the latest Indian Standards listed below form part of these specifications

IS: 1077 Specifications for common burnt clay building bricks

IS: 1200 Measurement for Building works

IS: 1725 Specifications for solid cement blocks used in general Building construction

IS: 1905 Code of practice for structural safety of buildings Masonry walls

IS: 2116 Sand for masonry mortars

IS: 2180 Specifications for heavy duty burnt clay building bricks

IS: 2185 Specifications for concrete masonry units Hollow and Solid concrete blocks

IS: 2212 Code of practice for brick work

IS: 2222 Specification for burnt clay perforated building bricks

IS: 2250 Code of practice for preparation and use of masonry mortar

IS: 2691 Specification for burnt clay facing bricks

IS: 3115 Specification for lime based blocks

IS: 3414 Code of practice for design and installations of joints in Buildings

IS: 3466 Specification for masonry cement

IS: 3861 Method of measurement of plinth, carpet and rent able Areas of buildings

IS: 3952 Specification for burnt clay hollow blocks for walls and Partitions

IS: 4098 Specification for lime-puzzolona mixture

IS: 4441 Code of practice for use of silicate type chemical resistant mortars

IS: 4442 Code of practice for use of sulphur type chemical resistant mortars

IS: 5495 Size & shape for fire bricks

Other I.S. Codes not specifically mentioned here but pertaining to the use of bricks for structural purposes form part of these specifications.

3.0 MATERIALS

3.1 BRICKS

3.1.1 Bricks shall be of regular and uniform size. Shape and colour, uniformly well burnt throughout but not over burnt. They shall have plane rectangular faces with parallel sides and sharp straight and right angled edges. Bricks shall be free from cracks or other flaws. They shall have a frog of 10 mm depth on one of their flat faces.

3.1.2 They shall give a clear metallic sound when two bricks are struck. Bricks shall show a fine grained, uniform homogeneous and dense texture on fracture and be free from lumps of lime, laminations, cracks, air holes, soluble salts causing efflorescence or other defects which may in any way impair their strength, durability, appearance or usefulness for the purpose intended. They shall not have any parts under-burnt. They shall not break when thrown on the ground on their flat face in a saturated condition from a height of 60 cm.

3.1.3 Size of bricks:

The size of the conventional bricks shall be 250mm x 125mm x 75mm. The following tolerances are permitted in the standard conventional size adopted on a particular work.

Length – plus or minus 3 mm (about 1/8”)

Breadth – plus or minus 1.5 mm (about 1/16”)

Depth - plus or minus 1.5 mm (about 1/16”)

The size of the modular bricks shall be 200mm x 100mm x 100mm

3.1.4 Absorption

After immersion in water, absorption by weight shall not exceed 20% of the dry weight of the brick when tested according to IS: 1077-1976

3.1.5 Crushing Strength

The load to crush the brick when dry shall not be less than 75 Kg/sq.cm. and when thoroughly soaked shall not be less than 50 Kg./sq.cm.

3.2 FLY-ASH BRICKS

3.2.1 The specific conditions as laid down by EIA, Fly-ash to be used in construction. The brick shall be machine molded and made from suitable Fly-Ash, Sand, Cement and Water. The bricks shall be free from cracks and flaws.

3.2.2 The standard size of bricks shall be 250mm. (length) x 125mm (width) x 75mm. (height). The bricks when tested in accordance with the procedure laid down in IS: 3495 (part -1) – 1992 shall have a minimum average compressive strength of 50 kg. Per Sq.cm.

3.2.3 The bricks, when tested in accordance with the procedure laid down in IS:3495 (Part -2) – 1992 after immersion in cold water for 24 hours, water absorption shall not be more than 20 percent by weight.

3.3 CONCRETE BLOCKS

3.3.1 The blocks shall be machine molded and made from suitable Fly-Ash, Sand, Cement and Water. The bricks shall be free from cracks and flaws.

3.3.2 The standard size of solid blocks and hollow blocks shall be 400 mm (Length) X 200 mm (Width) X 200 mm. (height). When tested at site the blocks shall have a minimum average compressive strength of 75 kg. Per Sq.cm. The hollow blocks shall be with 2 / 4 cavities per block.

3.3.3 A suitable hard standing shall be prepared for storing blocks. They shall not be off-loaded by tipping from vehicles, but shall either be off-loaded by hand or in pallets by means of a forklift truck, crane or similar lifting device. They shall not be stacked directly on sulphate bearing ground. They shall be stacked on newly cast hard-standing. Blocks shall be arranged in orderly stacks and used approximately in the order in which they were delivered. Broken and rejected blocks shall be stacked separately and removed from site as soon as possible.

3.3.4 Blocks shall not be used until one month after casting. All blocks shall be well soaked before being used and tops of walls left off shall be wetted before work is restarted. Blocks shall be laid on a full bed of mortar and all joints filled and thoroughly flushed up as the work proceeds. All joints shall be uniform and shall not exceed 12 mm. The maximum height of block work built in a day shall be 1.2 m and the Contractor shall be fully responsible for ensuring the stability and strength of the works as they proceed. Any wall or partition necessarily left at different levels must be raked back. All perpends, quoins, internal and external angles etc. shall be kept strictly true and square and the whole properly bonded together and leveled round at each floor.

3.3.5 Partitions shall be bonded to the main walls by toothing every fourth course into the main walls to a depth of not less than 100mm.

3.3.6 Block should be manufactured with minimum cement content of 200 kg. per cubic meter.

3.4 LIGHT WEIGHT CONCRETE BLOCKS

3.4.1 The Basic raw materials used in the production of Light Weight Blocks to be cement, fly ash, lime and water.

3.4.2 Fire Resistant Properties: Light weight blocks to have a remarkable level of fire resistance. These blocks to be fire proofs up to 1100c .These blocks to be completely inorganic and incombustible.

3.4.3 Sound insulation Properties: Light weight concrete blocks to have inherent sound insulating properties.

3.4.4 For external load bearings walls min 200 mm thick blocks and for internal load bearing walls min 150 mm thick blocks are used

3.4.5 The compressive strength of the block to be 3 N/mm² and fire resistance is 4 hours as per standard specification. The thickness of joints shall not exceed 10 mm for Light weight block wall. Al the face joints shall be raked to a minimum depth of 15 mm by raking tool during the progress of block work. The item shall include mixing, scaffolding, reinforcement, lifting, raking of joints, curing and wastages etc. Scaffolding, curing and surface shall be smooth sponge finish as per standard specifications. All joints between RCC and Light weight block shall be covered with chicken mesh before plastering.

Face Size	**630 x 230x200mm**	**630x230x150mm**	**630X230X100mm**
Dry Weight (in Kg)	7.8	11.7	15.6
Wall Thickness	100	150	200
Compressive Strength(N/mm 2)	4.0		
Normal Dry Density (kg/m3)	650		
Thermal Conductivity	0.16		
Sound Reduction (in decibels)	38-50 db depending on thickness		
Fire Resistance (in hours)			
NLB (Non load bearing)	4	6	6
LB (load bearing)		4	4
Maximum Overhang, unsupported	300 mm		

3.5 MORTARS

3.5.1 Cement and sand shall be mixed dry in 1:4 proportions. The required quantity of water shall then be added and the mortar mixed to produce uniform mix and workable consistency.

3.5.2 The mixing shall be done intimately in a mechanical mixer unless hand-mixing is in special cases permitted by the ER/PMC. If hand mixing is done, the operation shall be carried out on a clean watertight plat form and cement and sand shall be first mixed dry in the required proportion to obtain a uniform colour and then the mortar shall be mixed thoroughly after addition of water. The mortar so prepared shall be used within 30 minutes of adding water. Only such quantity of mortar shall be prepared as can be used within 30 minutes. The mortar remaining unused after that period or mortar, which has partially hardened or is otherwise damaged shall not be retempered or remixed. It shall be destroyed or thrown away.

3.5.3 Necessary tests to determine compressive strength of the mortar, for consistency of the mortar and its water retentively shall be carried out in accordance with IS-2250. The frequency of testing shall be one cube for every 2 cubic metre of mortar prepared subject to a minimum of 3 cubes for a day's work or as directed by the ER/PMC.

4.0 CONSTRUCTION

4.1 SOAKING OF BRICKS

Bricks shall be soaked in water for a minimum period of one hour before use so that they will be saturated and will not absorb water from the mortar. When bricks are soaked they shall be removed from the tank sufficiently in advance 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 spoilt by dirt, earth, etc.

4.2 LAYING OF BRICKS

4.2.1 All brick shall be laid in English bond even and true to line, plumb, level and all joints accurately kept. The bricks used on the face shall be selected whole ones of uniform size and with true rectangular face. Brick shall be laid with frogs up, on a full bed of mortar. When laying, bricks shall be slightly pressed so that the mortar gets into all the surface pros of bricks to ensure proper adhesion. All shall be properly flushed and packed with mortar so that no hollow spaces are left.

4.2.2 Before laying bricks in foundation, a layer of not less than 12 mm of mortar shall be spread to make the surface, on which the brickwork will be laid, even. Immediately thereafter, the first course of bricks shall be laid.

4.2.3 The brickwork shall be built in uniform layers, corners and other advanced work shall be raked back. Brickwork shall be done true to plumb or in specified batter No part of it, during construction, shall rise more than half a meter above the general construction level, to avoid unequal settlement and improper joining. The height of brick works constructed shall not exceed a meter in a day.

4.2.4 Toothing may be done where future extensions contemplated but shall be used as an alternative to raking back.

4.3 JOINTS

The thickness of joints shall not exceed 10 mm. and this thickness shall be uniform throughout.

4.4 JOINING WITH EXISTING STRUCTURE

When fresh masonry is to be placed against existing surfaces of structures, the latter shall be cleaned of all loose material, roughened and wetted as directed by the EIC so as to effect a good bond with the new work.

4.5 CURING

Green work shall be protected from rain by suitable covering. Masonry work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. The top of the masonry work shall be left flooded with water at the close of the day during hot weather. All finished or partly completed work shall be covered or wetted in such manner as will prevent rapid drying of the brick work.

4.6 SCAFFOLDING

The scaffolding shall be sound and strong to withstand all loads likely to come upon it and will be double or single as is warranted for the particular work. The holes, which provide resting space for horizontal members, shall not be left in masonry under one meter in width or immediately nearer the skew backs of arches. The holes left in the masonry work for supporting the scaffolding shall be filled and made good with 1:4:8 cement concrete. Double scaffolding shall be erected for external brickwork, plaster etc

4.7 CONDITION OF EQUIPMENT

All equipment used for mixing or transporting mortar and bricks shall be clean and free from set mortar, dirt or other injurious foreign substances.

4.8 FINISHING OF SURFACES

For a surface which is to be subsequently plastered or pointed, the joints shall be squarely raked out to a depth of 15 mm while the mortar is still green. Before plastering/pointing the raked joints shall be well brushed to remove dust and loose particles and the surfaces shall be thoroughly washed with water, cleaned and wetted.

5.0 DAMP PROOF COURSE (DPC)

DPC shall be provided over all walls or as directed by EIC. Concrete for DPC shall be of M-15 grade and shall be laid over the full width of the wall. An integral

waterproofing compound shall be provided in the concrete in the proportion specified by manufacturer. The DPC shall be inclusive of integral waterproofing compound and shuttering required. Thickness of DPC shall be 40mm.

PART – 9: RUBBLE MASONRY

1.0 **GENERAL**

These specifications cover the materials used and workmanship in construction of all types of masonry. The provision of the latest revisions of the following IS Codes shall form a part of these specifications to the extent they are relevant.

I.S. 1121 Method of test of determination of strength properties of natural building stones (all parts)

I.S. 1122 Method of identification of natural building stones

I.S. 1123 Methods of identification natural building stones

I.S. 1124 Methods of test for determination of water absorption, apparent specific gravity and porosity of natural building stones

I.S. 1125 Methods of test for determination of weathering of natural building stones

I.S. 1126 Method of test for determination of durability of natural building stones

I.S. 1127 Recommendations for dimensions and workmanship of natural building stones for masonry work.

I.S. 1129 Recommendation for dressing of natural building stones

I.S. 1200 Method of measurement of Building and Civil Engg. Works – Stone Masonry

I.S. 1597 Code of practice for construction of stone masonry

Part I – Rubble Stone Masonry

Part II – Ashlar Masonry

I.S. 2250 Code of practice for preparation and use of masonry mortars

I.S. 10067 Material constants in building works

Other I.S. codes pertaining to the items of rubble masonry work and not listed above shall also be deemed to come under the purview of these clauses.

1.1 STONES

1.1.1 All stones to be used these specifications shall be obtained from quarries approved by Engineer - in-Charge and shall be of trap, basalt, granite, quartzite or any other approved quality and it shall be sound hard and of durable quality, free from voids, flaws, cracks, earth cover, zeolites, etc. Use of stones with stained surfaces shall not be allowed; if stains can be washed off they shall be allowed after cleaning. Unsound, weathered and disintegrated stones shall be rejected outright, stones

shall be such that they will not absorb water more than 1% by weight after being kept under water for 24 hours minimum size of stone shall not be less than 15 cm on any face. The quality and physical properties of stone shall satisfy the requirements laid down in relevant I.S. Codes.

1.1.2 Stones are to be wetted before use. All stones, chips, etc. shall be cleaned and freed from dust or mud to ensure a good bond with mortar and shall be wetted before being laid for this purpose. The stones that are immediately to be used shall be kept sprinkled with good clean water. There shall be good collection of stones and spalls within easy reach of mason to enable proper selection of stones for the individual locations while laying and the stones shall be kept continuously replenished.

1.2 DRESSING OF STONES

The stones shall be set in the work as received from quarry, after merely knocking off weak corners and edges with a mason's hammer and after clearing scales of foreign matter if any.

1.3 LAYING

1.3.1 The stones shall be laid carefully on their natural flat bed so as to break joints as much as possible. They shall be solidly bedded in mortar with close joints no joint shall exceed 40 mm nor shall it be less than 12 mm in thickness. Chips of stones and spalls shall be wedged into the works, wherever necessary to avoid thick. Beds or joints of mortar and to give masonry of maximum density.

1.3.2 No dry work or hollow space shall be allowed. Every stone, whether large or small shall be set flush in mortar, shaken and hammered down by a mallet to sink into it and to bring out all excess water and locked air inside beds. The smaller stones used in the filling shall be carefully selected to fit snugly into the interstices between the large ones.

1.3.3 Mortar to be added to fill the intervening spaces shall be well worked by trowel and steel bar. Disturbing the mortar during the period of setting shall be avoided. If it is necessary to move a stone after it has been placed in position it shall be lifted clearly and then placed. Care shall always be taken to see that the joints in masonry already laid are not disturbed while handling or moving stones.

1.3.4 Mortar joints of top and side of a layer shall be pressed and brushed over by a coir brush as soon as masonry is laid so as not to leave any loose mortar. No traffic will be allowed on freshly laid masonry.

1.4 BONDING AND BOND STONES

For ensuring good bond, masonry shall be finished uneven at the end of the day's work or at top surface of the work done in each shift. No mortar shall be allowed to

remain over the masonry at its top at the close of the day's work. All mortar on the top shall be removed.

1.5 PRECAUTIONS TO OBTAIN DENSE MASONRY

In order to obtain dense masonry the following precautions shall be taken.

1.5.1 Underpinning shall be avoided after a stone is laid, as it tends to lift the stone and create air pockets.

1.5.2 Putting chips in the intervening space before filling with mortar shall be avoided.

1.5.3 Leveling of masonry on the top of the course by use of chips, shall be avoided. All chips on ends will be driven on one end only which will helps to squeeze and compact mortar in the joints.

1.5.4 Limit on height of masonry to be done in a day. The maximum height of masonry layer that *will* be allowed to be constructed at a time shall be 0.6 m. No fresh masonry shall be laid over masonry previously laid within 24 hours of its laying. In case sufficient working space not available at higher levels, these conditions may be relaxed by the Engineer-in-Charge.

1.5.5 The work shall be built square, plumb curved or bettered as may be required by the design. It shall be carried to in a workmanlike manner with the laid of moulds, templates, center etc that will be provided by the contractor at no extra cost.

1.6 QUANTITY OF MORTAR

Every effect shall be made to see that proper quantity of mortar is used in the masonry. The quantity of mortar will be 30-40 percent of the masonry laid.

1.7 CURING OF MASONRY

All masonry as it progress shall be kept well watered on the top and sides of a period of not less than 14 days from the date of building in place at the close of day's work or for other period of cessation of the work, the top of all masonry is to be kept well watered, water being done carefully, so as not to disturb or wash out mortar. Where watering is done by manual labour, night shift, if necessary, shall be arranged for constant watering. Masonry shall on no account be allowed to present a dry surface during curing period. Should the mortar perish, i.e. become dry through neglect of watering such work shall be demolished and rebuilt at no extra cost. If the curing arrangements of the contractor are not satisfactory, the Engineer -in-Charge may in his discretion engage labour and provide material, equipment for curing and recover expenditure thus involved from the contractor.

1.8. WEAK OR DEFECTIVE MASONRY

1.8.1. If any portion of masonry is found to be defective either in materials or in construction, it shall be removed and rebuilt by the contractor without extra cost.

1.8.2. In the alternative at the discretion of the Engineer-in-charge, such masonry shall be sufficiently grouted at contractor's cost in a manner specified by the Engineer -in-charge and to his entire satisfaction.

2.0 COURSED RUBBLE MASONRY (IN 1:5 CEMENT MORTAR RATIO)

2.1. HEIGHT OF COURSE

The stones shall be laid in horizontal courses not less than 200 mm (8 inches) in height. The stones in each course shall be of equal height and all courses of the same height unless otherwise specified but no courses shall be thicker than any course below it.

2.2. DRESSING

The face stones shall be squared on all joints and beds. The beds shall be hammered or chisel dressed, true and square for at least 5 mm (3 inches) back from the face and the joints for at least 40 mm (1.5 inches). The face of the stones shall be hammer -dressed and bushing shall not project more than 30 mm (1.25").

2.3. THICKNESS OF JOINTS

No pinning will be allowed on the face. All side joints shall be vertical and bed horizontal and no joint shall be more than 10 mm in thickness.

2.4. BOND STONES AND HEADERS

In walls thicker than 1.2 m (4 ft.) vertical header bond stones shall be inserted every one and half metre apart in each direction. They shall be at least 500 sq.cm. in face area and shall have a tail of at least 0.6m. They shall run through the height of two courses. Their position shall be staggered in the successive course, so that any two courses shall be bonded with such vertical bond stones. Through stones shall be inserted about everyone and half metre in every course and shall run right through the wall when not more than 600 mm thick when the work is more than 600 mm a line of 2 or more headers shall be laid from face to back, which shall have a length of at least thrice the height of each course, and face area not less than 500 sq.cm. Break of joint Stones shall break joint by at least ½ the height of the course.

3.0 UNCOURSED RUBBLE MASONRY (IN 1:5 CEMENT MORTAR RATIO)

3.1. Stone for face work the stones shall be selected of uniform size, and not less than 500 square cm on the face and shall be rough dressed to knock off projections and corners, the tail should not be less than one and half times the least lateral face dimension and shall approach 32 cm.

3.2. Filling Face stones shall be laid without any pinning on the surface and shall be fitted so as to form neat and close joints. If necessary, the edges shall be hammered to ensure close jointed work. Care shall be taken to ensure that face work is bonded well into the masonry.

3.3. Bond Stones For good bond, bond stones shall be provided at the rate of one per square metre of the face work. They shall be at least 500 sq.cm. In face area and shall have a tail of at least 0.6 m.

3.4. Joints: The joints in the face work shall not be more than 2 cm and stones shall be arranged to break joints as much as possible and long vertical lines of joints shall be avoided.

4.0 POINTING (IN 1:3 CEMENT MORTAR RATIO)

4.1 The joints in masonry to be pointed shall be raked square for a minimum depth of 4 cm within 24 hours of laying of masonry in special circumstances; this period may be relaxed to 48 hours. The refilling and pointing shall be done within 3 days of raking of the joints so as to ensure good adhesion between the two mortars. If the raking is not done within the period specified above, the Engineer-in-charge may engage labour for raking joints and recover the cost thereof from the contractor.

4.2 Flush Pointing: The joints shall be filled with cement mortar which shall be thoroughly rammed and caulked into the joints. No lines shall be pressed o the joint but the joints shall instead be merely rubbed smooth with the ‘Nayala as soon as the mortar has begun to set. The extra mortar on the edge shall be carefully scraped off to give a neat appearance. Pointing shall be carried out as rapidly as possible and not touched again after the mortar has once begun to set.

4.3 Pressed Pointing: The joint shall be pressed with special trowel ‘Nayala as soon as the mortar has begun to set and the hollow spaces refilled with fresh mortar to consolidate in the joints shall be rubbed with Nayalas till they are about 5 mm deep into the masonry. After rubbing, the extra mortar of the edges of the joint shall be rubbed with Nayalas till they are about 5 mm deep into the masonry. After rubbing, the extra mortar of the edges of the joint shall be carefully scraped off with the nose of the trowel to give a neat finish.

5.0 WEEP HOLES

Weep holes of suitable sizes as directed by the Engineer -in-charge shall be provided in the walls as and where directed through the full width of masonry. The sides of weep holes shall be formed as uniform as possible, by using flat faces of stones around the holes. The holes shall have the bedding at the specified grade. The opening of each weep hole on the file side shall be covered by graded materials by the seeping water.

PART – 109: FLOORING AND ALLIED WORKS

1.0 SCOPE

These specifications cover flooring, skirting, dado or cladding works using different types of stone / slabs / tiles as detailed hereunder.

2.0 GENERAL

The provision of the latest revisions of the following IS Codes shall form a part of this specification to the extent they are relevant.

IS 269 Specification for ordinary, rapid hardening and low beat Portland cement

IS 383 Specification for coarse and fine aggregate from natural sources for concrete

IS 777 Specification for glazed earthenware tiles

IS 1200 Part XI Method of measurements for Building and Civil Engg. Works, paving, floor finishes, dado & skirting

IS 1237 Specification for cement concrete flooring tiles

IS 1443 Code of practice for laying and finishing of cement concrete flooring tiles

IS 2541 Code of practice for use of lime concrete in buildings

IS 2571 Code of practice of laying in situ cement concrete flooring

IS 10067 Material Constants in Building work

Other IS Codes not specifically mentioned here, but pertaining to floor finishes form part of these specifications.

3.0 INDIAN PATENT STONE FLOORING

3.1 MATERIALS

Cement concrete. The cement concrete shall generally conform to specifications for ordinary concrete. The coarse aggregates shall be carefully selected. Sufficiently tough and hard stone pieces broken in a manner that will provide particles of approximately cubical shape affording good interlocking. The maximum size of coarse aggregate shall be 12 mm. The fine aggregate shall consist of properly graded particles. The proportion of mix shall be M20 (1:1.5:3). The least amount of mixing water that will produce a workable mix and will allow finishing without excessive troweling shall be used. Generally a water cement ratio of 0.5 should suffice.

3.2 WORKMANSHIP

3.2.1 The sub-grade in all cases shall be formed to proper levels and slopes, well compacted and cured. The top surface shall be kept slightly rough.

3.2.2 The surface of the sub-grade shall be cleaned off all loose material and moistened immediately before laying the concrete floor. The concrete flooring shall be laid in alternate bays not exceeding 6.25 sq.m. (about 67 sf. ft.) each. The edge of each panel into which the floor is divided should be separated by flat bars of Glass. Their depth shall be the same as that proposed for the finished floor as mentioned in the item.

3.2.3 The concrete shall be laid immediately after mixing. While being placed the concrete shall be vigorously sliced and spaded with suitable tools to prevent formation of voids or honey comb pockets. The concrete shall be brought to the specified levels by means of a heavy straight edge resting in the side forms and drawn ahead with a sawing motion in combination with a series of lifts and drops alternating with small lateral shifts. While concreting the adjacent bays care shall be taken to ensure that the edges of previously laid bays are not broken by careless or hard tamping.

3.2.4 Immediately after laying the concrete, the surface shall be inspected for high or low sports and any needed correction made up by adding or removing the concrete. After striking off the surfaces to the required grade concrete shall be compacted with a wooden float. The blows shall be fairly heavy in the beginning but as consolidation takes place, light rapid strokes shall be given to complete the ramming. The floating shall be flowed by steel trowel after the concrete has hardened sufficiently to prevent excess of fine material from working to the surface. The finish shall be brought to a smooth and even surface free from defect and blemishes and tested with straight edges. No dry cement or mixture of dry cement and sand shall be sprinkled directly on the surface of the concrete to absorb moisture or to stiffen the mix. After the concrete has been rammed and has dried sufficiently, the surface shall be rendered with a thin coat of 1:1 cement mortar with fine sand and uniformly floated. If so directed by the ER/PMC, approved mineral colour pigment conforming to appendix-B of IS 657 shall be added to the cement mortar to give the required colour and shade to the flooring. The junctions of floor and walls shall be rounded off if so directed, without any extra payment.

3.3 FINISHING

3.3.1 When the rendering is somewhat stiff, neat cement may be sprinkled on sparingly though a paper pot on the surface and rubbed lightly to give smooth polished ordinary cement coloured surface.

3.3.2 If coloured flooring is required by the Engineer-in-Charge the approved coloured cement shall be used Surface shall be protected from direct sun when it is green.

3.4 CURING

Curing shall start on the next day after finishing and shall be continued for 14 days.

4.0 FLOOR HARDENER TOPPING

4.1 MATERIALS& WORKMANSHIP

Floor hardener topping shall be provided either as integrally finished over the structural slab/ grade slab or laid monolithically with the concrete/ granolithic floor finish on top of hardened concrete base.

Floor hardener of the metallic or non-metallic type suitable for the performance of normal/ medium/ heavy duty function of the floor, the quantum of ingredients and the thickness of topping shall be as specified in the respective items of work.

For monolithic application with the floor finish/ slab the thickness of the layer shall be 15 mm. The topping shall be laid within 2 to 3 hours after concrete is laid when it is still plastic, but stiffened enough for the workmen to tread over it by placing planks. The surface of the concrete layer shall be kept rough for providing adequate bond for the topping. Laitance shall be removed before placing the topping. The topping shall be screened and thoroughly compacted to the finished level. Trowelling to a smooth finish shall be carried out as per clause 1.19.2. After the surface has hardened sufficiently, it shall be kept continuously moist for atleast 10 days.

The procedure for mixing the floor hardener topping shall be as per manufacturer's instructions.

Surface shall be prevented from any damages due to subsequent building operations by covering with 75 mm thick layer of sand.

5.0 PVS SHEET / TILE FLOORING

5.1 MATERIALS

PVC floor covering shall be of either unbacked homogeneous flexible type in the form of sheets/ tiles conforming to IS: 3462 or homogeneous PVC asbestos tiles conforming to IS: 3461.

The surface of the sheets/ tiles shall be free from any physical defects such as pores, blisters, cracks, etc., which affects the appearance and serviceability. Tiles/ sheets shall meet with the tolerance limits in dimensions specified in the IS codes. Contractor shall submit the test certificates, if so desired by the Engineer.

Each tile/ sheet shall be legibly and indelibly marked with the name of the manufacturer or his trade mark, IS certificate mark and batch number.

The adhesive to be used for laying the PVC flooring shall be rubber based and of the make as recommended and approved by the manufacturer of PVC sheets/ tiles.

The type, size, colour, plain or mottled and the pattern shall be as specified in the respective items of work.

5.2 WORKMANSHIP

PVC floor covering shall be provided over an underbed of cement concrete floor finish over the base concrete or structural slab. It is essential that the sub-floor and the underbed are perfectly dry before laying the PVC flooring. This shall be ensured by methods of testing as stipulated in Appendix-A of IS: 5318.

The surface of the underbed shall have trowelled finish without any irregularities, which creates poor adhesion. Surface shall be free of oil or grease and thoroughly cleaned of all dust, dirt and wiped with a dry cloth.

PVC sheets/ tiles shall be brought to the temperature of the area in which they are to be laid by stacking in a suitable manner within or near the laying area for a period of about 24 hours. Where air-conditioning is installed, the flooring shall not be laid on the underbed until the A/C units have been in operation for atleast 7 days. During this period, the temperature range shall be between 200.C and 300.C and this shall be maintained during the laying operations and also for 48 hours thereafter.

Layout of the PVC flooring shall be marked with guidelines on the underbed and PVC tiles/ sheets shall be first laid for trial, without using the adhesive, according to the layout.

The adhesive shall be applied by using a notched trowel to the surface of the underbed and to the backside of PVC sheets/tiles. When the adhesive has set sufficiently for laying, it will be tacky to the touch, which generally takes about 30 minutes. The time period need be carefully monitored since a longer interval will affect the adhesive properties. Adhesive shall be uniformly spread over only as much surface area at one time, which can be covered with PVC flooring within the stipulated time.

PVC sheet shall be carefully taken and placed in position from one end onwards slowly so that the air will be completely squeezed out between the sheet and the background surface and no air pockets are formed. It shall then be pressed with a suitable roller to develop proper contact. The next sheet shall be laid edge to edge with the sheet already laid, so that there is minimum gap between joints. The

alignment shall be checked after each row of sheet is completed and trimmed if considered necessary.

Tiles shall be laid in the same manner as sheets and preferably, commencing from the centre of the area. Tiles should be lowered in position and pressed firmly on to the adhesive with minimum gap between the joints. Tiles shall not be slided on the surface. Tiles shall be rolled with a light wooden roller of about 5 kg to ensure full contact with the underlay. Work should be constantly checked to ensure that all four edges of adjacent tiles meet accurately.

Any excess adhesive, which may squeeze up between sheets/ tiles shall be wiped off immediately with a wet cloth. Suitable solvents shall be used to remove hardened adhesive.

A minimum period of 24 hours shall be given after laying for the development of proper bond of the adhesive. When the flooring is thus completed, it shall be cleaned with a wet cloth soaked in warm soap solution.

Metallic edge strips shall be used to protect the edges of PVC sheets/ tiles, which are exposed as in doorways/ stair treads.

Hot sealing of joints between adjacent PVC sheet flooring to prevent creeping of water through the joints shall be carried out, using special equipment as per manufacturer's instructions.

6.0 FALSE OR CAVITY FLOORING

6.1 FRAME WORK

The false floor shall consist of a framework of suitable structural members designed to carry the loads specified. This frame work shall be supported on suitably designed stools placed at 600 mm centre to centre in both directions. The stools shall consist of a mild steel base plate with a mild steel stud having adjustable lock nut and coupling at the centre and another mild steel plate at top serving as a prophead. The above framework shall be suitably designed to accommodate 35 mm thick, 600 mm square panels. The base plate shall be fixed to the reinforced concrete floor with an approved adhesive compound or with 4 nos. 6 mm dia. anchor fasteners. Bedding of 1:2 or richer cement sand mortar shall be provided locally under the base plates of stools to provide a level surface.

The prophead shall be provided with mild steel lugs welded on top and each placed perpendicular to the other for proper positioning and supporting the main and cross members. The stools shall be capable of adjustment to accommodate concrete floor level irregularities upto plus or minus 15 mm. The framing members shall be completely removable and shall remain in position without screwing or bolting to

the propheads. All steel framework including steel stools shall be given a coat of zinc chromate primer and two coats of enamel paint of approved colour and shade.

6.2 FLOOR PANELS

The floor panels shall be made of 600 mm x 600 mm x 35 mm thick medium density unveneered/ non-prelaminated teak wood particle boards having a density of not more than 800 kg/m3 bonded with boiling water proof phenol formaldehyde synthetic resin and shall be of fire resistant, termite resistant and moisture proof quality, generally conforming to IS: 3087-specification for wood particle boards (Medium Density) for general purposes.

The thermal conductivity of the boards shall not exceed 0.12 k Cal/hr/sqm/deg/C/m.

The panel size given above may be suitably modified near electrical panel/ equipment and also to suit room dimensions with panel size not more than 600 mm under any circumstances. Exposed 2 mm thick vinyl edging shall be provided on all edges of individual panels. Each panel shall be given a coat of primer and two coats of approved fire resistant paint from underside.

The particle boards shall be faced with 600 mm x 600 mm x 2 mm thick approved make flooring tiles conforming to IS: 3462 and of approved colour and shade. The completed panel shall be completely removable and shall remain in position without screwing or bolting to the supporting framework. Each floor panel shall be marked on the inner side with stickers for easy identification and reassembly whenever required.

Suitable backing material shall be provided on the underside of the particle board to prevent warping and/ or to cater to specified loading.

Suitable removable covers shall be provided to serve as outlets for the cables.

6.3 FINISHED HEIGHT OF FALSE FLOORING

The finished height from top of reinforced concrete floor to the finished floor surface of false/ cavity floor shall be as specified or as shown on drawings.

6.4 RAMP and STEPS

Ramps and steps shall be provided as shown on the Engineer's drawing and as directed by the Engineer without any extra cost to the Owner.

6.5 IMPOSED LOADING

The finished floor shall be capable of supporting a uniformly distributed loads of 500 to 1000 Kg/ m2 of floor area as specified in data sheet. A point load of 450 Kg/

m2 on 600 mm2 on any part of the panel or a line load of 725 Kg on 100 mm strip across the panel length shall not result in a deflection greater than 2.5 mm.

6.6 FINISH

The finished floor shall be true to lines and levels and present a neat flush surface.

6.7 GENERAL

Supply shall be made by a specialist supplier who is to be approved by Engineer. Supplier shall prepare and submit a layout drawing for false floor giving all details including supporting system for approval. If so called for, supplier shall also submit his calculations for the supporting system with all relevant data assumed, to the Engineer for his approval. Work shall be carried out on approved drawings only.

7.0 GLAZED TILES

7.1 The tiles shall be of first quality and shall generally conform to IS: 777. These shall be flat, and true to shape and free from cracks, crazing, spots, chipped edges and corners. The glazing shall be of uniform shade and shall be provided in Dado of kitchen and toilets. The tiles shall be set over screed/ plaster 12mm thick with cement mortar 1:3 (1 cement: 3 coarse sand) to all surface, set and jointed with neat white cement slurry. The joints shall be neat and fine. Tiles face shall be kept flush with the skirting below.

7.2 Size of glazed tiles both for toilets, Baths, WC and kitchen shall be as shown on drawings.

7.3 The colour of tiles shall be white/coloured as approved by ER/PMC

7.4 Height of glazed tiles dado above skirting in toilets and in kitchen, above kitchen platform shall be as shown on the drawings.

8.0 FINISH OF WORKING PLAT FORMS IN KITCHENS/PANTRY

8.1 GRANITE PANTRY COUNTERS ON CUDDAPAH BACKING

Providing and fixing 600mm wide pantry counter with top made of 20mm thick pre-polished granite slab top of approved shade laid on 25mm thick one side polished Cuddapah on a bed of cement mortar 1:4, 25mm thick, supported on 20mm thick both sides polished Cuddapah verticals as directed. Providing, 100mm high front facia and 150mm high band above the counter top of same shade granite. All exposed surfaces of plat form to be finished in same granite slab. Necessary cut-outs for sink to be provided and all cut-outs, exposed edges to be half round bull nosed with mirror polished. Cost to also include making necessary cut-outs for taking pipes through counter top. Cost of Pre-Polished Granite Rs. 1800/Sqm. Mode of measurement to be in Running Meter

8.2 GRANITE PANTRY COUNTER ON MARINE BACKING

Providing and fixing 600mm wide pantry counter with top made of 20mm thick pre-polished granite slab top of approved shade laid on 20mm thick marine ply backing, supported on 19mm thick marine ply verticals as directed. Providing, 100mm high front facia and 150mm high band above the counter top of same shade granite. All exposed surfaces of plat form to be finished in same granite slab. Necessary cut-outs for sink to be provided and all cut-outs, exposed edges to be half round bull nosed with mirror polished. Item to include making necessary cut-outs for taking pipes through counter top.

8.3 GRANITE PANTRY COUNTERS ON MARINE BACKING WITH SS SUPPORTS

Providing and fixing 600mm wide pantry counter with top made of 20mm thick pre-polished granite slab top of approved shade laid on 19mm thick marine ply backing, supported on SS legs 50mm dia, 3mm thick as directed. Providing, 100mm high front facia and 150mm high band above the counter top of same shade granite. All exposed surfaces of platform to be finished in same granite slab. Necessary cut-outs for sink to be provided and all cut-outs, exposed edges to be half round bull nosed with mirror polished. Item to also include making necessary cut-outs for taking pipes through counter top.

9.0 POLISHED KOTA STONE FLOORING

9.1 GENERAL

The Kota stone slabs shall be machine polished and of selected quality, hard, sound, dense and homogeneous texture, free from cracks decay watering and flaws. They shall be machine cut to the requisite thickness. The edges shall truly vertical. The colour of the slabs will be approved by the ER/PMC, before starting of work. The slabs shall have the top (exposed) face polished before being brought to site. The slabs shall conform to the size required. The thickness of the slabs shall be 20 / 25mm.

9.2 DRESSING

Every slab shall be cut to the required size and shape and fine chisel dressed in the edges to the full depth. The edges shall be table rubbed with coarse sand or machine rubbed before paving. All angles and edges shall be true and square and the surface shall be true and plane.

9.3 PREPARATION OF SURFACE AND LAYING

The sub grade concrete or RCC slab on which the kota stone slabs are to be laid shall be cleaned, wetted and mopped. The bedding shall be with cement mortar of an average thickness of 20mm and mix 1:4 (1 cement: 4 coarse sand) over this bedding, neat grey cement slurry of honey lie consistency shall be spread. The edges shall be pasted with cement slurry @ 4.4 Kgs. of cement per sqm. mixed with pigment to match the shade of the slabs. The joints shall be kept as thin as possible.

9.4 POLISHING AND FINISHING

The floor shall then be kept wet for a minimum period of seven days. The surface thereafter shall be grounded with machine fitted with grit block No. 60, then No. 120 and finally with No. 320. Between every two successive grindings the surface shall be washed, cleaned and covered with a thin coat of grey cement in order to fill any pin hole that appear. After the final polish oxalic acid shall be dusted over the surface at the rate of 33 gm. per square metre sprinkled with water and rubbed hard with mamdah block (pad 7% woolen rags) the following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

10.0 **POLISHED KOTA STONE IN RISERS, TREADS AND SKIRTING**

10.1 The kota stone slabs for skirting shall be as specified in clause 10 above and of thickness 20 mm for risers& treads. The height of skirting shall be 100mm high.

10.2 Preparation of surface and laying: The surface shall be chipped off the projections/ productions if any cleaned and wetted 12mm thick plaster of cement mortar 1:3 (1 cement: 3 coarse sand) shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal lines 2mm deep at approximately 7.5 cms. centre both ways. The back and edges of the stone slabs shall be buttered with a coat of grey cement slurry and set in the bedding mortar.

10.3 Cutting, Polishing and finishing: Cutting, grinding and polishing of skirting shall be done in the same manner as of flooring but by hand.

11.0 **CERAMIC TILES (ANTI SKID OR GLAZED) / VITRIFIED TILES**

11.1 GENERAL

Ceramic tiles (Anti Skid/Glazed) shall be 300mm x 300mm x10 mm. thick in size, Vitrified tiles to be 600 mmx600 mm x10 mm / 1000 mm x 1000 mm x 10 mm thick or as specified in the Item and of best quality, Indian make obtained from approved manufacturer. The tiles shall be sound, hard, well and evenly treated, free from twist, with fine and sharp edges. Sample of the tiles shall be first got approved by the ER/PMC and all the tiles which shall be used in the work shall strictly conform to the approved sample otherwise all the tiles will be rejected. The surface to be laid for the flooring or dado shall be thoroughly hacked, joints of masonry racked, cleaned of all mortar scales, concrete" lumps, loose materials, etc. and washed to remove mud, dirt, etc. from the surface. Unless and until the surface is approved by the PMC the flooring and dado shall not be started. The prepared surface shall be thoroughly drenched with water.

11.2 FLOORING

11.2.1 A bedding 20 mm thick (unless otherwise specified) of cement mortar 1:3 shall be laid evenly to levels or slope as directed, The tiles shall then be laid on the bedding with a backing of thin cement paste. All tiles shall be truly and evenly set and

pressed in position to obtain a uniform plane surface. The tiles shall be closed jointed and all joints shall be uniform and run in perfect straight lines. Joints shall be filled with matching cement paste. Entire finished surface shall be thoroughly cleaned to remove all cement stains, etc. The joints shall be kept wet for 7 days. Size of Vitrified tiles both for toilets, Baths, WC and kitchen shall be as shown on drawings.

11.2.2 The colour of tiles shall be white/coloured as approved by ER/PMC

11.3 CERAMIC /VITRIFIED TILE SKIRTING

11.3.1 Where shown/indicated in the drawing/ schedule of finishes shall be provided 100mm high over 10mm thick cement mortar 1:3 (1 cement : 3 coarse sand) and jointed with white cement paste pigmented to the tile shade.

11.3.2 The tile to be protected with plastic & POP board/ PVC bubble sheet as specified by the ER/PMC.

11.4 DADO

The prepared surface shall be plastered with cement mortar 1:3 to get a bedding of 12mm thick. The plastered surface shall be even, uniform and true to plumb. The tiles shall be fixed in position with a backing of cement paste or water proof adhesive of approved manufacturer as specified in the item. All tiles shall be evenly set and pressed in position to a true plane surface. The specifications for workmanship shall be exactly similar to tile flooring. The tiles shall be closed jointed and all joints shall be uniform and run in perfect straight lines. Joints shall be filled with matching cement paste. Entire finished surface shall be thoroughly cleaned to remove all cement stains, etc.

12.0 VDF FLOORING ('TREMIX' OR EQUIVALENT)

Providing & laying in position and compaction as specified machine mixed, plain cement concrete of grade M20 using maximum 20 mm downgraded coarse aggregate using Vacuum Dewatering procedure "TREMIX or Equivalent" including all necessary dewatering, form work, casting in panels of specified size and thickness, wherever necessary, to shape and depth as specified curing, etc., complete for any specified thickness, cutting grooves, filling joints etc

Specification to be inclusive of:

12.1 Steel form work with steel channel sections as approved by ER/PMC, mechanical vibration using needle and screed vibrators.

12.2 Vacuum dewatering and Curing

12.3 Cutting mechanically the dummy joints of 6mm wide and up to 0.33 times depth within 24hours - 36 hrs after casting the slab. The dummy joints are at approx 4m x 4m grids.

12.4 Filling the grooves for joints with approved primer and approved joint sealing compound. The joint sealant will be filed flush with PCC surface.

12.5 The joints will be kept filled with thermocol immediately after cutting and before filling, the same shall be removed & joints cleaned thoroughly with compressed air etc as directed.

12.6 The acceptable level difference of VDF shall be only maximum 5mm at entire length.

13.0 SCREED AS BASE FLOOR IN OFFICE AREAS

The entire office areas inclusive of passages, Stair Landings to be provided with average 62mm thick Cement Concrete with cement concrete 1:1.5:3 laid in alternate panels of sizes 3m x 3m etc., all materials and labour complete. Surface to leveled uniformly and roughened to receive the top finished surface.

14.0 EXPANSION JOINT TREATMENT ON HORIZONTAL SURFACE

The requirement for expansion joint to be as per structural drawing. The expansion joint cover for horizontal joints to be as indicated in sketch below. Shop drawing along with the performance criteria to be submitted to ER/PMC for prior approval.

15.0 EXPANSION JOINT TREATMENT ON VERTICAL SURFACE

The requirement for expansion joint to be as per structural drawing. The expansion joint cover for vertical joints to be as indicated in sketch below. Shop drawing along with the performance criteria to be submitted to ER/PMC for prior approval.

B = as per manufacturers Specification approx size – 300mm

A = as per structural requirement.

16.0 URINAL PARTITION (GRANITE STONE SLAB)

Urinal partition to be made of 20mm thick both sides Pre-polished granite of approved shade inclusive of full round bull nosing on the edges with mirror polish. Size of granite partitions 600x1200mm (Overall). For design please refer detailed drawings.

PART – 11: PLASTERING & POINTING

1.0 GENERAL

1.1 SCAFFOLDING

Scaffolding shall be double and shall be erected with steel sections or pipes of adequate strength so as to be safe for construction operations. The contractor shall take all measures to ensure the safety of the work and working people any instructions of the Engineer in this respect shall also be complied with. The contractor shall be entirely responsible for any damage to properly or injury to persons resulting from ill erected scaffolding, defective ladders and materials or otherwise arising out of his default in this respect. Proper scaffolding shall be provided to allow easy approach to every part of the work. Overhead work shall not be allowed.

1.2 TOOLS AND ACCESSORIES

Tools and accessories used in plasterwork shall conform to IS: 1630. All tools shall be cleaned by scrapping and washing at the end of each day's work or after use. Metal tools to be cleaned after each operation. All tools shall be examined to see that they are thoroughly cleaned before plastering is begun.

1.3 PROGRAMME OF WORK IN RELATION TO PLASTERING

The programme of other building operations before, during and after plastering shall be according to the instructions contained in clause 9 of IS: 1661.

1.4 GENERAL PRECAUTION IN PLASTERING

All general precautions as specified in IS. 1661, Clause 9, shall be taken and preparation of the background shall be done as laid down in IS: 1661, Clause 13. Care shall be taken to see that other parts of the work or adjacent works are not damaged while plastering. **Making good of chases made for electrical conduit laying shall be in the scope of electrical contractor.**

1.5 PREPARATORY WORK

All joints in the face work that is to be plastered shall be raked out to depth equal to not less than the width of the joints or as directed by the Engineer. The raking shall be done taking care not to allow by chipping of masonry. In new work the raking out shall be done when the mortar in the joints is still green. Smooth surfaces of concrete, old plaster, etc. most be suitably roughened to provide necessary bond for the plaster. All dirt, soot, oil paint or any other material that might interface with satisfactory bond shall be removed. In the case of stone masonry, scrubbing on the walls to receive the plaster shall not be more than 12 mm (1 ½"). The surface to be plastered shall be cleaned and scrubbed with fresh water and kept wet for 6 hours prior to plastering. It shall be kept damp during the progress of the work. The

plastering shall be commenced unless the Engineer passes the preparatory work in writing.

1.6 GAUGES

Patches of plaster 15 cm x 15 cm shall be put on about 3 m apart as gauges to ensure even plastering in one plane.

1.7 WORKMANSHIP

1.7.1 Plastering

In all plaster work the mortar shall be firmly applied with somewhat more than the required thickness and well pressed into the joints and on the surface and rubbed and leveled with a flat wooden rule to give required thickness. Long straight edges shall be freely used to give perfectly plane and even surface. All corners most be finished to their true angles or rounded as directed by the Engineer. The surface shall be finished to plane or curved surface as shown on the plan or directed by the Engineer, and shall present a neat appearance. The mortar shall adhere to the masonry surface intimately when set and there should be no hollow sound when struck. Cement plastering should be done in squares or strips as directed. Plastering shall be done from top downward. Plaster on internal surfaces of wet areas will have to be done with integrated waterproofing compound mixed with cement mortar at no extra cost.

1.7.2 First or Backing Coat

The first coat of the specified thickness shall be applied as described above. The subsequent coat shall be applied after this coat has been allowed to set for 3 to 5 days depending upon weather conditions. The surface shall not be allowed to dry during this period.

1.7.3 Plastering to Ceiling

Projecting burns 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 surface shall be poke marked with a pointed tool at spacing of not more than 50 mm centers, the pokes being made not less than 3 mm deep, to ensure a proper key for the plaster. The mortar shall be washed off and surface cleaned of all oil, grease etc., and well wetted before the plaster is applied. These specifications cover the use of Brick Masonry for the structural purposes

2.0 **SAND FACED PLASTER IN CEMENT MORTAR (APPLICABLE FOR FACADE WHERE THERE IS NO CLADDING MATERIAL AS EXTERNAL FINISHED SURFACE)**

2.1 BASE COAT

2.1.1 The base coat plaster shall be of cement mortar 1:4, Waterproofing compound of approved make shall be added according to the manufacturer's instructions to make the mortar waterproof.

2.1.2 The plaster with this mortar shall be laid as specified above with a thickness of not more than 40mm for brickwork and concrete surfaces, and 15 mm for rubble stone masonry. Keys shall be formed on the surface by thoroughly combing it with wavy horizontal lines about 12 mm apart and about 3 mm deep when the mortar is still plastic. The base coat shall be cured for not less than 2 days.

2.2 SAND FACED TREATMENT

The cement mortar for sand faced plaster shall have washed Kharasalis or similar type of approved sand with slightly larger proportion of coarse material. The proportion of cement to sand shall be 1:4. The water is added gradually to make the mixture homogeneous. The thickness of finishing coat shall not exceed 7 mm. After application, the surface should be finished with a wooden flat, lined with cork and tapped gently to retain a coarse surface texture. When the finishing coat has hardened, the surface shall be kept moist continuously for 14 days.

3.0 **ROUGH COAT CEMENT PLASTER WITH CEMENT MORTAR**

3.1 BASE COAT

The first coat of plaster shall be of cement mortar of 1:4 mix and applied according to the relevant provisions of IS: 1661 Clause 14.1 The finished thickness of the first coat shall be 12 mm for brick masonry or concrete surface and 1 4 mm for rubble stone masonry. The plaster shall be laid by throwing the mortar (by using a strong whipping motion) on the prepared surface with a trowel in a in a uniform layer, and pressed to form a good bond. The surface shall be roughened.

3.2 SECOND COAT

The second coat shall be the rough coat mixture consisting of aggregate, which may vary in size from 5 to 8 mm and may consist of specially graded mixture mixed with fine sand and cement. The proportion of cement to sand and aggregate shall be 1:1 ½:3. It shall be flung upon the first coat with large t rowels to form an even protective coat. The second coat must be applied while the first coat is still soft and plastic. The work shall generally conform to clause 16.5 of IS: 166. The thickness of the coat shall be about 12 mm.

4.0 **SMOOTH INTERNAL PLASTER**

Applying one coat, 12mm thick Plaster on Internal surfaces of RCC/ brick/block walls in cement mortar 1:5, finished smooth with extra cement finishing, with cement not less than 2.2 kg per sqm. Scope shall include for scaffolding. grooves, sills, pattas, curing, surface preparation before the application of plaster, providing galvanised chicken wire mesh as mentioned in the notes above to a width of

150mm at the junctions of masonry and concrete works including tying in position by using suitable nails / clamps / screws and as directed etc. complete at all levels. The contractor shall make good the grooves, pockets etc. after the scaffolding is removed.

PART – 12: PAINTING

1.0 SCOPE

These specifications cover the use of paints for the plastered and concrete surfaces. It also includes the painting of wood and metal surfaces.

2.0 GENERAL

The provisions of the latest revisions of the following IS: Codes shall form a part of this specification

IS: 63 Whiting for Painting Ready mixed paint, brushing, grey filler, for Enamels, for use over primers

IS: 426 Specification for paste filler for colour coats

IS: 428 Specification for Distemper, Oil Emulsion, colour as required.

IS: 710 Marine Plywood

IS: 1200 (Part XIII) Method of Measurement of Building & Civil Engg Works –White Washing colour washing, distempering & other finishes

IS: 1477 (Part I) Code of practice for painting for ferrous metals in buildings Pretreatment

IS: 1477 (Part II) Code of practice for finishing of ferrous metals in building Painting

IS: 2338 (Part I) Code of practice for finishing of wood and wood based materials Operations and workmanship for finishing

IS: 2338 (Part II) Code of practice for finishing of wood and wood based materials, Schedule

IS: 2395 (Part I) Code of practice for painting concrete masonry and plaster surfaces Operation & workmanship

IS: 2395 (Part II) Code of practice for painting concrete masonry and plaster surfaces Schedule

IS: 159 Specification for ready mixed paint, brushing, acid resistant

IS: 2524 (Part I) Code of practice for painting of non-ferrous metal in building Pre-treatment

IS: 2524 (Part III) Code of practice for painting of non-ferrous metal in building Painting

IS: 3140 Code of practice for painting asbestos cement buildings

IS: 5410 Specification for cement paints, colour as required

IS: 15489-04 Specification for External Paint

Other IS Codes not specifically mentioned here, but pertaining to painting form part of these specifications.

3.0 MATERIALS

Materials shall strictly conform to the relevant IS: Specifications.

3.1 PLASTERED OR CONCRETE SURFACES

3.1.1 General

(a) Wherever scaffolding is necessary, it shall be erected in such a way that as far as possible no part of scaffolding shall rest against the surface to be painted.

(b) For painting on external surfaces secured double scaffolding to be used.

(c) Where ladders are used, pieces of old gunny bags shall be tied at top and cotton to prevent scratches to the walls and floors. For painting of ceilings, proper stage scaffolding shall be erected, where necessary.

3.1.2 Preparation of surfaces

(a) The surface shall be thoroughly cleaned off all dirt, dust, mortar dropping and other foreign matter, before paint is to be applied. New plaster surfaces shall be allowed to dry for at least 2 months, before applying paint. All unnecessary nails shall be removed. Pitting in plaster shall be made good with putty. The surface shall then be rubbed down again with a fine grade sand paper and made smooth.

(b) The surface shall be allowed to dry thoroughly before the regular cost of paint is allowed.

(c) The surface affected by mounds moss, fungi, algae lichens, efflorescence shall be treated in accordance with IS 2395 (Part I) before applying paint. The Adjoining surfaces/ finishes shall be protected with either masking tape / plastic to avoid damages to other finishes.

(d) The masking tape / plastic shall be removed without damaging the finishes.

4.0 POP / GYPSUM PLASTER

4.1 Preparation of Surfaces

4.1.1 Any smooth surface shall be hacked in order to make the surface rough as POP is always required to be applied on a rough surface for better strength and bonding.

4.1.2 All the back boxes, conduits etc. to be protected well in order to avoid damages to other services.

4.2 Leveling of the surface

All the surface of the wall / ceiling shall be leveled by maintaining a uniform surface with a tolerance level as per IS codes and corners to be 90 degree.

4.3 Application

4.3.1 POP / Gypsum plaster as per the approved list of make specified by the ER/PMC shall be mixed with water as per the approved technical specification and applied with a straight, clean, dry and smooth aluminum box section on clean and dry surface. Horizontal grid shall be given first and vertical grid shall be applied immediately afterwards. This entire operation will checked by the EIC.

4.3.2 The surface shall be finished as uniformly as possible leaving without undulation. It shall be allowed to dry for at least 48 hours, the moisture content should be completely dried and if any tracks are developed shall be repaired and finished.

5.0 OIL-BOND DISTEMPERING

5.1 PREPARATION OF SURFACES

Any unevenness shall be made good by applying putty, made of plaster of Paris mixed with water on the entire surface including filling up the undulation and then sand papering the same after it is dry.

5.2 PRIMER COAT

The primer where used as an undercoated surfaces shall be alkali resistance primer or distemper primer as specified in the item. These shall be of the same manufacture as of out bound distemper. If the wall surface plaster has not dried completely alkali resistance primer shall be applied before distempering the walls. But if the distempering is done after the wall surface is dried completely, distemper primer shall be applied.

5.3 APPLICATION

Primer shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one cost. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for at least 48 hours, before oil bound distemper or paint is applied.

5.4 PREPARATION OF OIL BOUND DISTEMPER WITH LOW VOC AS PER IGBC RATING

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 days work shall be prepared.

5.5 APPLICATION OF DISTEMPER COAT

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 printing coat. All loose particles shall be dusted off after rubbing. Minimum two coats of distemper shall be applied with brushes in horizontal strokes followed to immediately by vertical, which together shall constitute one coat. The subsequent coats shall be applied after a time interval of at least 24 hours between consecutive coats to permit the proper drying of the preceding coat.

5.6 The finished surface shall be even and uniform without patches, brush marks, distemper, drops, etc.

5.7 Sufficiently quantity of distemper shall be mixed to finish one room at a time. The application of a coat in each room shall be finished in one operation and no work shall be started in any room, which cannot be completed the same day.

5.8 15 cm. Double bristled distemper brushes shall be used. After each day's work, brushes shall be thoroughly washed in hot water with soap solution and hung down to dry. Old brushes that are dirty and caked with distemper shall not be used on the work.

6.0 WATER PROOF CEMENT PAINT

6.1 PREPARATION OF SURFACES

The surfaces shall be thoroughly wetted with clean water before the waterproof cement paint is applied.

6.2 PREPARATION OF PAINT

6.2.1 Portland cement paints are made readily by adding paint power to water and stirring to obtain a thick paste, which shall then be diluted to a brushable consistency. Generally equal volumes of paint powder and water make a satisfactory paint. In all cases the manufacturer's instructions shall be followed. The paint shall be mixed in such quantities as can be used up within an hour of mixing as otherwise the mixture will set and thicken, affecting flow and finish.

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

6.3 APPLICATION OF PAINT

6.3.1 No painting shall be done when the paint is likely to be exposed to a temperature of below 7 degree within 48 hours after application.

6.3.2 When weather conditions are such as to cause the paint to dry rapidly, work shall be carried out in the shed as far as possible. This helps the proper hardening of the paint film by keeping the surface moist for a longer period.

6.3.3 To maintain a uniform mixture and to prevent segregation the paint shall be stirred frequently in the bucket.

6.3.4 For undercoated surfaces, the surface shall be treated with minimum two coats of water –proof cement paint. Not less than 24 hours shall be allowed between two coats and the second or subsequent coat shall not be started until the preceding coat has become sufficiently hard to resist marking by the brush being used. In hot dry weather the preceding coat shall be slightly moistened before applying the subsequent coat.

6.3.5 The finished surface shall be even and uniform in shade without patches, brush marks, paint drops, etc.

6.3.6 Cement paints shall be applied with a brush with relatively short stiff hog or fibre bristles. The paint shall be brushed in uniform thickness and shall be free of excessively heavy brush marks. The laps shall be well brushed out.

6.4 CURING

Painted surfaces shall be sprinkled with water two or three times a day. This shall do between coats and for at least two days following the final coat. The curing shall be started as soon as the paint has hardened so as not to be damaged by the sprinkling of water, say about 12 hours after its application.

7.0 WHITE WASHING

7.1 GENERAL

7.1.1 The item refers to whitewashing over old and new concrete, stone masonry brick plastered surfaces and asbestos cement sheets.

7.1.2 White wash shall be prepared from fresh burnt white stone lime or shell lime. This lime shall be of class type as per IS: 712. Surkhi lime or lime of equivalent quality may be used. The lime shall be dissolved in a tub with sufficient quality of water (about 4.5 liters/Kg. Of line) and the whole shall be thoroughly mixed and stirred until it attains the consistency of thin cream. The white wash shall be taken out in small quantities and strained through a clear course cloth. Alternatively with IS: 63 may also be used. Clean gum dissolved in hot water shall then be added in suitable proportion of 2 gm of gum Arabic to a little of lime or whiting to prevent the white-wash coming off easily when rubbed. Rice may be used instead of gum.

7.2 SCAFFOLDING

This may be double or single according to requirements. If ladders are used, pieces of old gunny bags or cloth rags shall be tied on their tops to avoid damage or scratches to the wall. Proper stage scaffolding shall be created when whitewashing ceiling. The contract shall be responsible for accidents if any taken place.

7.3 PREPARATION OF SURFACE

7.3.1 The surface shall be prepared by removing all mortar dropping and foreign matter and thoroughly cleaned with wire or fiber brush or other means as may be ordered by the Engineer to produce an approved clean and even surface. All loose pieces and the scales shall be scraped off and holes stopped with mortar. In case where the surface has been previously colour washed, the old colour wash must be entirely removed before the white-wash is applied. In the case of surface, which has once been white-washed, the old loose white-wash shall be broomed down. In case, the loose whitewash cannot be removed by brooming, the Engineer may order scraping of the surface.

7.3.2 After cleaning the surface as specified above, the unwanted nails shall be removed and all nail holes, cracks and crevices stopped with mortar similar in composition to the surface to be stopped. The mortar should be cured.

7.4 APPLICATION OF WHITE-WASH

7.4.1 On the surface so prepared, the whitewash shall be laid. Each coat shall be laid on with a brush. The first stroke of the brush shall be form the top downward, another from bottom upwards over the first stroke, and similarly, one stroke from the right and another from the left over the first brush before it dries. This will from one coat. Each coat must be allowed to dry and shall be subject to inspection before the next coat is applied. When dry, the surface shall show no signs of cracking. It shall present a smooth and uniform finish free from brush marks and it should not come off easily when rubbed with a finger.

7.4.2 No portion in the surface shall be left out initially, to be patched up later on. For new work, the white washed surface shall present a smooth and uniform finish.

7.4.3 For old work, patches and repairs shall be white washed first. Thereafter, the whole surface shall be white washed with the required number of coats.

7.4.4 Doors, windows, floors and other articles of furniture, etc. shall be protected from being splashed upon. Splashing and droppings, if any, shall be removed and the surfaces cleaned.

7.5 PREPARING THE SURFACE FOR WHITE WASH INCLUDING THE SCAFFOLDING

Appling the white wash in required number of coats as specified above and prior white washing of repaired patched.

8.0 **PLASTIC EMULSION PAINTING ON WALL & CEILING**

8.1 GENERAL

Plastic emulsion paint are not suitable for application on external wood and iron surfaces and surfaces which are liable to heavy condensation and are to be used generally on masonry or plastered surfaces. Suitable primer as per manufacturer shall be provided.

8.2 PAINT

Plastic emulsion paint of approved brand and manufacture with low VOC as per IGBC rating and of the required shade shall be used.

8.3 PREPARATION OF SURFACE

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 undulation and then sand papering the same after it is dry.

8.4 APPLICATION

8.4.1 The number of coats shall be as stipulated in the item.

8.4.2 The paint will be applied in the usual manner with brush or roller.

8.4.3 The paint dries by evaporation of the water content and as soon as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surfaces to 2 to 3 hours on non-absorbent surfaces.

8.4.4 The thinning of emulsion is to be done with water and not with turpentine.

8.4.5 Thinning with water will be particularly required for the undercoat, which is applied on the absorbent surface. The quantity of thinner to be added shall be as per manufacturer’s instructions.

8.4.6 The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

8.5 PRECAUTIONS

8.5.1 Old brushes if they are to be used with emulsion paints should be completely dried of turpentine or oil paints by washing in warm soap water.

10.5.2 Brushes should be quickly washed in water immediately after use and kept immersed in water during break periods to prevent the paint from hardening on the brush.

8.5.3 In the preparation of walls for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.

8.5.4 Splashes on floors etc. shall be cleaned out without delay, as they will be difficult to remove after hardening.

8.5.5 Washing of surfaces treated with emulsion paints shall not be done within 3 to 4 weeks of application.

8.6 OTHER DETAILS

These shall be as per specification for “Painting” as far as they are applicable.

9.0 ACRYLIC PAINTING TO EXTERNAL SURFACES

9.1 GENERAL

9.1.1 Acrylic weather shield paint of low VOC as per the IGBC rating from the approved brand shall be applied over plastered surfaces as directed by the EIC.

9.1.2 Other specifications including preparation of surfaces, application of paint etc. shall conform to section 7.0 above and as directed by EIC. The primping coat, anti-fugal treatment, preparation of paint etc. shall be carried out as per manufacturer’s specification /as directed by EIC. General

9.1.3 Acrylic weather shield paint with IGBC rating of SEZ shall be applied on surfaces which are liable to external condensation and are to be used generally on masonry or plastered surfaces. Suitable primer as per manufacturer shall be provided.

9.2 PAINT

Acrylic weather shield paint with IGBC rating for SEZ of approved brand and manufacture as per the required shade shall be used.

9.3 PREPARATION OF SURFACE

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 external putty mixed with water on the entire surface including filling up the undulation and then sand papering the same after it is dry.

9.4 APPLICATION

9.4.1 The number of coats shall be as stipulated in the item.

9.4.2 The paint will be applied in the usual manner with brush or roller.

9.4.3 The paint dries by evaporation of the water content and as soon as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surfaces to 2 to 3 hours on non-absorbent surfaces.

9.4.4 The thinning of paint is to be done with water and not with turpentine.

9.4.5 Thinning with water will be particularly required for the undercoat, which is applied on the absorbent surface. The quantity of thinner to be added shall be as per manufacturer's instructions.

9.4.6 The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

9.5 PRECAUTIONS

9.5.1 Old brushes if they are to be used with paints should be completely dried of turpentine or oil paints by washing in warm soap water.

9.5.2 Brushes should be quickly washed in water immediately after use and kept immersed in water during break periods to prevent the paint from hardening on the brush.

9.5.3 In the preparation of walls for painting, no oil base putties shall be used in filling cracks, holes etc it should be only the external putties.

9.5.4 Splashes on floors etc. shall be cleaned out without delay, as they will be difficult to remove after hardening.

9.5.5 Washing of surfaces treated with emulsion paints shall not be done within 3 to 4 weeks of application.

9.6 OTHER DETAILS

These shall be as per specification for "Painting" as far as they are applicable.

PART – 13: WOODWORK AND JOINERY

1.0 SCOPE

The specifications refer to woodwork in general including carpentry and joinery work in the building.

2.0 GENERAL

The provision of the latest revisions of the following I.S. codes shall form a part of these specifications.

IS: 205 Specifications for non-ferrous metal butt hinges

IS: 287 Recommendation for maximum permissible moisture content of Timber used for different purposes

IS: 303 Specification for plywood for general purpose

IS: 362 Specification for parliamentary hinges

IS: 419 Specification for putty for the use on window frames

IS: 883 Code of practice for design for structural timber in building

IS: 1003 Specification for Timber paneled and glazed shutters part – II Window and ventilator shutters

IS: 1200 Method of measurement of building and Civil Part XXI Engineer Works – Wood Work and joinery

IS: 1341 Specification for steel butt hinges

IS: 1658 Specification for Fibre Hard Boards

IS: 1761 Specification for transparent sheet glass for glazing and framing purposes

IS: 3087 Specification for wood particle boards (medium density for structural timber in building

Other I.S. codes not specifically mentioned here, but pertaining to woodwork and joinery form part of these specifications.

3.0 MATERIALS

Timber to be used shall be first class Teak wood as per IS: 4021. Timber shall be of the best quality and well seasoned by a suitable process before being planed to the required sizes. The maximum permissible moisture content shall be from 10 to 16% for timber 50 mm and above in thickness and 8 to 14% for timber less than 50 mm in thickness for different regions of the country as stipulated in IS: 287. Timber shall be close grained, of uniform colour and free from decay, fungal growth, boxed

heart, pitch pockets or streaks on the exposed edges, borer holes, splits and cracks.

Flush door shutters of the solid core type with plywood face panels shall conform to IS: 2202 (Part 1) and with particle board/ hard board face panels shall conform to IS: 2202 (Part 2).

Builder's hardware for fittings and fixtures shall be of the best quality from approved manufacturers.

4.0 WORKMANSHIP

The workmanship and finish of wood work in doors shall be of a very high order. Contractor shall ensure that work is executed in a professional manner by skilled carpenters for good appearance, efficient and smooth operation of the shutters.

All works shall be executed as per the detailed drawings and/ or as directed by the Engineer.

All members of the door shall be straight without any warp or bow and shall have smooth well planed faces. The right angle shall be checked from the inside surfaces of the respective members of the frame. Frames shall have mortice and tenon joints which shall be treated with an approved adhesive and provided with metal or wood pins. The vertical members of the door frame shall project 50 mm below the finished floor level. The finished dimension of frames shall be rebated on the solid for keying with the plaster and for receiving the shutters. The depth of rebate for housing the shutter shall be 15 mm. The size of the frames shall be as specified in the respective items of work. The workmanship shall generally conform to the requirements specified in IS: 4021.

The face of the frames abutting the masonry or concrete shall be provided with a coat of coal tar.

Three hold fasts using 25 mm x 6 mm mild steel flats 225 mm long with split ends shall be fixed on each side of door frames, one at the centre and the other two at 300 mm from the top and bottom of the frame. For window and ventilator frames less than 1 m in height, two hold fasts on each side shall be fixed at quarter points.

Timber panelled shutters for doors shall be constructed in the form of framework of stiles and rails with panel insertion. The panels shall be fixed by either providing grooves in the stiles and rails or by beading. Glazing bars shall be as detailed in the drawings. The stiles and rails shall be joined by mortice and tenon joints at right angles. All members of the shutter shall be straight without any warp or bow and shall have smooth, well planed faces at right angles to each other. The right angle for the shutter shall be checked by measuring the diagonals and the difference shall not be more than ±3 mm. Timber panels made from more than one piece shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. The workmanship shall generally conform to the

requirements specified in IS: 1003 (Parts 1 & 2). The thickness of the shutter, width/ thickness of the stiles/ rails/ panel type shall be as specified. Marine plywood panels conforming to IS: 710 shall be used for doors where specified.

Details of the wooden flush door shutters, solid core type with specific requirement of the thickness, core, face panels, teak wood lipping, etc. shall be as specified. Panels of shutter shall be of marine plywood conforming to IS: 710. Flush door shutters shall be from reputed manufacturers and Contractor shall submit test results as per IS: 4020, if so desired by the Engineer.

Glazing of door shall be with either flat transparent sheet glass, wired or figured glass. Transparent sheet glass shall be of 'B' quality as per IS: 2835. The thickness and type of glazing to be provided shall be as specified in the item of work.

The properties of glass shall be as follows:

Type: Single pane pyrolytic solar control Low-2.

Minimum thickness: 6 mm

Visible light transmittance: 60%

U-Value (summer): 0.49 Btu/hr.sft.Deg F

Shading coefficient: 0.59

The material of the fittings and fixtures shall be either of chromium plated steel, cast brass, copper oxidised or anodised aluminium as specified. The number, size and type of the fittings and fixtures shall be as indicated in the drawings/ item of work.

Wood work shall not be provided with the finishes of painting/ varnishing, etc. unless it has been approved by the Engineer. The type of finish and the number of coats shall be as stipulated in the respective items of work.

Wooden hand railing and architraves shall be of the size and shape with the fixing arrangement as indicated in the drawings.

Any carpentry work which shows defects due to inadequate seasoning of the timber or bad workmanship shall be removed and replaced by Contractor with work as per Specifications at no extra cost to the Owner.

5.0 FLUSH DOOR SHUTTERS

5.1 GENERAL

The door shall be of flush type solid core with single or double shutter as the case may be.

5.2 SHUTTERS

The shutters shall be decorative or non-decorative type of the exterior or interior grade as described in the item and as shown in the drawings. It shall conform to the relevant specifications for the type and grade given in I.S. 2202/1983, specifications for Wooden Flush door shutter (solid core type). The finished thickness shall be as mentioned in the item. Face veneers used shall be of the pattern and colour approved by the engineer.

5.3 FIXTURES AND FASTENINGS

5.3.1 These shall be as shown in table on the drawings or as indicated in the specifications. Where it is not specified they shall be oxidized brass and shall be of good workmanship. All fixtures and fastenings shall be sound and strong. They shall be sectional and of the best quality. The size, shape, design and finish shall be as shown on drawings and approved by the Engineer.

5.3.2 Unless otherwise specified each leaf shall be hung with four hinges with screws. Each door shall be furnished with aldrop and latch, brass flush bolts, etc. the fixtures shall comply with the relevant Indian standards. Samples of all fixtures and fastening shall be got approved by the Engineer and deposited in his office for reference.

5.3.3 All the fixtures shall be fixed to the joinery in a secure and efficient manner. Metal sockets shall be provided to all bolts where the shoots enter, stone, concrete

6.0 **FIRE RATED WOODEN DOORS**

6.1 DOOR FRAME

Hard wood 120mm x 70mm with heat activated in tumescent fire seal strip of size 10mm x 4mm provided in grooves on all three sides with one coat of fire resistant primer.

6.2 DOOR

50mm thick non –metallic Asbestos free Fire Resistant doors conforming to BS: 476 Part 20 , 22 / IS : 3614 Part 2 as per proto type tested and certified at CBRI Roorkee suitable for mounting on above door frame. The shutter shall be made of non combustible vermiculite board of 35mm thick sand witched with Fire resistant insulation material, faced with 3mm thick teak ply on both the faces and Hard wood lipping all around the shutter with heat activated in tumescent fire seal strip of size 10mm x 4mm mounted on the grooves in the shutter on all sides except bottom.

6.3 HINGES

Heavy duty & shall be fixed to each door shutter.

6.4 DOOR HANDLES & HASP BOLTS

Door Handle and Hasp Bolts shall be as per the approved list of make / approved sample by the ER/PMC

6.5 VISION PANEL

Vision panels of size as per the detail drawing approved and two (1) hours fire rated doors shall be Borosilicate single clear toughened glass of as approved by the Engineer-in-Charge or its equivalent make to the thickness of 6mm. to withstand one hours fire rating.

6.6 DOOR HARDWARE

6.6.1 All door hardware shall be (1) hour fire rated. All fixtures and fastenings shall be sound and strong. They shall be sectional and of the best quality. The size, shape, design and finish shall be as shown on drawings and approved by the Engineer.

6.6.2 Unless otherwise specified each leaf shall be hung with four hinges with screws. Each door shall be furnished with aldrop and latch, brass flush bolts, etc. the fixtures shall comply with the relevant Indian standards. Samples of all fixtures and fastening shall be got approved by the Engineer and deposited in his office for reference.

6.6.3 All the fixtures shall be fixed to the joinery in a secure and efficient manner. Metal sockets shall be provided to all bolts where the shoots enter, stone, concrete etc.

6.7 TEST

Proto type Test and certified at CBRI Roorkee meeting all criteria such as Stability, Integrity & Insulation Size: 1100mm x 2100mm (Height) Approx. or As specified.

7.0 FIRE RATED STEEL DOORS

7.1 GENERAL

Fire door shall be 1 Hour / 2 hour fire rated and door quality shall be approved by CBRI and the door should be tested to conform the Performance Criteria as per IS: 3614 and should meet the requirements of CBRI. General purpose Door shall be as per Manufacturer's specification.

Unless otherwise specified, the door shall be provided to the height of 2100 mm. If the height specified as above 2100 mm and upto 3000 mm height, the options would be:

a) A man operation door upto 2100 mm high shall be provided with a removable / fixed panel on top as below: (ie. above 2100 mm level as below).

• Fire Door: Fully flush double skin steel panel construction to a total thickness of 46 mm.

• General purpose Door: Fully flush double skin steel panel construction to a total thickness of 46 mm or fixed Glazing Panel on the top with Single / Double glass panel.

b) The construction and finish of panel above 2100 mm level shall be designed similar to that of a shutter in case of flush panel in order to match the exterior finish.

7.2 DOOR FRAME

Frame shall be manufactured by using Galvanized steel sheets complying with latest IS 277. Galvanized coating shall be GPL grade Z 120 coating.

Fire Door and General Purpose door frame profile shall be as given below: • Fire Door - 2 Hour rating: Double rebate profile of size 143 x 57 mm (+/- 0.3) with bending radius of 1.4 mm.

• Fire Door - 1 Hour rating: Single rebate profile of size 100 x 57 mm (+/- 0.3) with bending radius of 1.4 mm.

• General Purpose Door: Single rebate profile of size 100 x 57 mm (+/- 0.3) with bending radius of 1.4 mm.

Frame shall be fabricated from galvanized steel sheet to the thickness specified below and to the specified profile and dimensions:

• Fire Door - 2 Hour rating : 16 Gauge or 1.6 mm thick.

• Fire Door - 1 Hour rating : 18 Gauge or 1.25 mm thick.

• General Purpose Door : 18 Gauge or 1.25 mm thick.

Frames fabricated at factory shall be in knock down form with butt joints for bolted assembly at site or as per manufacturer's Specification.

Frames shall be provided with 3 mm thick back plates on all jambs with provision for anchor bolt fixing to wall openings.

Frames shall be provided with hinge plates 3 mm thick pre-drilled to receive approved type and make of hinges for screw mounted fixing.

Frames shall have factory finish-pre-punched cut outs to receive specified type & make of hardware and iron mongery. All cut outs including hinge plates, strike plates to have mortar guard covers from inside to prevent cement,dust ingress into cut outs at the time of grouting of the frame.

Frames shall have reinforcement pads for fixing of door closer, locks and handles at appropriate location as per manufacturer's details.

Frames shall have plug-in type rubber silencer not less than 2 mm dia on the strike jambs for single shutter frames and on the head jambs for double shutter frames.

7.3 SHUTTER

Shutter shall be manufactured with double skins press formed by using Galvanized steel sheets complying with latest IS 277. Galvanized coating shall be GPL grade Z 120 coating.

Shutters should be press formed with double skins in such a way to get 46 mm thick double skin hollow door with lock seam joints at stile edges.

Fire Door and General Purpose door frame profile shall be as given below:

• Fire Door - 2 Hour rating : 18 Gauge or 1.25 mm thick.

• Fire Door - 1 Hour rating : 20 Gauge or 0.80 mm thick.

• General Purpose Door : 20 Gauge or 0.80 mm thick.

Shutters shall have no visible screws or fasteners on both face and internal reinforcement shall be provided at top, bottom and stile edges for desired fire rating.

Shutters shall be provided with honeycomb paper core as infill material and to be bounded to the inner faces of the shutter or as per Manufacturer's specification. Door should have been tested with Infill material proposed by the manufacturer and the same should have been approved by CBRI.

Shutters shall be provided with factory prepared and with pre-punched cutouts and reinforcement pads to receive the approved type and make of Hardware and Iron mongery. The shutter should have an interlocking arrangement at this stile edges for flat surface on either side.

Shutters shall have pre-drilled hinge plates with hinge guard covers.

Shutters with locks to have concealed lock box with lock fixing brackets with pretapped holes and screws.

Shutter shall have reinforcement pad at appropriate location to receive the locks, Door closer, Panic Bar, etc as per the approved type and make of Hardware and all as per manufacturer's design and conforming to Standards. Necessary provision / fixing arrangements shall be provided in the shutter as well as in the frame to receive / fix the Electromagnetic latch, Electromagnetic contact for hooter with reinforcement pads and in such a way to connect the same to the card access control system / IBMS. Fixing Details of the above latches shall be provided in coordination with IBMS agency.

Vision panel shall be provided as given below:

a) Fire rated Door (1 Hour / 2 Hour) - Provide Borosilicate single clear toughened glass of approved equivalent make to the thickness of 6 mm to with stand two hours fire rating.

b) General purpose Door - Provide Single / Double clear toughened glass of approved equivalent make to the thickness of 5 mm to the specified size and as per Manufacturer specification.

Glass to be fixed with clip on frames for square and rectangular vision panels and with spin turned rings for circular vision panels.

One side adhesive Glazing tape shall be provided in the frame to fix the vision panel glass in position and ensuring the stability of the fixing.

7.4 FINISH

a) Surface of the frame and shutter shall be cleaned suitably & thoroughly with solvents and as per manufacturer's specification.

b) Apply Zinc etch primer coating as shop coat to receive additional coat of primer and top coats.

c) Apply stove zinc phosphate primer (35 microns DFT) as additional coat.

d) Apply as finish coat and finish the surface neatly with thermo setting polyurethane paint (35 microns DFT) of approved colour and make.

7.5 WORKMANSHIP

7.5.1 FRAME:

a. Door frames should be assembled adjacent to the place of installation as per the Manufacturer's specification.

Frames are not allowed for transporting in an assembled condition. If the manufacturer is desired to transport the frames in an assembled condition, the frames should be designed suitably and adequate packing to be given prior to transport in order to avoid any damage, bending etc during transport. If any defects found during the installation, such frames will be summarily rejected and will not be allowed to use.

b. After assembly it is to be ensured that all threaded preparations / joints are covered by using 15 x 10 self adhesive sponge strips at the back of the frame to prevent penetration of grouting mortar into screw threads. The head member of assembled frame shall be positioned against jambs ensuring correct alignment and secured using M 8 x 20 mm long plated Stainless steel bolts together with nuts spring and flat washers. Frames to be assembled at site with aid of roofing bolts and the protective film shall not be removed during installation.

c. Assembled frame shall be kept in position within the opening by means of bracing. In order to correctly position the frame against finished floor level or equalize on adjustable floor anchors where specified, suitable strength PVC nylon

shim shall be used under jambs. The frame shall be checked for squareness, alignment, twist etc. with carpenters bevel and plumb.

d. A tie rod shall be fixed to the frame during installation to ensure the correct dimensions between the frame rebates and the same may be removed after installation.

e. Where re fixing the frame is necessitated, the required gap between frame and jambs shall be created to accommodate the PVC nylon shims in such a way to maintain the uniform frame level.

f. Methodology to be followed during the installation of the frames:

• Site survey shall be conducted to ensure the opening size and reveal the correct opening size prior to installation of the frames.

• Place the frame in position, brace, level etc.

• Mark all positions of fixings anchors on the wall / lintel.

• Remove frame and drill wall to appropriate fastener or anchor bolts size.

• Place and fit rod anchor shells metal expansion bolts into the wall.

• Place and fit jamb spacer bracket into back of frame profile.

• Reposition the frame back into opening and realign.

• Lightly tighten the CSK HD machine screws into shells.

• Check the position of the nylon shims placed behind frame to ensure the uniform gap between the frame and jamb.

• Slowly fasten the screws continually by checking the plumb, squareness etc. and finally ensure that the frames are not deformed while tightened.

• After fixing the frame in position, the frame shall be pressure grouted with cement slurry 1:3 ratio or filling the pre- cast solid block core to the frame profile as approved. The surface after grouting shall be neatly cleaned and to be ensured that there is no scratch in the door frames after grouting.

• Back fill the frame through holes provided and insert plug in type nylon plugs after cleaning the surface. Nylon plugs shall be provided to suit the frame finish and colour.

• Gap between the frame and masonry surface shall be grouted with cement slurry and sealed with Intumeasent sealant of approved make, if called for in the Bills of quantities.

7.5.2 SHUTTER:

a. Fix all the hardware to the door shutter like hinges, flush bolts, bolts, Mortise locks, Dead lock, handle, Push plate, Door closer, Door stoppers, etc. with the appropriate SS screws and bolts supplied.

b. The shutter is to be then fixed in to the installed frame and align the shutter to match the hardware to the cutouts in the frame. Tighten the hinge screws.

c. Clean the door jamb rebate surfaces of all dust, oil etc.

d. Affix self-adhesive 'FLAT' seal on the door frame rebates, on hinge jambs, strike jambs, head member, sill etc and affix 'FLAT' seal in the shutter by using self adhesive EPDM smoke seal 'FLAT' type (Polyethylene cross linked foam of size 2 mm thick and 12.5 mm width) of Monarch Make and as indicated by the manufacturer and if specifically called for in the bills of quantities.

7.6 TESTING / INSPECTION & GUARANTEE

During the process of manufacturing the Door by the agency, successful vendor shall arrange an inspection of the factory by the representative of Owner/OE & PMC/LA within the quoted rate. After installing the door, the Nominated sub Contractor shall test the performance of the Door Frame and Shutter in the presence of the Owner / OE & PMC. The doors shall be smoothly operable under all ambient conditions. All control, hard wares and locking devices shall give fault free performance.

A successful bidder shall arrange a test for one door with the specified hardware and place the door for testing in exactly the same way as fixed at site. The Owner / OE & PMC at random basis will select the door during the process or end of the manufacture and conduct the test at an approved laboratory in the presence of the representative of Owner / OE & PMC within the quoted rate and ensure that the door shall comply with the set out criteria.

8.0 ALUMINIUM SLIDING WINDOWS & LOUVERS

8.1 MATERIALS

Aluminum alloy used in the manufacture of extruded sections for the fabrication of doors, windows, ventilators shall conform to designation HE9-WP of IS: 733.

Transparent sheet glass shall conform to the requirements of IS: 2835. Wired and figured glass shall be as per IS: 5437. For glass properties refer to clause 1.8.2.

Builder's hardware of fittings and fixtures shall be of the best quality from approved manufacturers.

8.2 WORKMANSHIP

All windows shall be of the type and size as specified. and shall conform to IS: 1949, if so specified.

All aluminum units shall be supplied with matching Valspar, Fluropon Classic II Wisteria 3998799 anodised finish. The minimum anodic film thickness shall be 20 micron.

Windows shall be of an approved manufacture. Fabrication of the units shall be with the extruded sections, cut to correct lengths, mitred and welded at the corners to a true right angle conforming to the requirements of IS: 1948. Tolerance in overall dimensions shall be within ±1.5 mm. The frames and shutters shall be free from warp or buckle and shall be square and truly plane. Punching of holes, slots and other provisions to install fittings or fixtures later shall be made at the correct locations, as per the requirements.

Aluminum sliding windows, shall be as described in the items of work/ drawings.

IS: 1948 and IS: 1949 refers to incorporating the sizes, shapes, thicknesses and weight per running metre of extruded sections for various components of the units. However, new sizes, shapes, thicknesses with modifications to suit snap-fit glazing clips, etc. are continuously being added by various leading manufacturers of extruded sections, which are available in the market. As such, the sections of the various components of the unit proposed by the Contractor, will be reviewed by the Engineer and will be accepted only if they are equal to or marginally more than that given in the codes/ specified in the items of work.

The framework of the partitions with mullions and transomes shall be with anodised aluminium box sections. Anodised aluminium box sections shall be in-filled with timber of class 3 (silver oak or any other equivalent) as per IS: 4021. Panels of double/ single glazing/ plywood shall be fixed as per details indicated in the drawings. Partitions shall be fixed rigidly between the floor and the structural columns/ beams including provision of necessary shims for wedging, etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction drawings.

Specific provisions as stipulated for windows shall also be applicable for this item work. Glazing beads shall be of the snap-fit type suitable for the thickness of glazing proposed as indicated in the items of works. A layer of clear transparent lacquer shall be applied on aluminium sections to protect them from damage during installation. This lacquer coating shall be removed after the installation is completed.

The rates quoted shall be deemed to include the following:

Fabrication, hoisting and fixing in position shall unless otherwise specified confirm to method of fixing and glazing of aluminium windows as per IS: 1081 using all specials like couplers, holdfasts, sill and kick plates, plastic putty, standard approved hardware, aluminium beading, weather bars, etc. as detailed out in drawings including all materials and labour.

Supplying and fixing all hardware of specified and approved type and make as per schedule of fittings/ fixtures and as per instructions of manufacturer.

The Contractor shall appoint an experienced specialist Sub-Contractor with prior approval of the Engineer to execute the work.

Provision of necessary aluminium couplers, weather bars, transoms, beading, moulding, special kick/ push plates, concealed tower bolts, three way six-lever brass locking arrangement with stainless steel keys, handles of special designs, concealed brass and steel spring hinges/ floor/ lintel mounted and stainless steel screws as per schedule of fixtures and fittings.

Providing and filling with approved resilient but non bleeding sealants of Dow/ Corning/ GE or other approved equivalent make to ensure water tightness, protection of installed items, till handing over, removing all protective coats, cleaning and leaving in perfect condition just before handing over. The Contractor shall also be required to prove the water tightness of each window fitted.

Providing for specified glass, glazing clips and EPDM gaskets.

Before fabrication, the Contractor must obtain approval of the Engineer for type of sections, hardware and glass to be utilised. Contractor shall submit samples for approval of sub frame joints and drain section joints with verticals. Fabrication shall be based on actual measurements at site.

Sub frame mitred joint fixed with cleat angle from behind and sealing of joints and screw holes by sealant.

Drain section ends to be properly plugged with non-degradable material, PVC solid cut to size blocks, etc. and sealed with sealant.

Heavy duty louvred glass carrying frame, hardware, Z section to be used shall be approved by Owner/ Engineer.

Applying approved sealant at all junctions of two different materials i.e. aluminium, external plaster, sub frame on horizontal and vertical faces and aluminium to aluminium junctions.

9.0 STEEL ROLLING SHUTTERS

9.1 MATERIALS and WORKMANSHIP

Rolling shutters shall be of an approved manufacture, conforming to the requirements specified in IS: 6248.

The type of rolling shutter shall be self coiling type (manual) for clear areas upto 12 m2, gear operated type (mechanical) for clear areas upto 35 m2 and electrically operated type for areas upto 50 m2. Mechanical type of rolling shutters shall be suitable for operation from both inside and outside with the crank handle or chain gear operating mechanism duly considering the size of wall/ column. Electrical type of rolling shutter shall also be provided with a facility for emergency mechanical operation.

Rolling shutters shall be supplied duly considering the type, specified clear width/ height of the opening and the location of fixing as indicated in the drawings.

Shutters shall be built up of interlocking laths 75 mm width between rolling centres formed from cold rolled steel strips. The thickness of the steel strip shall not be less than 0.90 mm for shutters upto 3.50 m width and not less than 1.20 mm for shutters above 3.50 m width. Each lath section shall be continuous single piece without any welded joint.

The guide channels out of mild steel sheets of thickness not less than 3.15 mm shall be of either rolled, pressed or built up construction. The channel shall be of size as stipulated in IS: 6248 for various clear widths of the shutters.

Hood covers shall be of mild steel sheets not less than 0.90 mm thick and of approved shape.

Rolling shutters shall be provided with a central hasp and staple safety device in addition to one pair of lever locks and sliding locks at the ends.

All component parts of the steel rolling shutter (excepting springs and insides of guide channels) shall be provided with one coat of zinc chrome primer conformity to IS: 2074 at the shop before supply. These surfaces shall be given an additional coat of primer after erection at the site along with the number of coats and type of finish paint as specified in the respective items of work.

In case of galvanised rolling shutter, the lath sections, guides, lock plate, bracket plates, suspension shaft and the hood cover shall be hot dip galvanised with a zinc coating containing not less than 97.5% pure zinc. The weight of the zinc coating per sqm shall be as specified in the items of work.

Guide channels shall be installed truly plumb at the specified location. Bracket plate shall be rigidly fixed with necessary bolts and holdfasts. Workmanship of erection shall ensure strength and rigidity of rolling shutter for trouble free and smooth operation.

10.0 MS HAND RAILING

10.1 MATERIALS

All structural steel shall conform to IS 226-1963 sections for grills and shall be freefrom loose mill scales, rusts, pitting or any other defects affecting its strength anddurability.

10.2 FABRICATION

The grill/railing shall be fabricated to the design and pattern shown in thedrawings. All joints shall be made in best workman like manner with slotting andwelding as required to the specified size and shape. The edge of the M.S. flatsshall be suitably mitred before welding to get the desired shape. The joints shallbe filled to remove excess stay after welding screws, nuts, washers, bolts, rivetsand any other miscellaneous fastenings devices shall be of steel and shall beprovided by the contractor.

Manufactured Rails then be fixed in between the posts, balusters, M.S. framework etc. to correct alignment. Any undulations, bends etc. found shall be rectifiedby the contractor at his own cost. The complete assembly of railing so fixed shallbe firm and there shall not be any lateral movements.

10.3 INSTALLATION

The approved grills shall be fixed in position where specified and shown indrawings including in masonry walls, teakwood frames, hand railings etc. Anydamages to walls, frames etc. caused during fixing the grills shall be made goodby grouting with cement mortar/packing /repairing properly at the contractors cost.

PART – 14: PLUMBING

1.0 Scope

This specification covers the general requirements of providing and laying water mains and water supply piping, providing and fixing sanitary fixtures and piping and providing and laying drainage lines.

The said work shall be carried out and completed under this contract in every respect in conformity with the rules and regulations of the local authority.

The Contractor shall supply all labour, material, appliances, tools and equipment necessary for the work for plumbing services installation including testing, commissioning and maintenanceas specified herein, and as per the relevant Bureau of Indian Standards (BIS), British Standards codes, and local legalities. This also includes any material, appliances and equipment not specifically mentioned herein or noted on the drawings as being supplied or installed which are necessary and customary to make a complete installation properly connected and in working order.

For specifications, mode of measurements and scope of work covered under the respective items for the work included under this contract, following documents shall be referred to in the order of precedence as given below:

(a) Description of the items and notes if any given in the Schedule of Quantities.

(b) Specifications.

(c) Additional Conditions of Contract.

(d) General Conditions of Contract

(e) Applicable Codes and Standards as specified herein with amendments/ revisions issued till date.

In the event of any discrepancy among the documents referred above, the document in the higher order of precedence shall prevail.

In the event of any element of specification not being available in any of the documents mentioned above, the instructions of the Engineer-in-Charge in writing shall be followed by the Contractor.

The Work shall be carried out in accordance with the drawings and designs as would be issued to the Contractor by the Engineer-in-Charge duly signed and stamped by him. The Contractor shall not take cognisance of any drawings, designs, specifications, etc. not bearing Engineer-in-Charge's signature and stamp. Similarly the Contractor shall not take cognisance of instructions given by any other Authority except the instructions given by the Engineer-in-Charge in writing.

The Work shall be executed and measured as per metric dimensions given in the Schedule of Quantities, drawings etc.

The Contractor shall acquaint himself fully with the partial provisions for supports that may be available in the structure and utilise them to the extent possible. In any case the Contractor shall provide all the supports regardless of provisions that have been already made. Nothing extra shall be payable for situations where bed plates (for supports) are not available or are not useful.

The Contractor shall incorporate seismic considerations of anchoring and isolation in the design of the systems as called for the different equipment.

The contractor shall carryout all incidental works connected with plumbing services installation such as excavation of trenches and back filling, cutting and chasing in concrete and brick and making good, cutting/drilling holes through walls, floors, slabs, beams and grouting for fixing of fixtures / equipment and so forth.

The contractor shall furnish and install complete workable plumbing services installation as shown on the drawings and described in this specification and as per the latest Bureau of Indian Standards (BIS), British Standards (BS) specifications including all that which is necessary to all the buildings, internally and externally including MS angle Iron brackets, high quality pipe supports required for pipe fixing on walls and ceiling.

The contractor shall furnish, receive, store and install the sanitary wares, accessories, sewerage pipes and sewerage appurtenances (a complete and workable sewerage system) internally as well as around the building and up to the sewage treatment plant as indicated in the drawing.

The contractor has to co-operate, co-ordinate and achieve interfacing with other trade contractors in putting the installation in place. Any work done without regard or consultation with other trade contractors, shall be removed by the contractor without additional cost, to permit proper installation of all other work, as desired by the client / consultants.

The contractor has to repair all damage done to the premises as a result of this installation and remove all debris left by those engaged for this installation to the satisfaction of client / consultants. All the pipes, concealed as well as exposed shall be painted as specified. 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.

The contractor has to clean and test all plumbing and sanitary fixtures. In addition to the sectional testing carried out during the construction, the Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakage and shall replace all defective materials in the system. Any consequential damage done, on account of Contractors carelessness, open or burst pipes or failure of fittings, during testing and commissioning to the building, furniture and fixtures shall be made good by the Contractor.

It is the responsibility of the contractor to take care of all fittings and fixtures fitted until the time of final handing over to the clients.

1.1 FULL SCALE MOCKUPS

1.1.1 THE CONTRACTOR SHALL PREPARE THE FULL SCALE MOCK UP AT SITE FOR TOILET CONTAINING ALL NECESSARY SANITARY FIXTURES AND FITTINGS SPECIFIED IN THE BOQ, WHICH WILL COVER THE ENTIRE SCOPE OF WORKS OF THIS CONTRACT.

1.1.2 THE CONTRACTOR SHALL ESTABLISH THE ACCEPTABLE QUALITY OF WORKMANSHIP AS DESIRED BY THE ENGINEER FOR EACH OF THE ITEMS OF THE WORKS AND THEIR ELEMENTS BY PREPARING SPECIMENS AND MOCK UPS AS DIRECTED BY THE ENGINEER. NOTHING EXTRA SHALL BE PAYABLE FOR PREPARING THE SPECIMENS AND THE MOCK UPS.

1.1.3 ALL FINISHES, COMPONENTS, DETAILS SHALL BE AS INDICATED IN THE DETAILED SPECIFICATIONS.

1.1.4 ALL SANITARY FIXTURES AND FITTINGS INSIDE TOILET SHALL BE INSTALLED ACCORDING TO THE DETAIL DRAWINGS PROVIDED.

1.1.5 THE MOCKUPS SHALL BE ERECTED WITHIN 30 DAYS FROM DATE OF CONTRACT.

1.2 SUBMITTALS

THE CONTRACTOR SHALL PROVIDE THE SUBMITTALS AS MENTIONED HEREUNDER.

1.2.1 TECHNICAL DATA FOR EACH PLUMBING MATERIAL GIVEN IN THE SPECIFICATION SHALL BE SUBMITTED BEFORE INSTALLATION OF THE MATERIAL ON THE SITE.

1.2.2 SAMPLES OF WC, WASH BASIN, URINAL, SINK, SHOWER SET, TOILET PAPER HOLDER, ROBE HOOK, SOAP DISPENSER, HAND DRIER TO BE SHOWN, FROM WHICH TWO SAMPLES OF EACH FIXTURE SHALL BE SHORTLISTED FOR THE FINAL FULL-SCALE MOCKUP FOR APPROVAL BY THE CLIENTS.

1.2.3 TECHNICAL DATA SHEETS FOR EACH APPROVED SANITARY FIXTURES OPTION:

(A) WATER CLOSET

(B) WASH BASIN

(C) URINAL

(D) SINK

(E) TOILET PAPER HOLDER

(F) ROBE HOOK

(G) SOAP DISPENSER

(H) HAND DRIER.

1.2.4 HARDWARE & ACCESSORIES

(A) SAMPLES OF ALL HARDWARE AND ACCESSORIES FOR SANITARY FIXTURES AND FITTINGS SUCH AS CP FITTINGS, CHAIR BRACKETS, HINGES, HANDLES, GUARD RAILS, ETC. AS SPECIFIED AND/OR AS PER STANDARD SYSTEM COMPONENTS, SHALL BE SUBMITTED FOR OWNERS APPROVAL.

(B) TWO SETS OF APPROVED SAMPLES SHALL BE SUBMITTED FOR THE SITE AND DESIGN OFFICE, FOR READY REFERENCE

2.0 GENERAL PROVISIONS

2.1 SPECIFICATIONS AND DRAWINGS

The specifications and drawings shall be considered as part of this contract and any work or materials shown on the drawings and not called for in the specifications or vice versa shall be executed as if specifically called for in both.

2.1.1 The Tender Drawings Indicate:

(a) The extent and general arrangement of the sanitary fixtures, drainage system, etc.

(b) The points of supply and network layout. However, any changes found essential to co-ordinate this work with other trades shall be made without any additional cost. The drawings and specifications are meant for the assistance and guidance of the contractor, and exact location, distance and levels will be governed by the individual building and site conditions. Therefore, approval of the clients / consultants shall be obtained before commencement of work.

(c) Exact run and sizes of all pipes on all floors and vertical stacks

(d) Ground and invert levels of all drainage pipes together with location of all gully traps, inspection chambers, manholes and connections up to outfall.

(e) Run of all water supply lines with diameters, location of control valves, access panels etc.

(f) Location of all mechanical equipment with layout and piping connections

2.1.2 General site instructions for contractor:

(a) Contractor will have to attend weekly site meetings as per the directions and Architects/Owners.

(b) Chasing of walls for concealing of Plumbing pipes shall be done by cutter only.

(c) All debris emanating out of the Plumbing work shall be removed and dumped at a designated dumping place within the building premises

(d) Scaffolding if required for Plumbing work shall be provided by contractor at no extra cost.

(e) Contractor has to submit his activity schedule in accordance with the civil activity bar chart (especially water proofing, tiling etc.) and ensure proper coordination with the civil agency.

(f) All temporary water lines required for the civil activity shall be done by contractor at no extra labour cost.

(g) Contractor shall depute sufficient Nos. of competent Engineers for supervision of works from his end and ensure that the quality of work is carried out as per the specifications and quality standards specified in the tender.

(h) Contractor shall insert all the necessary sleeves as indicated in the drawings fabricated out of PVC material for Over Head Tanks which shall be provided by the Contractor at no extra cost.

All “Warranty Cards” given by the manufacturers shall be handed over to the client / consultants.

2.2 MANUFACTURER’S INSTRUCTIONS

Where manufacturers have furnished specific instructions relating to the materials used in this job and methods of construction that are not specifically mentioned in these documents, such instructions shall be followed in all cases. The contractor shall also furnish six sets of the detailed instruction, operating and maintenance manuals including detailed completion drawings on a bound copy to approved scale. Further it is the responsibility of the contractor to train the Owner’s Authorized Representatives’ personnel in the operation and maintenance of the system.

2.3 EQUIPMENTS, MATERIALS AND WORKMANSHIP

Determine that each piece of equipment meets the detailed requirements of the contract documents and that it is suitable for the installation shown. Notify the Architect of any shortcomings found during the tendering period. Each piece of equipment not meeting all requirements will not be acceptable, even though specified by name along with other manufacturers.

Where two or more units of the same class of equipment are furnished, use product of the same manufacture component parts of entire system need not be product of the same manufacture. Furnish all material and equipment, new and free from

defects and of size, make, type and quality herein specified or approved by the Architect or consultant. All shall be installed in a near and workmanlike manner.

Materials shall be of approved make and quality specified, however the final choice shall always remain with the client / consultants. They shall conform to the respective Bureau of Indian Standards, British Standards Specifications and supported by Manufacturing Certificate / test certificate.

In any case of no availability of materials in metric sizes, the nearest size of FPS units shall be provided with prior approval of the client / consultants at no extra cost.

2.4 PROTECTION AGAINST DAMAGE

All pipe and conduit openings shall be closed by means of plugs or caps to prevent the entrance of foreign matter. All piping, conduit, fixtures, equipment or apparatus shall be protected. Any such items damaged prior to final completion of work shall be restored to its original conditions or replaced at no expense to the Owner.

2.4.1 Care shall be taken to avoid damage from any cause at all stages. Packing pieces used for protection shall not disfigure or otherwise permanently mark the Works.

2.4.2 Surface protection shall be afforded by careful handling and the avoidance of the use of hooks, crowbars, or other implements that are likely to damage the works.

2.4.3 Protection during construction: Decorative surfaces shall be carefully protected during construction by a temporary cover.

Protection of finished work: At all stages of the Contract it is essential that all works are properly protected.

Suitable packing shall be used to ensure that scaffolding does not damage erected stone, marble, granite or other finished works.

Any disfigurement, discolouration or imperfection whatsoever due to any reason shall not be accepted and the Contractor shall either remedy the same or redo the work at no extra cost. The decision of the Engineer-in-Charge, as to whether any work either in whole or in part, is acceptable or not shall be final and binding on the Contractor.

2.6 LICENSED PLUMBER

All work performed by the contractor shall be through licensed plumbing supervisor possessing a valid plumbing contractor’s license employing engineers, technicians, foremen, plumbers, masons, helpers, etc., as required.

2.7 FEES, PERMITS AND NOTICES

Contractor shall comply with all bye-laws and regulations of local and other statutory authorities having jurisdiction over the works and shall be responsible for

the payment of all fees and other charges and giving and receiving of all necessary notices. Contractor shall keep the clients / consultants timely informed about regulations and requirements of statutory authorities and shall obtain the final certificates of inspection and approval from the authorities.

2.8 GUARANTEE

The contractor shall guarantee both the material and workmanship of first class quality corresponding to standard engineering practice for a period of 12 months from the date of issue of completion. The Contractor shall indemnify the Engineer-in-Charge for a similar period against any damage to property and injury to persons on account of any defective work or maintenance carried out by the Contractor. The format and text of the Guarantee and the Indemnity Bond shall be given by the Engineer-in-Charge.

3.0 SITE UTILITIES

3.1 UTILITIES TRENCHES

The specification establishes general criteria for efficient implementation of site utilities. The following site utilities shall be placed in trenches as per the planning and specifications.

3.1.1 Storm water drainage

3.1.2 Soil and waste system

3.1.3 Domestic water supply system

3.2 ALIGNMENT AND GRADE

Drains are to be laid to correct alignment & grade shown in the drawings but subject to such modifications as necessary to meet the requirements of the works. No deviations from the lines, 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 / consultants. The pipe shall be laid to slope with the socket and spigot ends on higher and lower side respectively.

3.3 OPENING OUT TRENCHES

All PVC / HDPE pipes below ground shall be laid in trenches with a minimum cover of 600mm. The width and depth of the trenches shall be as follows except at places where jointing etc. needs larger width of trench. Additional width/ depth shall be provided as necessary for welding/ jointing etc. at no additional cost:

Diameter of pipe	Width of trench	Depth of trench
15mm to 50mm	300mm	750mm
65mm to 100mm	450mm	1000mm

In excavating the trenches, the road metalling, pavement kerbing, etc. shall be carefully placed aside and preserved for reinstatement and the trench or other excavation shall be filled up and laid back to original condition at no extra cost. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the client / consultants. The contractor shall not cut or break down any fence or live trees in the line of the proposed works but shall tunnel under them unless the client orders the contrary. The contractor shall scrub and clear the surface over the trenches and other excavations of all stumps, roots and other encumbrances affecting execution of work and shall remove the same from the site as per the directions of the client

3.4 EXCAVATION TO BE TAKEN TO PROPER DEPTH

Trenches shall be excavated in all conditions of soil and to such a depth that the sewers / or other pipes shall rest as described in the several clauses relating thereto and so that the inverts may be at the levels given on the section. Should the contractor excavate the trench to a greater depth than is required the extra depth shall have to be filled up with concrete at the contractor's own cost to the requirements and satisfaction of the client / consultants.

3.5 BACK FILLING OF THE TRENCHES (IS: 12288 – 1987)

After the sewer or other piping work has been laid and proved to be water-tight, the trench or other excavation shall be refilled. Utmost care shall be taken in doing this so that no damage is caused to the sewer and other permanent works.

For the purpose of back filling, the depth of the trench shall be considered as divided into the following three zones from the bottom of the trench of its top, for the purpose of refill materials to be used.

ZONE A

From bottom level of trench, to the level of the centre line of the pipe

ZONE B

From the level of the centre line of the pipe to a level 30 cm above the top of the pipe, and

ZONE C

From a level 30 cm above the top of the pipe to the top of the trench

3.6 BACKFILL MATERIALS

All backfill materials shall be free from cinders, ashes, slag, refuse, rubbish, vegetable or organic materials, lumpy or frozen materials boulder, rocks or stone or other materials which in the opinion of the client / consultants, is unsuitable for deleterious. Fine excavated earth which shall pass through a sieve of aperture size

20 mm can be used for filling in zones A & B. However, material containing stones up to 20mm as their greatest dimension may be used in zone C only unless otherwise specified by the clients / consultants. Where excavated material in considered by the clients / consultants not suitable for back filling, clean river sand shall be used for the same.

3.6.1 Backfill Sand

River sand used for back fill shall be natural sand complying with para 3.6 graded from fine to coarse. The total weight of clay in it shall not exceed 10 percent. All material shall pass through a sieve of aperture size 20mm (IS-2405-1980) and not more than 5 percent shall remain on IS sieve of aperture size 6.30mm.

3.6.2 Backfill gravel

Gravel used for back fill shall be natural gravel and having durable particles graded from fine to coarse in a reasonably uniform combination with no boulders or stone larger than 50mm in size. It shall not contain excessive amount of loam and clay and not more than 15 percent shall remain on a sieve of aperture size 75 micron.

3.6.3 Back filling in zone A

It shall be done by hand with fine excavated material or river sand, fine gravel or other approved materials placed in layers of 8cm and compacted by tapping. The back filling material shall be deposited in the trench for its full width of each side of the pipe, fittings and appurtenances simultaneously.

3.6.4 Back-filling in zone B

Back filling in zone B using fine excavated material shall be done by hand or approved mechanical methods. Special care has to be taken during tamping to avoid injuring or moving the pipe. If excavated material is not suitable, the type of back-fill material shall be prescribed by the client / consultants to suit individual locations.

3.6.5 Back filling in zone C

It shall be done by hand or approved mechanical methods and well compacted. Excavated earth having stones of size not exceeding 20 mm can be used for zone C. If the excavated earth is unsuitable for back fill, the filling material shall be specified by the client / consultants.

3.6.6 Backfill with excavated materials

Where the excavation is made through permanent pavements, curbs, paved footpaths, or where such structures are undercut by the excavation, the entire back fill to the sub-grade of the structures shall be made with sand or cement concrete in accordance with para 1.6. The method of placing and consolidating the back fill material shall be prescribed by the client / consultants.

3.7 CONCRETE SLABS OVER PIPES

When pipes are laid under roads and pavements subjected to heavy traffic loads the trenches may be covered with reinforced concrete slabs of suitable dimension, supported on edges to relieve the load on pipes to the adjoining earth.

3.8 SITE CLEANING ON COMPLETION OF WORK

All surplus pipes and fittings, valves, etc., and all tools and temporary structures shall be removed from the site as directed by the client / consultants. All dirt rubbish and excess earth from the excavation shall be removed and transported and disposed at a suitable place as directed by client / consultants and the construction site left clean to the satisfaction of the client / consultants.

3.9 RESTORATION OF SETTLEMENT AND DAMAGES

The Contractor shall at his own cost make good promptly, during the whole period that the works are in hand, any settlement that may occur on the surfaces of roads, beams, footpaths, gardens, open spaces, etc. whether public or private caused by his trenches or his other excavations and he shall be liable for any accidents caused thereby. He also shall, at his own expense and charge, repair and make good any damage done to the buildings and other properties.

3.10 DISPOSAL OF SURPLUS

The Contractor shall at his own cost dispose within the site or as directed all surplus excavated materials not required to be used in the work.

3.11 TIMBERING

The Contractor shall at all times support efficiently and effectively the sides of trenches and other excavations by finest selected timbering, piling, sheeting material, etc., at his own cost. The trenches shall be close timbered in loose or sandy strata and below the surface of the sub-soil table. All timbering, sheeting and piling with their walls and supports shall be of adequate dimensions and strength and fully braced and strutted so that there is no risk of collapse or subsidence of the walls of the trench. The Contractor shall be held accountable and responsible for the adequacy of all timbering, bracing, sheeting and piling used and for all damages to persons and property resulting from the improper quality, strength, placing, maintenance, or removing of the same.

3.12 REMOVAL OF WATER

The Contractor shall at all times during the progress of work keep the trenches and excavations free from water at his own expense which shall be disposed off by him in a manner as will neither cause injury to public health nor to public or private property, to the work completed or in progress, to the surface of any roads or streets and cause any interference with the use of the same.

3.13 TRENCH WIDTH

The width of excavated trenches shall be as per the table given below:

	Width at bottom		
Excavation up to:	**Up to 100 mm dia pipe**	**Up to 150 mm dia pipe**	**Up to 300 mm dia pipe**
900 mm depth	330 mm	330 mm	600 mm
900 to 1500 mm depth	600 mm	600 mm	900 mm
1500 to 3000 mm depth	750 mm	750 mm	1100 mm
3000 to 5000 mm depth	900 mm	1000 mm	1300 mm

3.14 PROTECTION OF EXISTING SERVICES

All pipes, water mains, cables, etc. met with during the course of excavation shall be carefully protected and supported.

3.15 ROAD CROSSINGS

All pipelines laid below roads shall be taken through suitable underground trenches. The size of trenches shall be as per drawings.

3.16 CONSTRUCTION ACROSS ROADS

All works across roads shall be carried out as per the directions of the client / consultants.

4.0 APPLICABLE CODES AND STANDARDS

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practices given below as amended till date. All equipment and material being supplied by the contractor shall meet the requirements of IS, and other Codes/ Publications as given below.

GENERAL

SP:6(1)	Structural steel sections
IS:27	Pig lead
IS:325	Three phase induction motors
IS:554	Dimensions for pipe threads where pressure tight joints are required on the threads

IS:694	PVC insulated cables for working voltages up to and including 1100 V.
IS:779	Specification for water meters (domestic type)
IS:782	Specification for caulking lead
IS:800	Code of Practice for general construction in steel
IS:1068	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium
IS:1172	Code of Basic requirements for water supply drainage and sanitation
IS:1367	(Part 1) Technical supply conditions for threaded steel fasteners: Part I Introduction and general information
IS:1367	(Part 2) Technical supply conditions for threaded steel fasteners: Part 2 Product grade sand tolerances.
IS:1554	PVC insulated (heavy duty) electric(Part 1) cables: Part 1 For working voltages up to and including 1100 V.
IS:1554(Part 2)	PVC insulated (heavy duty) electric cables: Part 2 For working voltages from3.3 kV up to and including 11 kV.
IS:1726	Specification for cast iron man-hole covers and frames
IS:1742	Code of practice for building drainage
IS:2064	Selection, installation and maintenance of sanitary appliances - Code of practice
IS:2065	Code of practice for water supply in buildings
IS:2104	Specification for water meter boxes(domestic type)
IS:2373	Specification for water meters (bulk type)
IS:2379	Colour code for identification of pipelines.
IS:2527	Code of practice for fixing rain water gutters and down pipes for roof drainage
IS:2629	Recommended practice for hot dip galvanizing on iron and steel

IS:4111(Part 1)	Code of practice for ancillary structures in sewerage system: Part 1Manholes
IS:1536	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage
IS:1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS:1538	Cast iron fittings for pressure pipes for water, gas and sewage
IS:1729	Sand cast iron spigot and socket soil, waste and ventilating pipes, fitting sand accessories
IS:1879	Malleable cast iron pipe fittings
IS:4853	Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes
IS:4985	Unplasticised PVC pipes for potable water supplies – specification.
IS:5329	Code of practice for sanitary pipe work above ground for buildings
IS:5455	Cast iron steps for manholes
IS:6159	Recommended practice for design and fabrication of material prior to galvanising
IS:7558	Code of practice for domestic hot water installations
IS:8321	Glossary of terms applicable to plumbing work
IS:8419 (Part 1)	Requirements for water filtration equipment: Part 1 Filtration media sand and gravel
IS:8419 (Part 2)	Requirements for water filtration equipment: Part 2 Under drainage system
IS:9668	Maintenance of water supplies and fire fighting.
IS:9842	Preformed fibrous pipe insulation
IS:9912	Coal tar based coating materials and suitable primers for protecting iron and steel pipe lines
IS:10221	Code of practice for coating and wrapping of underground mild steel pipelines
IS:10234	Recommendations for general pipeline welding

IS:10446	Glossary of terms relating to water supply and sanitation
IS:11149	Rubber Gaskets
IS:11790	Code of practice for preparation of butt welding ends for pipes, valves, flanges and fittings
IS:12183(Part 1)	Code of practice for plumbing in multi-storeyed buildings: Part 1 Water Supply
BS:5572	Code of practice for sanitary pipe work
BS:6700	Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages
BS:8301	Code of practice for building drainage
BSEN274	Sanitary tap ware, waste fittings for basins, bidets and baths. General technical specifications
IS:458	Specification for precast concrete pipes(with and without reinforcement)
IS:1978	Line pipe
IS:1979	High test line pipe
IS:2643 (Part 1)	Dimensions for pipe threads for fastening purposes: Part 1 Basic profile and dimensions
IS: 2643 (Part 2)	Dimensions for pipe threads for fastening purposes: Part 2 Tolerances
IS:2643 (Part 3)	Dimensions for pipe threads for fastening purposes: Part 3 Limits of sizes
IS:3468	Pipe nuts
IS:3589	Seamless or electrically welded steel pipes for water, gas and sewage(168.3mm to 2032mm outside diameter)
IS:4346	Specifications for washers for use with fittings for water services
IS:778	Specification for copper alloy gate, globe and check valves for water works purposes

IS:780	Specification for sluice valves for water works purposes (50mm to 300mmsize)
IS:1703	Specification copper alloy float valves(horizontal plunger type) for water supply fittings.
IS:2906	Specification for sluice valves for water works purposes (350mm to 1200 mm size)
IS:3950	Specification for surface boxes for sluice valves
IS:5312 (Part 1)	Specification for swing check type reflux (non return) valves: Part 1Single door pattern
IS:5312	Specification for swing check type reflux (non return) valves: Part 2 Multidoor pattern
IS:12992	Safety relief valves, spring loaded: (Part 1) Part1Design
IS:13095	Butterfly valves for general purposes
IS:771 (Part 1 to 3)	Specification for glazed fire clay sanitary appliances
IS:774	Specification for flushing cistern for water closets and urinals (other than plastic cistern)
IS:775	Specification for cast iron brackets and supports for wash basins and sinks
IS:781	Specification for cast copper alloy screw down bib taps and stop valves for water services
IS:1700	Specification for drinking fountains
IS:2326	Specification for automatic flushing cisterns
IS:2548 (Part1)	Specification for plastic seats and covers for water closets: Part 1:Thermoset seats and covers
IS: 2548(Part 2)	Specification for plastic seats and covers for water closets: Part 2:Thermoplastic seats and covers
IS:2556(Part 1)	Specification for vitreous sanitary appliances (vitreous china): Part 1:General requirements
IS:2556(Part 2)	Specification for vitreous sanitary appliances (vitreous china) Part 2:Specific requirements of wash down water closets
IS:2556(Part 3)	Specification for vitreous sanitary appliances

	(vitreous china) Part 3 :Specific requirements of squatting pans
IS:2556(Part 4)	Specification for vitreous sanitary appliances (vitreous china) Part 4 :Specific requirements of wash basins
IS:2556 (Part 6 Sec 2)	Specification for vitreous sanitary appliances (vitreous china) Part 6 :Specific requirements of urinals, Section 2 Half stall urinals
IS:2556 (Part 6 Sec 4)	Specification for vitreous sanitary appliances (vitreous china) Part 6 :Specific requirements of urinals, Section 4 Partition slabs
IS:2556 (Part 6 Sec 5)	Specification for vitreous sanitary appliances (vitreous china) Part 6 :Specific requirements of urinals, Section 5 waste fittings
IS:2556 (Part 6 Sec 6)	Specification for vitreous sanitary appliances (vitreous china) Part 6 :Specific requirements of urinals, Section 6 Water spreaders for half stall urinals
IS:2556(Part 7)	Specification for vitreous sanitary appliances (vitreous china) Part 7 :Specific requirements of half round channels
IS:2556(Part 8)	Specification for vitreous sanitary appliances (vitreous china) Part 8: Specific requirements of symphonic wash down water closets.
IS:2556 (Part 11)	Specification for vitreous sanitary appliances (vitreous china) Part 11:Specific requirements for shower rose
IS: 2556(Part 12)	Specification for vitreous sanitary appliances (vitreous china) Part 12:Specific requirements of floor traps
IS:2556 (Part 15)	Specification for vitreous sanitary appliances (vitreous china) Part 15:Specific requirements of universal water closets
IS:2692	Specification for ferrule for water services
IS:2717	Glossary of terms relating to vitreous enamel ware and ceramic metal systems
IS:3311	Specification for waste plug and its accessories for sinks and wash basins.

IS:5961	Specification for cast iron gratings for drainage purposes.
IS:6249	Specification for flush valves and fittings for marine use
IS:6411	Specification for gel coated glass fibre reinforced polyester resin bath tubs
IS:8931	Specification for copper alloy fancy single taps, combination tap assembly and stop valves for water services
IS 12235 (Parts 1 to 11)	Methods of test for unplasticized PVC pipes for portable water supplies.
IS 13592 – 1992	Specification for unplasticized PVC pipes for soil and waste discharge system inside building including ventilation and rainwater.
IS 4985 – 1988	Specification for unplasticized PVC pipes for portable water supplies (second revision)
IS:9758	Specification for flush valves and fitting for water closets and urinals
IS:15778:2007	Specification for Chlorinated PVC pipes for portable water supply.

5.0 QUALITY ASSURANCE AND QUALITY CONTROL

(A) AT THE SITE LEVEL THE CONTRACTOR SHALL ARRANGE THE MATERIALS STACKING/ STORAGE IN APPROPRIATE MANNER TO ENSURE THEIR QUALITY. CONTRACTOR SHALL PROVIDE EQUIPMENT AND MANPOWER TO TEST CONTINUOUSLY THE QUALITY OF MATERIALS, ASSEMBLIES ETC. AS DIRECTED BY THE ENGINEER-IN-CHARGE. 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.

(B) THE ENGINEER-IN-CHARGE SHALL BE FREE TO CARRY OUT TESTS AS MAY BE CONSIDERED NECESSARY BY HIM AT HIS SOLE DISCRETION, 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.

(C) THE TEST SHALL BE CONDUCTED AT THE SITE LABORATORY THAT MAY BE ESTABLISHED BY ENGINEER-IN-CHARGE OR AT ANY OTHER STANDARD LABORATORY SELECTED BY ENGINEER-IN-CHARGE.

(D) THE CONTRACTOR SHALL TRANSPORT THE SAMPLES TO THE LABORATORY FOR WHICH NOTHING EXTRA SHALL BE PAYABLE. IN THE EVENT OF CONTRACTOR FAILING TO ARRANGE TRANSPORTATION OF THE SAMPLES IN PROPER TIME ENGINEER-IN-CHARGE SHALL HAVE THEM TRANSPORTED AND RECOVER TWO TIMES THE ACTUAL COST FROM THE CONTRACTOR'S BILLS.

(E) TESTING CHARGES SHALL BE BORNE BY THE ENGINEER-IN-CHARGE.

(F) 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.

6.0 SANITARY AND OTHER FIXTURES

6.1 SCOPE OF WORK

6.1.1 Without restricting to the generality of the foregoing, sanitary and other appliances shall inter-alia include the following:

(a) Sanitary appliances and fixtures for toilets like WC pan, wash basins, urinals, bidets, slop sinks etc

(b) Chromium plated brass fittings like water supply faucets, bib taps, stop cocks, showers, mixers etc

(c) Stainless steel sink

(d) Accessories e.g. seats for WC, traps, fixing brackets, waste couplings, flexible PVC or CP brass connector pipes, towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails, coat hooks etc.

(e) Hand driers, drinking water fountains, etc.

6.1.2 WHETHER SPECIFICALLY MENTIONED OR NOT THE CONTRACTOR SHALL PROVIDE FOR ALL APPLIANCES AND FIXTURES ALL FIXING DEVICES, NUTS, BOLTS, SCREWS, HANGERS AS REQUIRED.

6.1.3 All exposed pipes within toilets and near appliances/ fixtures shall be of chromium plated brass or copper unless otherwise specified.

6.2 GENERAL REQUIREMENTS

ALL MATERIALS SHALL BE NEW AND OF QUALITY CONFORMING TO SPECIFICATIONS AND SUBJECT TO THE APPROVAL OF THE ENGINEER-IN-CHARGE. WHEREVER PARTICULAR MAKES ARE MENTIONED, THE CHOICE OF SELECTION SHALL REMAIN WITH THE ENGINEER-IN-CHARGE.

6.2.1 ALL APPLIANCES, FIXTURES AND FITTINGS SHALL BE PROVIDED WITH ALL SUCH ACCESSORIES AS ARE REQUIRED TO COMPLETE THE ITEM IN WORKING CONDITION WHETHER SPECIFICALLY MENTIONED OR NOT IN THE SCHEDULE OF QUANTITIES, SPECIFICATIONS OR DRAWINGS. ACCESSORIES SHALL INCLUDE PROPER FIXING ARRANGEMENT, BRACKETS, NUTS, BOLTS, WASHERS, SCREWS AND REQUIRED CONNECTION PIECES.

6.2.2 FIXING SCREWS SHALL BE HALF ROUND HEAD CHROMIUM PLATED (CP) BRASS SCREWS, WITH CP BRASS WASHERS UNLESS OTHERWISE SPECIFIED

6.2.3 PORCELAIN SANITARY WARE SHALL BE GLAZED VITREOUS CHINA OF FIRST QUALITY FREE FROM WARPS, CRACKS AND GLAZING DEFECTS CONFORMING TO IS: 2556. THE CHOICE OF THE COLOR OF THE SANITARY WARE SHALL BE THAT OF THE ENGINEER-IN-CHARGE AND NOTHING EXTRA SHALL BE PAYABLE TO THE CONTRACTOR FOR FIXING OF SANITARY WARE OF ANY COLOR.

6.2.4 SINKS FOR KITCHEN SHALL BE OF STAINLESS STEEL OR AS SPECIFIED IN THE SCHEDULE OF QUANTITIES.

6.2.5 CHROMIUM PLATED FITTINGS SHALL BE CAST BRASS CHROMIUM PLATED OF THE BEST QUALITY APPROVED BY THE ENGINEER-IN-CHARGE.

6.2.6 ALL APPLIANCES, FITTINGS AND FIXTURES SHALL BE FIXED IN A NEAT WORKMANLIKE MANNER TRUE TO LEVEL AND TO HEIGHTS SHOWN ON THE DRAWINGS AND IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS. CARE SHALL BE TAKEN TO FIX ALL INLET AND OUTLET PIPES AT CORRECT POSITIONS. FAULTY LOCATIONS SHALL BE MADE GOOD AND ANY DAMAGE TO THE FINISHED FLOOR, TILING, PLASTER, PAINT, INSULATION OR TERRACE SHALL BE MADE GOOD BY THE CONTRACTOR AT HIS OWN COST.

6.2.7 ALL MATERIALS SHALL BE RUST PROOFED; MATERIALS IN DIRECT OR INDIRECT CONTACT SHALL BE COMPATIBLE TO PREVENT ELECTROLYTIC OR CHEMICAL (BIMETALLIC) CORROSION.

6.2.8 SANITARY APPLIANCES, SUBJECT TO THE TYPE OF APPLIANCE AND SPECIFIC REQUIREMENTS, SHALL BE FIXED IN ACCORDANCE WITH THE RELEVANT STANDARDS AND THE FOLLOWING:

(A) CONTRACTOR SHALL, DURING THE ENTIRE PERIOD OF INSTALLATION AND AFTERWARDS PROTECT THE APPLIANCES BY PROVIDING

SUITABLE COVER OR ANY OTHER PROTECTION IN ORDER TO ABSOLUTELY PREVENT ANY DAMAGE TO THE APPLIANCES UNTIL HANDING OVER. (THE ORIGINAL PROTECTIVE WRAPPING SHALL BE LEFT IN POSITION FOR AS LONG AS POSSIBLE).

(B) THE APPLIANCE SHALL BE PLACED IN CORRECT POSITION OR MARKED OUT IN ORDER THAT PIPE WORK CAN BE FIXED OR PARTIALLY FIXED FIRST.

(C) THE APPLIANCE SHALL BE FIXED IN A MANNER SUCH THAT IT WILL FACILITATE SUBSEQUENT REMOVAL IF NECESSARY.

(D) ALL APPLIANCES SHALL BE SECURELY FIXED. MANUFACTURERS' BRACKETS AND FIXING METHODS SHALL BE USED WHEREVER POSSIBLE. COMPATIBLE RUST PROOFED FIXINGS SHALL BE USED. FIXING SHALL BE DONE IN A MANNER THAT MINIMISES NOISE TRANSMISSION.

(E) APPLIANCES SHALL NOT BE BEDDED (E.G. WC PANS, PEDESTAL UNITS) IN THICK STRONG MORTAR THAT COULD CRACK THE UNIT (E.G. A CERAMIC UNIT).

(F) PIPE CONNECTIONS SHALL BE MADE WITH DE-MOUNTABLE UNIONS. PIPE WORK SHALL NOT BE FIXED IN A MANNER THAT IT SUPPORTS OR PARTIALLY SUPPORTS AN APPLIANCE.

(G) APPLIANCES SHALL BE FIXED SO THAT WATER FALLS TO THE OUTLET (E.G. BATHS).

(H) APPLIANCES SHALL BE FIXED TRUE TO LEVEL FIRMLY FIXED TO ANCHOR OR SUPPORTS PROVIDED BY THE MANUFACTURER AND ADDITIONAL ANCHORS OR SUPPORTS WHERE NECESSARY.

6.2.1 SIZES OF SANITARY FIXTURES GIVEN IN THE SPECIFICATIONS OR IN THE SCHEDULE OF QUANTITIES ARE FOR IDENTIFICATION WITH REFERENCE TO THE CATALOGUES OF MAKES CONSIDERED. DIMENSIONS OF SIMILAR MODELS OF OTHER MAKES MAY VARY WITHIN +10% AND THE SAME SHALL BE PROVIDED AND NO CLAIM FOR EXTRA PAYMENT SHALL BE ENTERTAINED NOR SHALL ANY PAYMENT BE DEDUCTED ON THIS ACCOUNT.

6.3 SQUATTING TYPE WATER CLOSET - ORISSA PATTERN

6.3.1 SQUATTING TYPE WATER CLOSET (WC) PAN SHALL BE OF ORISSA PATTERN OF SIZE AS SPECIFIED IN SCHEDULE OF QUANTITIES. EACH WC PAN SHALL BE PROVIDED WITH A 100 MM DIA PVC P OR S TRAP WITH OR WITHOUT VENT HORN AS DIRECTED BY THE ENGINEER-IN-CHARGE.

6.3.2 WC SHALL BE FLUSHED BY MEANS OF CONCEALED TYPE OR EXPOSED TYPE (AS DETAILED IN THE DRAWINGS OR AS DIRECTED BY THE ENGINEER-IN-CHARGE) 32MM SIZE CP BRASS FLUSH VALVE WITH REGULATOR VALVE.

6.4 WASH DOWN WATER CLOSET

6.4.1 WC SHALL BE WASH DOWN OR SIPHONIC WASH DOWN TYPE WALL MOUNTED SET, AS SHOWN IN THE DRAWINGS, DESIGNED FOR LOW VOLUME FLUSHING FROM 3-6LITRES OF WATER, FLUSHED BY MEANS OF AN EXPOSED OR CONCEALED TYPE (AS DETAILED IN THE DRAWINGS OR AS DIRECTED BY THE ENGINEER-IN-CHARGE) FLUSH TANK. FLUSH PIPE/ BEND SHALL BE CONNECTED TO THE WC BY MEANS OF A SUITABLE RUBBER ADAPTOR. WALL HUNG WC SHALL BE SUPPORTED BY CI FLOOR MOUNTED CHAIR WHICH SHALL BE FIXED IN A MANNER AS APPROVED BY THE ENGINEER-IN-CHARGE.

6.4.2 EACH WC SET SHALL BE PROVIDED WITH A SOLID PLASTIC SEAT, RUBBER BUFFERS AND CHROMIUM PLATED HINGES. PLASTIC SEAT SHALL BE SO FIXED THAT IT REMAINS ABSOLUTELY STATIONARY IN VERTICAL POSITION WITHOUT FALLING DOWN ON THE WC.

6.4.3 EACH WC SET SHALL BE PROVIDED WITH A FIXED TYPE CP BRASS ABLUTION JET, IF CALLED FOR IN SCHEDULE OF QUANTITIES, COMPLETE WITH CP/ PLASTIC PIPING, CONCEALED TYPE CP BRASS ANGLE COCK ETC. ALL OF APPROVED MAKE AND BRAND. THE NOZZLE OF THE ABLUTION JET AND ITS HOLDING DOWN PLATE SHALL HAVE SMOOTH AND ROUNDED EDGES AND SHALL NOT BE CAPABLE OF CAUSING ANY INJURY TO A USER OR CLEANER.

6.5 UNIVERSAL TYPE WATER CLOSET

UNIVERSAL TYPE WATER CLOSET SHALL BE WASH DOWN OR SIPHONIC TYPE FLOOR MOUNTED PORCELAIN WARE FLUSHED BY MEANS OF A PORCELAIN FLUSHING CISTERN OR AN EXPOSED OR CONCEALED TYPE (AS DETAILED IN THE DRAWINGS OR AS DIRECTED BY THE ENGINEER-IN-CHARGE) FLUSH TANK. FLUSH PIPE/ BEND SHALL BE CONNECTED TO THE WC BY MEANS OF A SUITABLE RUBBER ADAPTOR.

EACH WC SET SHALL BE PROVIDED WITH A SOLID PLASTIC SEAT, RUBBER BUFFERS AND CHROMIUM PLATED HINGES. PLASTIC SEAT SHALL BE SO FIXED THAT IT REMAINS ABSOLUTELY STATIONARY IN VERTICAL POSITION WITHOUT FALLING DOWN ON THE WC. CLAUSE 6.4.3 SHALL APPLY.

6.6 URINALS

6.6.1 URINALS SHALL BE LIPPED TYPE HALF STALL WHITE GLAZED VITREOUS CHINA OF SIZE AS CALLED FOR IN THE SCHEDULE OF QUANTITIES AND SHALL INCLUDE THE FOLLOWING.

6.6.2 HALF STALL URINALS SHALL BE PROVIDED WITH 15 MM DIA CP SPREADER, 32 MM DIA CP DOMICAL WASTE AND CP CAST BRASS BOTTLE TRAP WITH PIPE AND WALL FLANGE AND SHALL BE FIXED TO WALL BY CI BRACKETS, CI WALL CLIPS AND CP BRASS SCREWS AS RECOMMENDED

BY MANUFACTURER COMPLETE AS DIRECTED BY THE ENGINEER-IN-CHARGE.

6.6.3 FLUSHING FOR URINALS SHALL BE BY MEANS OF FLUSH VALVE, HAND OPERATED.

6.6.4 FLUSH PIPES SHALL BE PVC PIPES CONCEALED IN WALL CHASE BUT WITH CHROMIUM PLATED BENDS AT INLET AND OUTLET OR AS GIVEN IN SCHEDULE OF QUANTITIES. THESE SHALL BE MEASURED AND PAID FOR SEPARATELY.

6.6.5 PVC WASTE PIPES SHALL BE PROVIDED FOR URINALS. WASTE PIPES MAY BE EXPOSED ON WALL OR CONCEALED IN CHASE AS DIRECTED BY THE ENGINEER-IN-CHARGE. THESE SHALL BE MEASURED AND PAID FOR SEPARATELY.

6.7 URINAL PARTITIONS

6.3.1 URINAL PARTITIONS SHALL BE WHITE GLAZED VITREOUS CHINA OR GRANITE STONE OF SIZE SPECIFIED IN THE SCHEDULE OF QUANTITIES.

6.3.2 PORCELAIN PARTITIONS SHALL BE FIXED AT PROPER HEIGHTS WITH CP BRASS BOLTS, ANCHOR FASTENERS AND MS CLIPS AS RECOMMENDED BY THE MANUFACTURER AND DIRECTED BY THE ENGINEER-IN-CHARGE.

6.4 WASH BASIN

6.4.1 WASH BASINS SHALL BE WHITE/ PASTEL COLORED GLAZED VITREOUS CHINA OF SIZE, SHAPE AND TYPE SPECIFIED IN THE SCHEDULE OF QUANTITIES.

6.4.2 EACH BASIN SHALL BE PROVIDED WITH PAINTED MS ANGLE OR C.I. BRACKETS AND CLIPS AND THE BASIN SECURELY FIXED TO WALL. PLACING OF BASINS OVER THE BRACKETS WITHOUT SECURE FIXING SHALL NOT BE ACCEPTED. THE MS ANGLE SHALL BE PROVIDED WITH TWO COATS OF RED OXIDE PRIMER AND TWO COATS OF SYNTHETIC ENAMEL PAINT OF MAKE, BRAND AND COLOR AS APPROVED BY THE ENGINEER-IN-CHARGE.

6.4.3 EACH BASIN SHALL BE PROVIDED WITH 32MM DIA CP WASTE WITH OVERFLOW, POP-UP WASTE OR RUBBER PLUG AND CP BRASS CHAIN AS SPECIFIED IN THE SCHEDULE OF QUANTITIES, 32MM DIA CP BRASS BOTTLE TRAP WITH CP PIPE TO WALL FLANGE.

6.4.4 WASH BASIN SHALL BE PROVIDED WITH COLD WATER FITTING OR AS SPECIFIED IN THE SCHEDULE OF QUANTITIES.

6.4.5 BASINS SHALL BE FIXED AT PROPER HEIGHTS AS SHOWN ON DRAWINGS. IF HEIGHT IS NOT SPECIFIED, THE RIM LEVEL SHALL BE 790MM FROM FINISHED FLOOR LEVEL OR AS DIRECTED BY THE ENGINEER-IN-CHARGE.

6.5 SINKS

6.5.1 SINKS SHALL BE STAINLESS STEEL OR ANY OTHER MATERIAL AS SPECIFIED IN THE SCHEDULE OF QUANTITIES.

6.5.2 EACH SINK SHALL BE PROVIDED WITH PAINTED MS OR CI BRACKETS AND CLIPS AND SECURELY FIXED. COUNTER TOP SINKS SHALL BE FIXED WITH SUITABLE PAINTED ANGLE IRON BRACKETS OR CLIPS AS RECOMMENDED BY THE MANUFACTURER. EACH SINK SHALL BE PROVIDED WITH 40MM DIA CP WASTE AND RUBBER PLUG WITH CP BRASS CHAIN AS GIVEN IN THE SCHEDULE OF QUANTITIES. THE MS ANGLE SHALL BE PROVIDED WITH TWO COATS OF RED OXIDE PRIMER AND TWO COATS OF SYNTHETIC ENAMEL PAINT OF MAKE, BRAND AND COLOR AS APPROVED BY THE ENGINEER-IN-CHARGE.

6.5.3 SUPPLY FITTINGS FOR SINKS SHALL BE DECK MOUNTED CP SWIVEL FAUCETS WITH OR WITHOUT HOT AND COLD WATER MIXING FITTINGS AS SPECIFIED IN THE SCHEDULE OF QUANTITIES. THESE SHALL BE MEASURED AND PAID FOR SEPARATELY.

6.6 SHOWER SET

6.6.1 SHOWER SET SHALL COMPRISE OF TWO CP BRASS CONCEALED STOP COCKS, FOUR/ FIVE WAY AUTO-DIVERTER, ADJUSTABLE TYPE OVERHEAD SHOWER, ALL WITH CP WALL FLANGES OF APPROVED QUALITY ALL AS SPECIFIED IN THE SCHEDULE OF QUANTITIES. BATH SPOUT, HAND SHOWERS AND POP UP WASTES SHALL ALSO BE PROVIDED WHEREVER SPECIFIED.

6.6.2 WALL FLANGE SHALL BE KEPT CLEAR OF THE FINISHED WALL. WALL FLANGES EMBEDDED IN THE FINISHING SHALL NOT BE ACCEPTED.

6.7 TOILET PAPER HOLDER

6.7.1 TOILET PAPER HOLDER SHALL BE WHITE GLAZED VITREOUS CHINA OF SIZE, SHAPE AND TYPE SPECIFIED IN THE SCHEDULE OF QUANTITIES OR OF STAINLESS STEEL/POWDER COATED BRASS.

6.7.2 PORCELAIN TOILET PAPER HOLDER SHALL BE FIXED IN WALLS AND SET IN CEMENT MORTAR 1:2 (1 CEMENT: 2COARSE SAND) AND FIXED IN RELATION TO THE TILING WORK.

6.7.3 THE LATTER SHALL BE FIXED BY MEANS OF CREWS/CAPPING HAVING FINISH SIMILAR TO THE TOILET PAPER HOLDER IN WALL/ TIMBER PARTITIONS WITH RAWL PLUGS OR NYLON SLEEVES. WHEN FIXED ON TIMBER PARTITION, IT SHALL BE FIXED ON A SOLID WOODEN BASE EMBER PROVIDED BY THE ENGINEER-IN-CHARGE THROUGH ANOTHER AGENCY.

6.8 ROBE HOOK

6.8.1 ROBE HOOK SHALL BE CHROMIUM PLATED BRASS OR OF STAINLESS STEEL OR POWDER COATED BRASS OF SIZE, SHAPE AND TYPE SPECIFIED IN THE SCHEDULE OF QUANTITIES.

6.8.2 ROBE HOOK SHALL BE FIXED WITH SCREWS/CAPPING HAVING GOLDEN FINISH IN WALL/DOORS WITH RAWL PLUGS OR NYLON SLEEVES AND SHALL INCLUDE SCREWING AND MAKING GOOD AS REQUIRED OR DIRECTED BY THE ENGINEER-IN-CHARGE.

6.9 LIQUID SOAP DISPENSER

6.9.1 LIQUID SOAP DISPENSER SHALL BE WALL/ COUNTER MOUNTED SUITABLE FOR DISPENSING LIQUID SOAPS, LOTIONS, DETERGENTS.

6.9.2 LIQUID SOAP DISPENSER SHALL BE WITH C.P. BRASS BRACKET, CAPS ETC. FIXED TO WALL WITH C.P. BRASS SCREWS, AND SCREWED ONTO WOODEN RAWL PLUG. THE CONTAINER SHALL BE OF C.P. BRASS.

6.10 DRINKING WATER COOLER

6.10.1 WATER COOLER SHALL BE FLOOR MOUNTING TYPE MADE OF STAINLESS STEEL OR ANY OTHER MATERIAL AS GIVEN IN THE SCHEDULE OF QUANTITIES.

6.10.2 THE WATER COOLER SHALL BE WITH C.P. BRASS PUSH COCK, INLET FLOAT VALVE WITH ALL PLUMBING ACCESSORIES UP TO FLOOR DRAIN CONNECTION COMPLETE AS REQUIRED.

6.10.3 AN AQUA GUARD SHALL BE PROVIDED CONNECTING TO WATER COOLER AS GIVEN IN THE SCHEDULE OF QUANTITIES.

6.11 HAND DRIER

6.11.1 THE HAND DRIER SHALL BE NO TOUCH OPERATING TYPE WITH SOLID STATE TIME DELAY TO ALLOW USER TO KEEP HAND IN ANY POSITION.

6.11.2 THE HAND DRIER SHALL BE FULLY HYGIENIC, RATED FOR CONTINUOUS REPEAT USE (CRU).

6.11.3 THE RATING OF HAND DRIER SHALL BE SUCH THAT TIME REQUIRED TO DRY A PAIR OF HANDS UP TO WRISTS IS APPROXIMATELY 30 SECONDS.

6.11.4 THE HAND DRIER SHALL BE OF WALL MOUNTING TYPE SUITABLE FOR 230 V, SINGLE PHASE, 50 HZ, AC POWER SUPPLY.

6.12 MEASUREMENT AND RATES

6.12.1 SANITARY FIXTURES (PORCELAIN WARE AND CP FITTINGS) SHALL BE MEASURED BY NUMBERS.

6.12.2 RATE FOR PROVIDING AND FIXING OF SANITARY FIXTURES, ACCESSORIES, SHALL INCLUDE ALL ITEMS, AND OPERATIONS STATED IN THE RESPECTIVE SPECIFICATIONS AND SCHEDULE OF QUANTITIES AND NOTHING EXTRA IS PAYABLE.

6.12.3 RATES FOR ALL ITEMS UNDER SPECIFICATION CLAUSES ABOVE SHALL BE INCLUSIVE OF CUTTING HOLES AND CHASES AND MAKING GOOD THE SAME, CP BRASS SCREWS, NUTS, BOLTS AND ANY OTHER FIXING ARRANGEMENTS REQUIRED AND RECOMMENDED BY MANUFACTURERS, TESTING AND COMMISSIONING ETC. COMPLETE.

7.0 SOIL, WASTE, VENTS AND RAIN WATER PIPES

7.1 SCOPE OF WORK

Work under this section consists of supplying all labour, materials, equipment and appliances necessary and required to completely install soil, waste, vent pipes as indicated on the drawings and specification. Without restricting to the generality of

the foregoing, the soil, waste, vent and rain water pipes system shall inter-alia include the following:

7.1.1 VERTICAL AND HORIZONTAL SOIL, WASTE, VENT AND RAINWATER PIPES AND FITTINGS, JOINTS, CLAMPS AND CONNECTIONS TO FIXTURES

7.1.2 CONNECTION OF ALL PIPES TO SEWER LINES AS SHOWN ON THE DRAWINGS AT GROUND LEVEL.

7.1.3 FLOOR AND URINAL TRAPS, CLEAN OUT PLUGS, INLET FITTINGS AND RAINWATER (ROOF) OUTLETS.

7.1.4 TESTING OF ALL PIPES AND FITTINGS IN THE WORKSHOP

7.1.5 TESTING OF ALL PIPES LINES AFTER INSTALLATION

7.2 GENERAL REQUIREMENTS

7.2.1 Materials shall be of the approved make and quality specified. They shall conform to the respective Bureau of Indian Standards, British Standards Specifications, supported by Manufacturing Certificate and any other specification referred to herein.

7.2.2 PIPES AND FITTINGS SHALL BE FIXED TRULY VERTICAL, HORIZONTAL OR IN SLOPES AS REQUIRED IN A NEAT WORKMANLIKE MANNER.

7.2.3 PIPES SHALL BE FIXED IN A MANNER SO AS TO PROVIDE EASY ACCESSIBILITY FOR REPAIR AND MAINTENANCE AND SHALL NOT CAUSE OBSTRUCTION IN SHAFTS, PASSAGES ETC.

7.2.4 PIPES SHALL BE SECURELY FIXED TO WALLS, AND CEILINGS BY SUITABLE CLAMPS AT INTERVALS SPECIFIED. ONLY APPROVED TYPE OF ANCHOR FASTENERS SHALL BE USED FOR FIXING PIPES ON RCC CEILINGS AND RCC/ MASONRY WALLS.

7.2.5 ACCESS DOORS FOR FITTINGS AND CLEAN OUTS SHALL BE SO LOCATED THAT THEY ARE EASILY ACCESSIBLE FOR REPAIR AND MAINTENANCE.

7.2.6 SHORT OR LONG BENDS SHALL BE USED ON ALL MAIN PIPELINES AS FAR AS POSSIBLE. USE OF ELBOWS SHALL BE RESTRICTED FOR SHORT CONNECTIONS.

7.2.7 WHEREVER PIPING IS GOING ACROSS THE SEPARATION / EXPANSION JOINTS OF BUILDINGS, PIPING SHALL BE PROVIDED WITH FLEXIBLE

CONNECTORS ON BOTH SIDES OF SUCH JOINTS OR ON SINGLE SIDE DEPENDING ON WHETHER ANY WALL IS TO BE CROSSED OR NOT.

7.3 INTERNAL & EXTERNAL DRAINAGE (UPVC PIPES)

7.3.1 Unplasticised P.V.C. Pipes:

U.P.V.C. Pipes for Rain Water, Planter and AC drains shall conform to I.S.13592- 1992 (type - B, SWR quality) for concealed pipe within the toilet sunk portion. The jointing of the pipes shall be in solvent cement joints. All the shaft piping shall conform to I.S.13592-1992 (type - B, SWR quality). Vent Piping shall conform to I.S.13592- 1992 (type - A, SWR quality). All jointing in the shaft shall be by rubber ring joints. Rubber rings shall conform to IS 5382 and fittings to BS 4515 DIN 19531 & 19534. All the fittings like tees, bends, couplers cross etc. shall conform to IS 7834-1975. The joints of U.P.V.C. Pipes recommended shall be solvent cement, flanged, or threaded, joints. Pipes and fittings shall be free of any defects like cracks, etc.

7.3.2 STORAGE AND HANDLING:

U.P.V.C. Pipes: The pipes should be given adequate support at all times. Pipes should be stored in a reasonably flat surface free from stones and sharp projection so that the pipe is supported throughout its length. In storage, pipes racks should provide continuous support and sharp corners of Metal Racks should be avoided. Socket and spigot pipes should be stacked in layers with sockets placed at alternate ends of the stacks to avoid top sided stacks. It is recommended not to store pipe inside another pipe.

On no account pipes shall be stored in a stressed or bent condition or near the source of heat.

Pipes should not be stacked more than 1.5M high and pipes of different sizes and classes should be stacked separately.

The ends of pipes should be protected from abrasion particularly those specially prepared for jointing either by spigot or socket solvent welded joints or soldered for use with couplings.

If due to unsatisfactory storage or handling a pipe becomes kinked' the damaged portion should be cut out completely.

Kinking' is likely to occur in very thin walled pipes.

7.3.3 Jointing of unplasticised P.V.C. pipes:

Methods of Jointing:

a) Solvent Welded Joints

b) White cement & linseed oil mixture (Connection of U.P.V.C. to Cast Iron)

c) Screwed or threaded Joints

d) Rubber ring joints

7.3.4 Solvent Welded Joints:

This technique is used with spigot and socket type joints, in which the socket is made specially to form a close fit on the pipe end and with injection moulded/fabricated fittings.

Solvent Cement of Supreme Industries Ltd. Or equivalent make shall be used as per the recommendations of the manufacturers. The dust, oil, water grease etc. should be wiped out with dry cloth from the surface to be coated with solvent cement. The coating of solvent cement shall be applied evenly on the inside of the fittings for full length of insertion and then on the outside of the pipe end up to the marked line and the pipe twisted to a quarter of a turn to spread the cement evenly at the same time ensuring the pipe, pushed home fully into the socket. The pipe should be pushed into the fitting socket and held for one to two minutes as otherwise the pipes comes out of the fitting due to slippery quality of cement and the tapering inside bore of the fitting.

The surplus cement on the pipe surfaces shall be wiped out. In most of the cases the pipe inserted should be up to the marked line and in no case shall be less than 2/5 of the diameter of the pipe and up to marked line.

When the joint is made, the remaining cement on the pipe surfaces shall be wiped off immediately without fail as the continued action of solvent cement will weaken the wall on the pipe and cause failure under pressure.

Since solvent cements are inflammable they should not be used near the naked flames. In certain cases fumes given off from cement may be a source of danger if not carried in a well ventilated area.

When not in use containers of cement should be kept closed tightly to avoid loss of solvent or entry of dirt. Cement which has gelled or hardened should be discarded and removed from the site.

7.3.5 Rubber Ring Joints Or 'O' Ring Shrink Joints (Shaft Piping):

Unplasticized P.V.C. Pipe may be joined by employing approved rubber ring to provide the water tight seal. The ring may be housed in groove formed in a plastic or metallic housing. The rubber is compressed and makes a seal between the pipe and the housing.

U.P.V.C. Pipes to be connected to cast iron pipes shall be joined by using putty (mixture of white cement and linseed oil) as directed by Engineer-in-charge and as shown in the Drawing.

7.3.6 Traps:

General: Provide traps on all fixtures connected to the waste system, except for fixtures having integral traps. All traps

Suspended `P' Traps Inside Building: Provide heavy C.I. sealed gully traps, with single or double inlet as shown. Provide cast iron sealed cover for each trap secured with threaded gun metal bolts and felt gaskets of size 150mm square.

7.3.7 Fixing to supports:

The pipes and specials or fittings before being laid or fixed shall be examined to see that there are no cracks or defects. The pipes and fittings shall be thoroughly cleaned of all dust and dirt. After laying or fixing the pipes in position they shall be arranged in such a way that centre line of pipes coincide with the centre line of the alignment. Fittings, cleanout and floor drains shall also be laid in their position as stated above. U.P.V.C. Pipes shall be fixed vertically in shaft by means of U.P.V.C. clips anchored to walls using P.V.C. washers, G.I. Screws and Fibre Glass Plugs. In case of pipes laid horizontally, pipes shall be supported on G.I. Brackets/Hangers of approved design.

All pipes laid shall have its open ends securely closed with wooden plugs during progress of work.

Pipes and fittings shall be fixed by using proper approved holder bat clamps and special hangers. The pipes shall be fixed perfectly vertical or in a line as directed or as shown in the drawings. The Vertical Pipes shall have supporting CLAMPS at 1.5 Meter C/C and pipes laid horizontally, at every 1- 2 Meter C/C as shown in the Drawing or as directed. Vertical spacers shall be fixed after the first coat of plaster.

7.3.8 Testing:

All U.P.V.C. Soil, Waste, Vent, Antisyphonage and Fittings shall be tested by smoke test and left in working order after completion. The smoke test shall be carried out as stated below: Smoke shall be pumped into the Drain pipes at the lowest level from a smoke machine which consists of a bellow and a burner.

The materials usually burnt are greasy cotton waste which form clear pungent smoke which is easily detectable by sight as well as by smell if leaking at any point of the drain. During testing if any joint is found leaking the same shall be rectified by the Contractor at no extra cost & to the satisfaction of the Engineer-in-charge.

7.4 CUTTING AND MAKING GOOD HOLES / CHASES

PIPES SHALL BE FIXED AND TESTED AS THE BUILDING WORK PROCEEDS. CONTRACTOR SHALL PROVIDE ALL NECESSARY HOLES, CUT OUTS AND CHASES IN STRUCTURAL MEMBERS AS THE BUILDING WORK PROCEEDS. WHEREVER HOLES ARE CUT OR LEFT ORIGINALLY, THEY SHALL BE MADE GOOD WITH CEMENT CONCRETE 1:1:2 (1 CEMENT: 1COARSE SAND :2 STONE AGGREGATE 20MM NOMINAL SIZE) OR CEMENT MORTAR 1:2 (1

CEMENT :2 COARSE SAND) AS DIRECTED BY THE ENGINEER-IN-CHARGE AND THE SURFACE RESTORED AS IN ORIGINAL CONDITION TO THE ENTIRE SATISFACTION OF THE ENGINEER-IN-CHARGE AT NO EXTRA COST.

7.5 INSERTS & SLEEVES:

Network layout work done in advance of placing concrete slabs or construction of walls, will furnish and set inserts and sleeves necessary to complete the work. Cost of cutting or patching work necessary as a result of this operation shall be at no expense to the Owner. Openings shall be as per structural consultant's approval.

7.6 CLEAN OUT PLUGS

Floor clean out plugs shall be provided on head of each long drain / header at location indicated on plans or as directed by the Engineer-in Charge. Clean out plugs shall be of size matching the full bore of the pipe leading to it which shall be 110 mm dia unless stated otherwise. The clean out plugs shall be threaded and provided with keyholes for opening. Top of this cover shall be 15 mm above the top of slab. A removable flooring / tile will rest on this on a bed of rubber sheet as shown in drawing.

7.7 CLAMPS

7.7.1 Holder bat clamps shall be of standard design fabricated from MS flats 40x3mm thick and 12mm dia MS rod and 6mm nuts and bolts; painted with two coats of black bitumen paint before fixing. The clamps shall be fixed in cement concrete 1:2:4 mix (1 cement: 2 sand: 4 stone aggregate 20mm nominal size) blocks 100x100x100mm deep.

7.7.2 Where holder bat clamps are to be fixed in RCC column or slotted angles, walls or beam they shall be fixed with 40x3mm flat iron "U" type clamps with anchor fasteners of approved design.

7.7.3 Structural clamps shall be fabricated from MS structural members e.g. rods, angles, channels, flats as per detailed drawing or as directed. Contractor shall provide all nuts, bolts, welding material and paint the clamps with one coat of red oxide and two or more coats of black enamel paint to give an even shade.

Angles / channels

Slotted angle/ channel supports on walls shall be provided wherever shown on drawings. Angles/channels/ bolts shall be of sizes shown on drawings or specified in Schedule of Quantities. Angles / channels shall be fixed to brick walls with bolts embedded in cement concrete blocks of 1:2:4 mix (1cement: 2sand: 4 stone aggregate 20mm nominal size) and to RCC walls with suitable anchor fasteners as directed by the Engineer-in-Charge. The spacing of support bolts horizontally shall not exceed 1m.

7.8 HANGERS AND SUPPORTS

Hangers are provided to support water supply or drainage pipes when they run parallel to the ceiling in space.

General

Proper solid angle iron / channel section, supports shall be provided for all pipes complete with clamps. Wherever insulations come, wooden guide to support pipe on the angle iron hangers / supports, shall be provided. For attachment on concrete, “Dash” fasteners or Anchor plug tube inserts or equivalent shall be used. Hangers shall be provided within 90 mm of all changes in direction of main and minimum of three hangers per expansion band wherever shown in drawing. Any additional structural steel angles, channels or other members not specifically shown but are required for proper support, shall be provided.

Where necessary, additional hangers to be provided to arrest water hammer or hydraulic resonance with proper rubber padding.

Hanger Spacing

Hangers shall be spaced as noted below, except on all soil pipe which shall have a hanger of multiple fittings, sufficient no. of hangers shall be provided to maintain proper slope without sagging.

Pipe size in mm	Hanger Rod Dia
20 through 50	10 mm
65 through 125	12 mm
150 and above	15 mm

Pipe sizes	Spacing of supports
12 to 20 mm	1.5 m apart
25 to 40 mm	2 m apart
50 above	2 m apart

Hanger Supports

Provide floor stands, wall brackets or masonry piers etc. for all lines running near the floor or near walls. Pipes may be hung also by hangers carried from wall brackets at a higher level than pipes. Hanging of any pipe from another is prohibited.

For pipes running in shafts, they should be fixed away from the wall by supporting on an angle projecting from the wall and the pipe fixed to the angle by ‘U’ bolt and nut.

7.9 TRAPS

7.9.1 Floor Traps

(a) The PVC floor trap shall be of multi inlet and one single outlet type. The floor trap shall be deep seal type with an effective seal of minimum 75mm. The waste from sanitary fixtures shall be directly discharged to the floor trap. Jointing of the waste pipe to the floor trap shall be done as per manufacturer's instructions. The height riser fitting shall be made use of, wherever the floor drain is located in deep-sunk floors or is suspended from the ceiling. The floor trap shall be of reputed make and preferably of the same make as of the pipes used.

(b) The floor trap shall be provided with 150 x 150mm square or circular cast bronze CP or stainless steel frame and grating of approved design. Frame and grating shall be of a make and model approved by the client / consultants.

7.9.2 Urinal Traps

a) The urinal trap shall be double outlet type. The traps shall be deep seal type with an effective seal of minimum 75mm. The outlet from urinals after the trap shall be directly discharged to the floor trap. The floor trap shall be provided with 150 x 150mm SS or cost bronze chrome plated frame with screw type cover for airtight fitting. Frame and cover shall be of a make and model approved by the client / consultants.

7.9.2 Cockroach Traps

(a) Floor/ urinal traps shall be provided with 100-150mm square or round stainless steel cockroach trap assembly complete with ring, outer cup, inner cup, jali etc. of an approved make.

7.10 MEASUREMENTS AND RATES

7.10.1 General

(a) Rates for all items shall be inclusive of all work and items called for in the specifications given above and the Schedule of Quantities as applicable for the work under floors, in shafts or at ceiling level at all heights and depths.

(b) All rates are inclusive of cutting holes and chasing in RCC and masonry work and making good the same.

(c) All rates are inclusive of supply of material and labour for installation and shop testing, pre-testing at site and final testing of the installations, materials and commissioning.

7.10.2 Pipes

(a) The unit of measurement shall be linear metre to the nearest centimetre.

(b) All PVC soil, waste, vents, anti-siphonage and rain water pipes shall be measured net, correct to a centimetre, including all fittings along their length after fixing. The length shall be taken along centre line of the pipes and fittings. No allowance shall be made for the portions of pipe lengths entering the sockets of the adjacent pipes or fittings. The above shall apply to all cases i.e. whether pipes are fixed on wall face or pillars or embedded in masonry or pipes running at ceiling level.

7.10.3 Pipe Encasing/ supports

Cement concrete around pipes shall be measured along the centre of the pipe line measured per linear metre and include any masonry supports, shuttering and centring, curing, cutting etc. complete as described in the relevant specifications.

7.10.4 Clamps

Wherever MS clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement, RCC block and making good with cement concrete 1:2:4 mix (1 cement:2 sand:4stone aggregate 20mm nominal size) as directed by the Engineer-in-Charge.

7.10.5 Angles/ channels

Slotted angles/ channels shall be measured per linear metre of finished length and shall include support bolts and nuts, length embedded in the cement concrete blocks of 1:2:4 (1cement: 2 coarse sand: 4 stone aggregate 20mm nominal size) formed in the masonry walls; nothing extra shall be paid for the cement concrete block and making good the masonry wall, anchor fasteners etc. complete.

7.10.6 Traps

Unit of measurement shall be the number of pieces. All urinal traps, trap gratings, hoppers, clean out plugs shall be measured by number and shall include all items described in the relevant specifications and Schedule of Quantities. Cockroach traps shall not be measured separately and are deemed to be included in the rate for Traps.

7.10.7 Painting

Painting of pipes shall be measured per running metre for each diameter of pipe and shall be inclusive of all fittings and clamps. No deduction shall be made for fittings.

7.10.8 Excavation for soil pipes

No extra payment shall be admissible for excavation, dewatering, back filling, consolidation and disposal of surplus earth for soil and waste pipes.

8.0 EXTERNAL SEWERAGE SYSTEM AND SEWER APPURTENANCES

8.1 SCOPE OF WORK

WITHOUT RESTRICTING TO THE GENERALITY OF THE FOREGOING, THE DRAINAGE SYSTEM SHALL INTER-ALIA INCLUDE:

8.1.1 Sewer lines including earthwork for excavation, disposal, backfilling and compaction, pipelines, gully traps, grease traps, inspection chambers, manholes, drop connections and connections to the municipal or existing sewer.

8.1.2 Storm water drainage, earth works for excavation, disposal, backfilling and compaction, pipe lines, manholes, catch basins and connections to the existing municipal storm water drain or connected as indicated by the Engineer-in-Charge.

8.1.3 Testing of all pipe lines and the full system after installation.

8.2 GENERAL REQUIREMENTS

All materials shall be new and of quality conforming to specifications and subject to the approval of the Engineer-in-Charge. Wherever particular makes are mentioned, the choice of selection shall remain with the Engineer-in-Charge.

Drainage lines and open drains 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.

LOCATION OF ALL MANHOLES, ETC. SHALL BE GOT CONFIRMED BY THE ENGINEER-IN-CHARGE BEFORE THE ACTUAL EXECUTION OF WORK AT SITE.

All materials shall be rust proofed; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion

8.3 S.W. GULLY TRAPS

8.3.1 The Trap

Stoneware gully traps shall conform to IS 651:1992. These shall be sound, free from visible defects such as fine cracks or hair cracks. The glaze of the trap shall be free from crazing. They shall give a sharp clear note when struck with light hammer. There shall be no broken blisters.

The size of the gully trap shall be specified along with dimension and shall be installed in a chamber as described hereafter.

It shall be fixed on 15 cm. thick and 70 cm square 1:4:8 cement concrete bedding and the gully outlet shall be jointed. Construction of gully trap chamber shall be as indicated in the drawing. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating and the bottom of the chamber shall not be less then 230 mm. In addition to 150mm x 150mm CI grating, the chamber shall have a CI frame cover (300mm x 300 mm). It shall then be placed on top of the brick masonry. The frame and sealed cover shall weigh not less than 7.3 kg. Where ever necessary, sealed cover shall be replaced with CI grating of same size.

8.3.2 Gully trap- brick masonry chamber

After fixing and testing gully and branch drain, a brick masonry chamber shall be constructed as indicated in the drawing in second class brick in cement mortar 1:5 (1 cement : 5 fine sand). The chamber shall be built with a 115 mm thick brick work

round the gully trap from the top of the bed concrete up to ground level. The bedding shall be a 700 mm square in 1:4:8 cement concrete. The gully outlet shall be jointed to PVC pipes. The space between the chamber walls and the trap shall be filled in with cement concrete 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate). The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside with cement mortar 1:3 (1 cement: 3 coarse sand) finished with a floating coat of neat cement, the corners and bottom to the chamber shall be rounded off so as to slope towards the grating and form a hopper.

C.I. cover with frame 300 x 200 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete 1:2:4 (1 cement: 2 coarse: 4 graded stone aggregate 20 mm normal size) and rendered smooth. The finished top of cover shall be left about 4 cm. above the adjoining ground level so as exclude the surface water from entering the gully trap.

8.4 GREASE TRAP CHAMBERS

8.4.1 Design considerations

Design considerations are broadly based from the spacing of building line. The location and sizes are shown in the drawings. Bed concrete shall be in 1:4:8 cement concrete 100 mm thick. Brickwork shall be with best quality table moulded bricks in 1:6 cement mortar as per specification for brick masonry. Inside walls of manholes shall be plastered with 15mm thick cement plaster 1:3 mixed with waterproofing compound and finished smooth with a floating coat of neat cement. External walls shall be plastered in CM 1:3 and sponge finished. Covers and baffle slab should be as per the structural drawings.

8.4.2 Grease racking arm

Grease collected at the upper portion of the chamber shall be removed using raking arm made of galvanized MS with length and breadth as shown on the drawing.

8.5 Reinforced cement concrete pipes (NP-3 Class)

ALL UNDERGROUND SEWER LINES WHERE SPECIFIED (OTHER THAN THOSE SPECIFIED AS CAST IRON) SHALL BE CENTRIFUGALLY SPUN S&S RCC PIPES OF SPECIFIED CLASS CONFORMING TO IS: 458. PIPES SHALL BE TRUE AND STRAIGHT WITH UNIFORM BORE, THROUGHOUT. CRACKED, WARPED PIPES SHALL NOT BE USED ON THE WORK. ALL PIPES SHALL BE TESTED BY THE MANUFACTURER AND THE CONTRACTOR SHALL PRODUCE A CERTIFICATE TO THAT EFFECT FROM THE MANUFACTURER.

8.5.1 LAYING

RCC S&S 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 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 bonding rods etc. Cradles or concrete bed may be omitted, if directed by the Engineer-in-Charge.

8.5.2 Jointing of pipes

(a) Tarred gaskin shall first be wrapped round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid, the pipe shall then be adjusted and fixed in its correct position and the gaskin caulked tightly home so as to fill not more than one quarter of the total length of the socket.

(b) The remainder of the socket shall be filled with stiff mix of cement mortar (1 cement: 1 clear sharp washed sand). When the socket is filled, a fillet shall be formed round the joint with a trowel forming an angle of 45 degrees with the barrel of that pipe. The mortar shall be mixed as needed for immediate use and no mortar shall be beaten up and used after it has begun to set.

(c) After the joint has been made any extraneous materials shall be removed from the inside of the joint with a suitable scraper of "badger". The newly made joints shall be protected until set, from the sun, drying winds, rain or dust. Sacking or other materials which can be kept damp shall be used. The joints shall be exposed and space left all around the pipes for inspection by the Engineer-in-Charge. The inside of the sewer must be left absolutely clear in bore and free from cement mortar or other obstructions throughout its entire length, and shall efficiently drain and discharge.

8.5 INSPECTION CHAMBERS AND MANHOLES

8.6.1 Scope of work

This section will include all the inspection chambers and manholes of all specified sizes, within as well as out side the building but within the premises.

8.6.2 General requirements

Where depth of sewer is less than 1.2 m and where ever it is within the building, rectangular chambers shall be used having size as specified. The size shall be 450 x 900 up to a depth of 1.0 m and 600 x 900 mm for inspection chamber depth between 1.0 m and 1.5 m or up to within the building, whichever is deeper. These shall be constructed in the sewer line at such places and levels and dimensions as indicated on the drawings. Sizes specified shall be clear internal dimensions of the chamber.

Outside the building, where the depth of sewer exceeds 1.5 m, circular conical manholes with 500 diameter cover shall be provided. Various types and sizes of manholes are specified for different depths. Typical drawing of various types of manholes shall be supplied to the contractors. In the absence of such drawings the standard drawings of the BMC sewerage department or local body if available shall be followed.

(Depth of the sewer line shall be measured from the finished Ground level. Invert level shall be with reference to the GTS or whichever reference level given by Engineer-in charge).

8.6.3 Location and sizes

The size indicated in the drawings shall be the internal size of chamber. Unless otherwise specified, manholes and inspection chambers are provided at all changes of direction of drains and where branch drain meets the main drain. Chambers shall be of such size as to allow necessary examination and clearance of drains. The minimum internal sizes shall be taken as per detail drawings; standards specified and local byelaws if any. In the absence of local byelaws, the requirements stipulated in IS 4111 (Part I) Code of Practice for Ancillary Structures on Sewage System shall be followed. The work shall be done strictly as per standard drawings and following specifications:

8.6.4 Excavation

This shall be done to dimensions and levels on the drawings.

8.6.5 Bed Concrete

Bed concrete shall be in 1:4:8 cement concrete, 150 mm thick for inspection chambers, 230 mm thick for depths up to 2.1 m and 300 mm thick for greater depths in case of manholes or as specified by the Engineer-in-Charge.

8.6.6 Brick Masonry / RCC

Brickwork shall be with best quality table moulded bricks in 1:5 cement mortar as per specification for brick masonry. The thickness of masonry shall be as indicated on the drawings. RCC walls shall be as per structural design.

8.6.7 Plaster

Inside walls of chambers / manholes shall be plastered with 12mm thick cement plaster 1:3 mixed with waterproofing material and finished smooth with a floating coat of neat cement. External walls shall be plastered in CM 1:3 and sponge finished.

8.6.8 Vata

75 mm fillet shall be made with C.M. 1:3 all round the external joint between the bed concrete and brick masonry wall of manhole.

8.6.9 Benching

Channels and benching inside the inspection chambers and man holes shall be done in cement concrete 1:2:4, rendered smooth with neat cement. The channel

provided shall be of semicircular shape of the same diameter as the diameter of the sewer with vertical walls. The depth of channel shall be equal to the sewer diameter and the P.C.C. benching top will have a slope of 1 in 12 from the side walls to the channel.

The following sizes of channels for the bench shall be adopted:

Size of Drain	Depth of Centre	Depth at sides i.e., at walls
100 mm (4``)	150 mm (6``)	250 mm (10``)
150 mm (6``)	200 mm (8``)	300 mm (12``)
200 mm (8``)	250 mm (10``)	350 mm (14``)

8.6.10 PCC cap

PCC M: 15 cap of 150 mm thickness shall be provided on top of manholes or inspection chambers for fixing the manhole frame.

8.6.11 Chamber / manhole covers

Covers shall be of heavy-duty cast iron or fibre reinforced cement concrete as indicated in the drawings with lifting hooks as per IS1726-1974 and as per the details given in the drawings. The covers shall be fixed on the frame in cement concrete. Covers placed on the frames shall be airtight. Manholes and inspection chambers which are provided on roads or where heavy vehicular traffic is expected are provided with heavy duty C.I. airtight frame and cover. For those built on foot paths carriage drives and cycle tracks, medium duty covers are provided. For locations within domestic, premises or areas not subjected to wheel traffic loads they shall be provided with light duty cover.

Approximate weights for various dimensions of frames and cover of various dimensions shall be as follows:

Size	Heavy Duty	Medium Duty	Light Duty
Rect 450 x 900	230	200	50
Rect 600 x 900	275	251	70
Circular 500 dia	238	125	

The cover and frames shall be neatly cast and shall be free from air and sand holes. They shall be neatly pressed and carefully trimmed. All casting shall be free from voids either due to shrinkage or other causes. Covers shall have raised chequer design on the top surface to provide adequate non slip grip. The cover shall be capable of easy opening and closing and it shall be fitted in the frame in a work manlike manner. Covers shall be gas and water tight. Size of the cover and

frames shall be as per drawing and schedule. Sand shall be coated with a black anticorrosive paint of bituminous composition.

The coating shall be smooth and tenacious. It shall not flow at 63 °C and shall not drip off at 0 °C the covers shall be so fixed as to be flush with ground surface. After completion, the manhole covers shall be sealed by means of grease.

8.6.12 Steps

Steps shall be provided wherever the depth of the manhole / chamber is more than 1.2 m. Foot rest shall be C.I. rungs weighing 5.3 kg and conforming to IS 5455-1969 or made up of 20 mm diameter M.S. square or round bars as specified. These shall be embedded 20 cm deep in 20 × 20 × 10 cm blocks of P.C.C. 1:3:6. The blocks with M.S. or C.I. foot rest placed in its centre shall be cast in site along with masonry.

Footrest shall be placed 300 mm apart vertically and 375 mm horizontally in staggered fashion. First footrest shall be 450 mm below top. Footrest shall be painted with bituminous paint and the portion embedded shall be painted with thick cement slurry before fixing.

8.6.13 Reinforced cement concrete manholes

In high sub soil water conditions / filled up soil, manholes shall be constructed in reinforced cement concrete to grade M20 (IS 456). The manhole preferably shall be circular type. The base and walls shall be designed for all loads coming over including the earth and water pressure.

8.6.14 Testing

Manhole after it is raised above highest expected subsoil water level in monsoon shall be tested for water tightness. The mouths of all pipes entering the manhole shall be suitably plugged with brick masonry or wooden or any other type of plug. Manhole under test shall then be filled with water up to general subsoil water level and the level observed for one hour, it shall then be deemed as watertight. During testing the pit around shall be kept free of water and contractor shall observe the places where leakage takes place and take steps to correct the same.

8.7 DROP CONNECTIONS

In case the difference in invert levels between the main drain and the branch line requires a drop of more than 600 mm, a drop connection should be provided with a cast iron or stoneware four way junction, fixed at right angles to the drop pipe at the level where the branch pipe enters the manhole. Access for cleaning the bend should be provided at finished ground level. A typical drawing for drop connection shall be supplied to the contractor.

8.7.1 Excavation

The excavation shall be done for drop connection at the place where the branch line meets the manhole. The excavation shall be carried up to the bed concrete of the manhole and to the full width of the branch line.

8.7.2 Laying

At the end of branch sewer line a stoneware cross junction shall be fixed in the line which shall be extended through the wall of the manhole by a horizontal piece of S.W. pipe to form an inspection cleaning eye. The open end inside the manhole shall be closed by providing chain and lid. The stoneware drop pipe shall be connected to the cross at the top and to the S.W. bend at the bottom. The bend shall be extended through the wall of the manhole by a piece of S.W. pipe which shall discharge into a channel. Necessary channel shall be made with cement concrete 1:2:4 and finished smooth to meet the main channel in the direction of flow. The joint between S.W. pipe and fittings shall be cement mortar 1:1.The exposed portion of the drop connection shall be encased all round with single brick work in cement mortar 1:3 and plastered with cement mortar 1:3 on the inside of the manhole wall. The excavated earth work shall be backfilled in the trench in level with the original ground level.

The top arm of the cross shall be covered with a tile or the arm of cross extended up to ground level by another S.W. pipe and then covered; to act as clean out for vertical portion of the drop and shall be encased in brick work as for the drop pipe. The dia. of drop shall be 150 mm up to the sewer dia. of 300 mm.

8.8 MEASUREMENTS AND RATES

8.8.1 General

(a) Rates for all items shall be inclusive of all work and items called for in the specifications given above and the Schedule of Quantities as applicable for the work under floors, at all depths.

(b) All rates are inclusive of cutting holes and chasing in RCC and masonry work and making good the same.

(c) All rates are inclusive of shop testing, pre-testing at site and final testing of the installations, materials and commissioning.

8.8.2 Traps

(a) The gully trap shall be enumerated. Excavation shall be measured separately under relevant items of earth work or may be clubbed with the item.

(b) The rate shall be per number and will include the cost of material and labour involved in all the operations described above.

8.8.3 Inspection chambers and manholes

a) Measurement

Manholes, inspection chambers, gullies etc. shall be enumerated under relevant items in the schedule of quantities. Depth shall be measured from top C.I. cover to the invert of channel. Depth shall be measured as an extra over the depth specified under enumerated item and paid per running meter under separate item following the main item. Weight and duty of cover and frame shall be specified in the item.

b) Rates

The rate shall include the cost of material and labour involved in all the operations from above up to specified depth in the item. Excavation and refilling is generally paid for separately under relevant item or excavation can be clubbed with the item of manholes, but in that case maximum depth will have to be specified in the item. If the duty of the cover in the item is changed during execution by the Engineer-in-charge amount due to difference in weight of the cover shall be paid extra or deducted as the case may be.

8.8.4 Drop Connections

a) Measurement

Drop connection shall be enumerated. The depth beyond 760 cm shall be measured in running meters correct to a cm. under relevant items. This extra depth will be measured as difference of invert levels of main and meeting sewer minus 600 mm where the S.W. pipe is extended up to ground level for vertical clean out, the extra depth will be equal to depth of manholes minus 600 mm.

b) Rates

The rate shall include the cost of material and labour involved in all the operations described above but excluding the cost of excavation refilling for a specified height and of 600 mm depth above 600 will be paid as extra over per meter.

8.9 HIGH DENSITY POLYETHYLENE PIPES (HDPE)

8.9.1 Scope of work

The section includes all HDPE pipes, their joinery, fittings, laying, excavation, backfilling and making good. In this project, HDPE pipes are used in the system,

from inspection chambers to inspection chambers to manholes. They are used within as well as outside the building and under the road.

8.9.2 General Requirements

(a) Regarding guidance for laying and joining of polyethylene pipe, including storage and handling, a reference may be made to IS 7634 (Part 2) : 1973 'Code of practice for plastic pipe work for potable water supplies : Part 2 Laying and jointing polyethylene (PE) pipes'.

(b) The color of the pipe shall be black.

(c) High density polyethylene (HDPE) used for the manufacture of pipes shall conform to designation PEEWA-45-T-006 of IS 7328: 1992. HDPE conforming to designation PEEWA-45-T-012 of IS 7328: 1992 may also be used with the exception that melt flow rate (MFR) shall not exceed 1.10 g/10 min.

(d) When tested from a composite sample of minimum three pipes as per IS 2530:1963, at 190° C with nominal load of 5 kgf, Melting Flow Rate shall be between 0.4 to 1.1 g/10 min (both inclusive) and also shall not differ by more than 20 percent of the MFR of the material used in manufacturing pipes declared by the manufacturer.

(e) The percentage of anti-oxidant used shall not be more than 0.3 percent by mass of finished resin.

The outside diameter of pipes, tolerance on the same and ovality of pipe shall be as given in table.

Nominal Diameter, DN	Outside Diameter, mm	Tolerance, mm	Ovality,mm
63	63.0	0.6	1.5
75	75.0	0.7	1.6
90	90.0	0.9	1.8
110	110.0	1.0	2.2
125	125.0	1.2	2.5
140	140.0	1.3	2.8
160	160.0	1.5	3.2
180	180.0	1.7	3.6

Nominal Diameter, DN	Outside Diameter, mm	Tolerance, mm	Ovality,mm
200	200.0	1.8	4.0
225	225.0	2.1	4.5
250	250.0	2.3	5.0
280	280.0	2.6	9.8
315	315.0	2.9	11.1
355	355.0	3.2	12.5
400	400.0	3.6	14.0
450	450.0	4.1	15.6
500	500.0	4.5	17.5
560	560.0	5.0	19.6
630	630.0	5.7	22.1

(g) When tested from a composite sample of minimum three pipes, in accordance with IS 2530:1963, the carbon black content shall be within 2.5 (+-) 0.5 percent and the dispersion of carbon black shall be satisfactory.

(h) Tolerance on outside diameter and maximum ovality:

The values specified for tolerance on outside diameter have been calculated as 0.009 DN, rounded off to the next higher 0.1 mm, subject to minimum of 0.3 mm. No negative tolerances are allowed.

(i) The pressure rating of HDPE pipes specials shall be confirming to IS: 14333 or equivalent international standard with temperature & maximum allowable operating pressure criteria as per IS: 14333.

(j) Each straight length of the pipe shall clearly be marked in inedible ink/paint (inkjet printing) at every one meter with the following information:

i) The manufacturer's name and /trademark

ii) Designation of the pipe as per the standard specified.

iii) Lot number/Batch number/year of mfg.

iv) The words "PROJECT NAME".

k) All HDPE fabricated fittings shall be manufactured from the pipe itself made out of same raw material & dimensions as specified above. Necessary certificate to be provided by the manufacturer. No fabrication or moulding will be allowed at site, unless specifically permitted by the Engineer.

Manufacturer to provide drawings for HDPE fittings and non HDPE specials

8.9.3 Carting and handling

(a) Pipes and fittings / specials shall be transported from the factory to the work site places along the alignment of pipeline as directed by the Owner's representative.

(b) Contractor shall be responsible for the safety of pipes and fittings / specials in transit, loading / unloading. Every care shall be exercised in handling pipes and fittings / specials to avoid damage.

(c) While unloading the pipes and fittings / specials shall not be thrown down from the truck on to hard surface. They should be unloaded on timber skids with steadying ropes or by any other approved means.

(d) As far as possible pipes shall be unloaded on one side of the trench only. The pipes shall be checked for any visible damage while unloading and shall be sorted out for reclamation.

(e) Polythene is a tough resilient material which may be handled easily. However, because it is softer than metals it is more prone to damage by abrasion and by objects with a cutting edge. Such practices as dragging coils over rough ground should therefore be avoided.

(f) If, due to unsatisfactory storage or handling, a pipe is damaged or 'kinked', the damaged portion should be cut out completely.

(g) The material is not affected by low temperatures as much as are some other plastics materials, and there is no need of more cautious handling during cold weather.

8.9.4 Storage

(a) Black polythene pipe may be stored either under cover or in the open. It is suitably protected from ageing due to sunlight by the addition of the appropriate quantity and type of carbon black. Natural polythene pipe should be stored under cover and protected from direct sunlight.

(b) Coils may be stored either on edge 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.

(c) Storage of pipes in heated areas exceeding 27° C should be avoided.

8.9.5 Pipe laying and fixing

(a) While laying the pipe in trenches, the bed of the trench should be level and free from sharp edged stones. While laying in rocky areas suitable bed of sand or gravel should be provided. The initial back fill to about 10 to 15 cm above the pipe should be fine sand or screened excavated material. Where hard rock is met with, bed concrete M-100, 15 cm thick may be provided, before putting in the soft sand / gravel.

(b) All precautions shall be taken during laying operations to guard against possible damage to any existing structure / pipeline or water, gas, sewage etc. all pipes, fittings / specials shall be laid under the expert supervision of the pipe manufacturer. After excavation of trenches, pipes shall not be lowered unless the dimensions of trenches and bedding work for pipes at the bottom of the trenches are approved and measured by Engineer / Engineer's representative.

(c) Pipes and fittings / specials shall be carefully lowered in the trenches. Special arrangements such as cranes, tripods with chain pulley block for lowering the pipes and fitting / specials shall be made by Contractor.

(d) All the pipes are to be laid perfectly true both in alignment and to gradient specified.

(e) The laying of pipe shall always proceed upgrade of a slope. The pipes shall be secured in a place with approved backfill material tamped under it.

(f) Pipes and fittings / specials which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipes and fittings / specials of proper dimensions to ensure such uniform space.

(g) Precautions shall be taken to prevent dirt from entering the jointing space.

(h) At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by Owner's Representative.

(i) Provisions shall be made for the effects of thermal movement. Between the anchors for suspended pipes, the support should not grip or distort the pipe, but should allow free movement of the pipe due o temperature variation.

(j) Plastic pipe shall not be laid near hot water pipes or near any other heat sources.

8.9.6 Jointing

Jointing for pipes and fittings / specials shall be done in accordance with the relevant Owner's Requirements depending upon types of pipe being used.

The commonly used joints for HDPE pipes are as follows:

(a) Insert type joints

(b) Fusion welding

(c) Threaded joints

(d) Flanged joints

(e) Telescopic joints

8.9.7 Fittings

There are insert type of fittings of both plastic and metals available for use with PE pipes. In corrosive locations, plastic pipes are preferred because of their high resistance to corrosion. In less corrosive conditions, gun metal fittings are frequently used and in normal or slightly corrosive environments, brass fittings are commonly employed. In certain cases, threaded malleable cast iron fittings are used.

8.9.8 Testing

(a) All pipe work, fittings and appliances shall be inspected and tested hydraulically after the completion of installation. Before starting any test, the systems shall be visually inspected to ensure that the recommendations for the correct installation procedure have been compiled with, and that the pipe line together with appliances, valves and fittings are laid in the prescribed manner. Solvent welded pipe lines should not be pressure tested until at least 24 hours after the last solvent welded joint has been made.

(b) All control valves shall be positioned 'open' for the duration of the test and open ends temporarily closed with water-tight fittings. The testing pressure should not be less than one and a half times the rated pressure of the pipe under use.

(c) Pressure should be applied either by hand pump or power driven pump. Pressure gauges should be correctly positioned and closely observed to ensure that at no time are the test pressures exceeded. The system should be slowly and carefully filled with water, to avoid surge pressure of water hammer. Air vents should be open at all high points so that air may be expelled from the system during filling.

(d) When the system has been fully charged with water and air displaced from the line, air vents should be closed and the line initially inspected for seepage

at joints and the firmness of the support under load. Pressure then may be applied until the required test pressure is reached.

8.9.9 Clamps

Plastic pipe clamps may be used to support the pipe. Standard pipe clips may also be used but care shall be taken not to over tighten and cause the clips to bite into the pipe. Pipe clips should be correctly aligned and should provide a smooth flat surface for contact with pipe.

8.9.10 Maintenance

(a) Various methods may be employed for repairing leakages or damage to sections of PE pipes. In general, the best is to cut the damaged portion and to replace it by a new pipe or prefabricated replacement unit. The connections of new pipe to either ends of the old pipe may be done by insert type of fittings. When failure or damage occurs in a welded joint, the original weld shall be removed entirely before re-welding.

(b) Freezing: Although polyethylene pipe is not fractured by freezing, the flow of water may be stopped. Direct application of intense heat, such as a torch or open flame should not be used. Any other method of applying heat can be acceptable as long as the temperature of the polyethylene piping material is not raised above 45 °C. Compounds, such as methanol, propanol and ethylene glycol can be used as anti freezers without detrimental effect to polyethylene plastic pipe.

(c) Pressure Check: In any application where polyethylene pipe is attached to a pressure source which is higher than the pressure rating of the polyethylene pipe being installed, adequate pressure reduction devices shall be installed. Whenever such valves are installed, a regular check os such valves should be made to ensure their continued proper functioning as a protection to the polyethylene pipe.

(d) Temperature check: whenever polyethylene pipe is installed in a system in which the possibility of hot liquid could ‘back-up’ or ‘cross over’ into the polyethylene pipe, check valves should be installed to ensure against such ‘ back up’ or ‘cross over’. When such valves are installed, they should be inspected regularly to ensure their continued proper functioning.

9.0

EXTERNAL & INTERNAL WATER SUPPLY

9.1 SCOPE OF WORK

The water supply system shall inter-alia include the following:

9.1.1 DISTRIBUTION SYSTEM FROM MAIN SUPPLY OR OVERHEAD TANK TO ALL FIXTURES AND APPLIANCES FOR COLD AND HOT WATER

9.1.2 INSULATION FOR HOT WATER PIPES

9.1.3 PIPE PROTECTION AND PAINTING

9.1.4 CONTROL VALVES, MASONRY CHAMBERS AND OTHER APPURTENANCES.

9.1.5 CONNECTIONS TO ALL PLUMBING FIXTURES, TANKS, APPLIANCES AND MUNICIPAL MAINS

9.1.6 INSERTS, NOZZLES FOR R.C.C. TANKS

The term water supply is used as indicative of all water supply work required and necessary for the building including such external work as may be necessary to make the system functional.

9.2 GENERAL REQUIREMENTS

IF NECESSARY AND IF APPROVED BY THE ENGINEER-IN-CHARGE, WHERE UNAVOIDABLE, BENDS MAY BE FORMED BY MEANS OF A HYDRAULIC PIPE BENDING MACHINE FOR PIPES UP TO 20MM DIA. NO BENDING SHALL BE DONE FOR PIPES OF 25MM DIA AND ABOVE. AFTER BENDING ZINC RICH PAINT SHALL BE APPLIED WHEREVER THE ZINC COATING IS DAMAGED.

VALVES AND OTHER APPURTENANCES SHALL BE SO LOCATED AS TO PROVIDE EASY ACCESSIBILITY FOR OPERATIONS, MAINTENANCE AND REPAIRS. VALVES SHALL BE LOCATED AT A HEIGHT NOT EXCEEDING 1.6M ABOVE THEIR OPERATING FLOOR/ PLATFORM LEVEL. WHERE SUCH A PROVISION IS NOT POSSIBLE AND THE VALVE IS TO BE FREQUENTLY OPERATED A MS CHAIN SHALL BE PROVIDED FOR ITS OPERATION.

9.3 CPVC HIGH PRESSURE PIPES FOR COLD & HOT WATER SUPPLY

Chlorinated polyvinyl chloride (CPVC) pipes conforming to IS: 15778-2007 are used for hot & cold water supply in toilets concealed, ducts, underground and suspended below floor.

Coefficient of thermal expansion- ASTM D - 696-6.3x10^{-5} m/m^{0}K

Thermal conductivity – ASTM C 177 – 0.14 Wm/^{0}K/m^{2}

(FOR PIPE DIAMETER UPTO 50MM SDR 11)

Nominal Pipe Size		Outer Dia.	Inner Dia.	Wall Thickness
(Inch)	(mm)	(mm)	(mm)	(mm)
½"	15	15.90	12.44	1.73
¾"	20	22.20	18.14	2.03
1"	25	28.60	23.42	2.59
1 ¼"	32	34.90	28.54	3.18
1 ½"	40	41.30	33.78	3.76
2"	50	54.00	44.20	4.90

Pressure rating @23^{0}C – 27.6 Kg/cm^2

Pressure rating @82^{0}C – 7.03 Kg/cm^2

(FOR PIPE DIAMETER ABOVE 50MM Sch.40)

Nominal Pipe Size		Outer Dia.	Inner Dia.	Wall Thickness	Pressure rating
(Inch)	(mm)	(mm)	(mm)	(mm)	(Kg/cm^2)
2½"	65	73.30	62.10	5.16	21.10
3"	80	88.90	77.27	5.49	18.28
4"	100	114.30	101.50	6.02	15.47
6"	150	168.28	153.19	7.11	12.66

9.3.1 <u>Jointing Tubing and Fittings:</u>

(a) Cutting:

Tubing should be cut with a wheel type plastic tuning cutter, a hack saw or other fine toothed hand or power saws. Use of ratchet cutters is permitted provided blades are sharpened regularly. A meter box should be used to ensure a square cut when using a saw. Cutting as squarely as possible provides optimal bonding area within the joint. If any indication of damage or cracking is evident at the tubing end, cut off at least 2 inches (5cm) beyond any visible crack.

(b) Deburring/Beveling:

Burrs and filings can prevent proper contact between tube and fitting during assembly, and should be removed from the outside and inside of the tubing. A chamfering tool is preferred but a pocketknife or files are suitable for this purpose. A slight bevel on the end of the tubing will ease entry of the tubing into the fitting socket and minimize the chances of pushing solvent cement to the bottom of the joint.

(c) Fitting Preparation

Wipe any dirt or moisture from the fitting sockets and tubing end. Check the dry fit of the tubing ad fitting. The tubing should make contact with the socket wall 1/3 to 2/3 of the way into the fitting socket. At this stage, tubing should not bottom out in the socket.

(d) Primer / Cleaner Application

Primer or cleaner prepares the bonding area for the addition of cement and subsequent assembly. It is important to use a proper applicator. A dauber or natural bristle paint brush approximately 1/2 the size of the tubing diameter is appropriate. Apply primer to both the outside of the tubing end and in the fitting socket. Do not allow primer to puddle in the fitting.

(e) Solvent Cement Application

USE ONLY CPVC CEMENT CONFORMING TO ASTM - F-493 - OR JOINT FAILURE MAY RESULT. When the primed pipe and fitting surfaces are dry, apply a heavy, even coat of cement on the tubing end. Apply a thin coat inside the fitting socket.

(f) Assembly

Immediately insert the tubing into the fitting socket, rotating the tube 1/4 to 1/2 turn while inserting. This motion ensures an even distribution of cement within the joint. Properly align the fitting. Hold the assembly for approximately 10 seconds, allowing the joint to set up. An even bead of cement should be evident around the joint. If this bead is not continuous around the socket edge, it may indicate that insufficient cement was applied. In this case, remake the joint to avoid potential leaks. Wipe excess cement from the tubing and fittings surfaces for an attractive, professional appearance.

(g) Set And Cure Times

Curing time is shorter for drier environments, smaller sizes, and higher temperatures. Refer to the following table for minimum cure times after the last joint has been made up before pressure testing can begin.

MINIMUM CURE TIME PRIOR TO PRESSURE TESTING AT 150 PSI (1

Ambient Temperature du	Pipe Sizes	
Cure Period	1/2" – 1"	11/4"- 2"
Above 150^{0}C	1 Hour	2 Hours
4-150^{0}C	2 Hours	4 Hours
Below 40^{0}C	4 Hours	8 Hours

In extremely hot temperatures, make sure both surfaces to be joined are still wet with cement when putting them together.

(h) Testing

Once an installation is completed and cured the system should be hydrostically pressure tested-10 bar for one hour at least. When pressure testing the system should be filled with water and all air bled from the highest and farthest points in the run. If a leak is found the joint must be cut out discarded. A new section can be installed using couplings. Air testing is not recommended.

(i) Handling And Storage

Reasonable care should be exercised in handling tubing and fittings. They should not be dropped, stepped on, or have objects thrown on them. If improper handling or heavy impact results in cracking, splits or gouges, the damaged section should be discarded. Tubing should be covered with non-transparent material when stored outdoors for long periods of time. When installing pipe and fitting in an area that is exposed to direct sunlight for an extended period of time, protect the pipe with insulation or water based latex paint.

(j) Hangers And Supports

For vertical runs, provide a support at each floor level, plus a mid-story guide. For horizontal runs, support at 3 foot (90cm) intervals for larger sizes. Piping should not be anchored tightly to support, but rather secured with smooth straps or hangers that allow for movement caused by expansion and contraction. The hangers should not have rough or sharp edges which come in contact with the tubing.

9.4 GUNMETAL VALVES

Valves 65mm dia and below shall be heavy gunmetal full way valves or globe valves conforming to Class I of IS: 778. Valves shall be tested at manufacturer's works and the same stamped on it.

All valves shall be approved by the Engineer-in-Charge before they are allowed to be used in the Work.

9.5 SLUICE VALVES

Unless otherwise specified all valves 80mm dia and above shall be CI double flanged sluice valves with non rising spindle. Sluice valves shall be provided with

wheel when they are in exposed positions and with a cap top when they are located underground. Contractor shall provide suitable operating keys for sluice valves with cap tops.

Sluice valves shall be of approved makes conforming to IS: 780 of Class as specified.

9.6 BUTTERFLY VALVES

Where specified Valves 80mm dia and above shall be cast iron butterfly valve to be used for isolation and/ or flow regulation as directed by the Engineer-in-Charge. The valves shall be tight shutoff/ regulatory type with resilient seat suitable for flow in either direction and seal in both directions. Butterfly valve shall conform to IS: 13095.

9.7 NON RETURN VALVE

Where specified non return valve (swing check type) shall be provided through which flow can occur in one direction only. It shall be single door swing check type of best quality conforming to IS: 5312.

9.7 TESTING

9.8.1 All pipes, fittings and valves shall be tested in accordance with IS: 2065 except as may be modified herein under. All pipes, fittings and valves, after fixing at site, shall be tested to a hydrostatic pressure of 5kg/sqcm or 1.5 times the shut off head of the pump whichever is greater.

9.8.2 The test pressure shall be maintained for a period of at least thirty minutes without any drop in pressure.

9.8.3 A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and the Engineer-in-Charge.

9.8.4 After commissioning of the water supply system, the Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently and effectively. Valves which do not operate efficiently and effectively shall be replaced by new ones at no extra cost and the same shall be tested as above.

9.8.5 All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.

9.9 MEASUREMENT AND RATES

9.9.1 CPVC pipes

(a) CPVC pipes above ground shall be measured per linear meter (to the nearest cm) along the centre line of the pipe and shall be inclusive of all fittings e.g. couplings, tees, bends, elbows, unions, flanges, etc. Deduction for valves shall be made. Rates quoted shall be inclusive of all fittings, clamps, cutting holes chases and making good the same and all other items mentioned in the specifications and Schedule of Quantities.

(b) CPVC pipes below ground shall be measured per linear meter (to the nearest cm) along the centre line of the pipe and shall be inclusive of all fittings e.g. couplings, tees, bends elbows, unions and flanges, etc. Deduction for valves shall be made. Rates quoted shall be inclusive of all fittings, cutting holes and chases and making good the same and all other items mentioned in the specifications and Schedule of Quantities. Excavation, filling, back filling with selected excavated earth, compaction and disposal of surplus earth, fine sand filling around CPVC pipes, in external work shall be measured separately, as per respective items.

9.9.2 Valves, Bib Cocks and Stop Cocks

GUNMETAL AND CAST IRON VALVES, BIB COCKS AND STOP COCKS SHALL BE MEASURED BY NUMBERS.

9.9.3 Flanges for Nozzles

(A) FLANGES FOR NOZZLES SHALL BE MEASURED BY NUMBERS AND THE QUOTED RATE SHALL INCLUDE WELDING OF THE FLANGES TO THE PIPE NOZZLES.

(B) PAINTING/ PIPE PROTECTION/ INSULATION.

Unless otherwise specified painting/ pipe protection/ insulation for pipes shall be measured and paid for separately. These shall be measured per linear meter along the centre line of the pipe, over the finished surface and shall include all valves and fittings for which no deduction shall be made.

9.10 GI PIPES, FITTINGS AND VALVES

9.10.1 General Requirements

(a) All pipes where specified, shall be M.S. galvanized steel tubes conforming to IS: 1239-1990 of Class specified. When Class is not specified they shall be Heavy Class.

(b) Fittings shall be of malleable cast iron galvanized, of approved make. Each fitting shall have manufacturer's trade mark stamped on it. Fittings for GI

pipes shall include couplings, bends, tees, reducers, nipples, unions, bushes etc. Fittings etc. shall conform to IS: 1879-1987.

(c) Pipes and fittings shall be jointed with screwed joints using teflon tape suitable for water pipes. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. Necessary vents and drains shall be provided at all high and low points respectively. All pipe joints after testing of the line shall be seal welded and the weld plus the adjoining portion shall be given two coats of zinc rich primer.

(d) Unions

Contractor shall provide adequate number of unions on all pipes to enable easy dismantling later when required. Unions shall be provided near each, stop cock or check valve and on straight runs as necessary at appropriate locations as required for easy dismantling and/ or as directed by the Engineer-in-Charge.

(e) Flanges

Flanged connections shall be provided on pipes as required for maintenance/ease in dismantling or where shown on the drawings, all equipment connections as necessary and required or as directed by the Engineer-in-Charge. Connections shall be made by the correct number and size of the GI nuts/ bolts as per relevant IS Standards and made with 3mm thick insertion rubber washer/gasket. Bolt hole dia for flanges shall conform to match the specification for CI sluice valve as per IS: 14846-2000. Gaskets shall conform to IS: 11149-1984.

9.10.2 Trenches

All GI pipes below ground shall be laid in trenches with a minimum cover of 1000mm. The width and depth of the trenches shall be as follows except at places where welding/ jointing etc. needs larger width of trench. Additional width/ depth shall be provided as necessary for welding/ jointing etc. at no additional cost:

Diameter of pipe	Width of trench	Depth of trench
Up to 100mm	600mm	1200mm
100mm to 150mm	750mm	1200mm

(a) Sand filling

GI pipes in trenches shall be protected with fine sand 150mm all around before filling in the trenches.

(b) Painting

All pipes above ground shall be painted with one coat of red lead and two coats of synthetic enamel paint of approved shade and quality to give an even shade, or as specified by the Engineer-in-Charge.

(c) Pipe protection

Where specified, pipes below ground shall be protected against corrosion by the application of two or more coats of solvent based rubberised asphaltic primer to give a uniform coat covered with 'Pipe coat Hiper', a puncture resistant non woven polyester mat. The application of pipe-coat primer and "Hiper" membrane shall be as specified by the manufacturer.

9.10.3 Testing

(a) All pipes, fittings and valves shall be tested in accordance with IS: 2065 except as may be modified herein under. All pipes, fittings and valves, after fixing at site, shall be tested to a hydrostatic pressure of 1.5 times the shut off head of the pump.

(b) The test pressure shall be maintained for a period of at least thirty minutes without any drop in pressure.

(c) A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and the Engineer-in-Charge.

(d) After commissioning of the water supply system, the Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently and effectively. Valves which do not operate efficiently and effectively shall be replaced by new ones at no extra cost and the same shall be tested as above.

(e) All pipes meant to be encased or buried shall be hydro tested before the pipe is encased or buried.

9.10.4 Insulation

(a) Insulation to pipes shall be with pre-moulded pipe sections, thickness for sections shall be:

(b) Pipe 50mm dia and below - 25mm thick

(c) Pipe 65mm dia and above - 40mm thick

(d) Application:

(e) All surfaces shall be thoroughly cleaned with a wire brush.

(f) One layer of approved primer shall be applied and pre-moulded pipe insulation sections shall be fixed.

(g) One layer of aluminium foil of thickness 0.711mm (20 SWG), shall be applied as a finish layer.

9.11 MEASUREMENT AND RATES

9.11.1 GI pipes

(a) GI pipes above ground shall be measured per linear metre (to the nearest cm) along the centre line of the pipe and shall be inclusive of all fittings e.g. couplings, tees, bends, elbows, unions, flanges, etc. Deduction for valves shall be made. Rates quoted shall be inclusive of all fittings, clamps, cutting holes chases and making good the same and all other items mentioned in the specifications and Schedule of Quantities.

(b) GI pipes below ground shall be measured per linear metre (to the nearest cm) along the centre line of the pipe and shall be inclusive of all fittings e.g. couplings, tees, bends elbows, unions and flanges, etc. Deduction for valves shall be made. Rates quoted shall be inclusive of all fittings, cutting holes and chases and making good the same and all other items mentioned in the specifications and Schedule of Quantities. Excavation, filling, back filling with selected excavated earth, compaction and disposal of surplus earth, fine sand filling around GI pipes, in external work shall be measured separately, as per respective items.

9.11.2 Cast iron valves, Bib cocks and stop cocks shall be measured by numbers.

9.11.3 Flanges for Nozzles

(a) Flanges for nozzles shall be measured by numbers and the quoted rate shall include welding of the flanges to the pipe nozzles.

(b) Painting/ pipe protection/ insulation

Unless otherwise specified painting/ pipe protection/ insulation for pipes shall be measured and paid for separately. These shall be measured per linear metre along the centre line of the pipe, over the finished surface and shall include all valves and fittings for which no deduction shall be made.

10.0 MAKE OF EQUIPMENT AND APPROVED MANUFACTURERS OR APPROVED EQUIVALENT

1. R.C.C. Pipe

		a. Pranali Industries Bombay or Equivalent
		b. Prathibha Industries
2.	ASTM UPVC Pipes & Fittings	a. Astral Aquarius
3.	CPVC Pipes & Fittings	a. Flowguard-Astral
		b. Flowguard-Ashirvad.
4.	G.I. Pipes & Fittings	a. Jindal
		b. Indus Tubes
		c. Poonam Enterprise
5.	Water Meters	a. Capstan Make or Equivalent
6.	Ball Valves	a. Zoloto
7.	Paint	a. Asian Paints
		b. Shalimar
		c. Equivalent
8.	S.W. Pipes	a. Sonya
		b. Rajura
9.	G. M. Non Return Valve	a. Zoloto
		b. Equivalent
10.	Cast Iron Pipe	a. Neco
11.	Cast Iron Gratings	a. Neco
12.	GRP Tank Covers	a. Thermodrain
13.	Automatic Air Release Valve	a. Honeywell
		b. Equivalent
14.	C.P Fittings	a. Jaguar
		b. Ess Ess
15.	Sanitary Fixtures	a. Hindware
		b. Parryware
		c. Equivalent

16.	Ductile Iron Pipe	a. Jindal	
		b Electrosteel	*******

PART – 15: MISCELLANEOUS

1.0 SCOPE

This specification covers the general requirements for building works comprising Rubble Subbase, Admixtures for Concrete, Grouting, Water stops, Preformed Fillers and Joint Sealing Compound, Inserts and Cutouts in Concrete Works, Miscellaneous inserts, bolts etc and forming a part of this job, which may be required to be carried out though not specifically mentioned above. The works under this specification shall consist of furnishing of all tools, plants, labour, materials, and everything necessary for carrying out the works.

2.0 RUBBLE SUB-BASE

2.1 MATERIALS

2.1.1 Stones used for rubble packing under floors on grade, foundations etc., shall be clean, hard, durable rock free from veins, flaws, laminations, weathering and other defects. Stones shall generally conform to the requirements stipulated in IS: 1597 (Part-I).

2.1.2 Stones shall be as regular as can be obtained from quarries. Stones shall be of height equal to the thickness of the packing proposed with a tolerance of + 10mm. Stones shall not have a base area less than 250 sq.cm nor more than 500 sq.cm, and the smallest dimension of any stone shall not be less than half the largest dimension. The quality and size of stones shall be subject to the approval of the ENGINEER.

2.2 WORKMANSHIP

2.2.1 Stones shall be hand packed carefully and laid with their largest base downwards resting flat on the prepared sub-grade and with their height equal to the thickness of the packing. Stones shall be laid breaking joints and in close contact with each other. All interstices between the stones shall be wedged-in by small stones of suitable size, well driven in by crow bars and hammers to ensure tight packing and complete filling-in of the interstices. The wedging shall be carried out simultaneously with the placing in position of rubble packing and shall not lag behind. After this, any interstices between the smaller wedged stones shall be in-filled with clean hard sand by brooming so as to fill the joints completely.

2.2.2 The laid rubble packing shall be sprinkled with water and compacted by using suitable rammers.

3.0 ADMIXTURES FOR CONCRETE

3.1 SCOPE

This Specification covers the general requirements of chemical admixtures for concrete used in general construction, their applicability, acceptability criteria,

proportioning, sampling, testing and precautions to be taken. The different types of admixtures covered by this specification are Accelerator, Retarder, Air entraining agents, Plasticizers and Super plasticizers. However, the requirements of Integral water proofing admixtures / compounds shall be in accordance with IS: 2645.

3.2 APPLICABLE CODES & SPECIFICATIONS

The following specifications, standards and codes, including all official amendments/ revisions and other specifications and codes referred to therein, shall be considered a part of this specification. In all cases the latest issue/ edition/ revision shall apply. In case of any discrepancy between this specification and those referred to herein, this specification shall govern.

3.2.1 IS: 516 Method of test for strength of concrete

3.2.2 IS: 1199 Method of sampling and analysis of concrete

3.2.3 IS: 2645 Specification for Integral Cement Water Proofing Compounds

3.2.4 IS: 3812-Part-II Specification for fly ash for use as Admixture for concrete

3.2.5 IS: 4926 Ready mixed concrete

3.2.6 IS: 6925 Methods of test for determination of water soluble chlorides in Concrete admixtures

3.2.7 I IS: 9103 Specification for Admixtures for concrete

3.2.8 BS: 5075-Part1 Specification for accelerating admixtures, retarding admixtures and water reducing admixtures

3.2.9 BS: 5075-Part3 Specification for Super plasticising admixtures

3.2.10 ASTM 494 Standard specification for chemical admixtures for concrete

3.3 TERMINOLOGY

3.3.1 Admixture

A material other than water aggregates and hydraulic cement, used as an ingredient of concrete or mortar and added to the batch immediately before or during its mixing to modify one or more of the properties of concrete in the plastic or under hardening state.

3.3.2 Accelerator

A substance, when added to concrete, mortar or grout, increases the rate of hydration of hydraulic cement, shortens the time of set, or increases the rate of hardening or strength development.

3.3.3 Retarder

An admixture which delays the setting of cement-paste and hence of mixtures, such as cement mortar or concrete.

3.3.4 Air Entraining Agents

An admixture for concrete or mortar which causes air to be incorporated in the form of minute bubbles in the concrete or mortar during mixing, usually to increase workability and resistance to freezing and thawing and disruptive action of de-icing salts.

3.3.5 Water Reducing Admixtures Or Plasticiser

A material which either increases workability of freshly mixed mortar or concrete without increasing water content or maintains workability with a reduced amount of water. The reduction in water content for plasticisers is of the order of not more than 10 to 15%.

3.3.6 High Range Of Water Reducers (Super Plasticisers)

Super plasticisers are the high range water reducing admixtures. The reduction in water content in the case of superplasticisers will be of the order of 25 - 30%. Chloride based Superplasticisers are not recommended for reinforced concrete, which may give rise to corrosion of steel.

3.4 GENERAL

3.4.1 Chemical admixtures may be used if permitted by the Engineer based upon evidence that with the passage of time neither the compressive strength nor its durability is reduced. In case their use is permitted, the type, amount and method of use of an admixture proposed by the Contractor shall be submitted to the Engineer for approval. No admixture shall be considered for use unless all tests complying with relevant codes (IS: 9103 or IS: 2645) have been done and a complete report from an independent laboratory of standing is submitted for scrutiny and approval of the Engineer.

3.4.2 The admixture shall be chloride free and shall be tested in accordance with IS: 6925.

3.4.3 Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded parts. When Calcium chloride is permitted such as in mass concrete works, it shall be dissolved in water and added to the mixing water by an amount not exceeding 1.5 percent of the weight of the cement in each batch of concrete. The designed concrete mix shall be corrected accordingly.

3.4.4 The contractor shall provide the following information concerning each admixture to the Engineer.

(a) Compliance to Indian/ International standards with test reports.

(b) Description of the product and its composition/ chemical names of main ingredients and properties.

(c) Primary uses of the product, applicability, advantages etc.

(d) Information to be considered in relevant mix design.

(e) Manufacturer's instructions regarding usage of admixtures.

(f) Typical dosage/ consumption and effects of over dosage, chances of air entrainment when used as per the recommended dosage.

(g) The chloride ion content and water soluble sulphate content (expressed as SO3) expressed as percentage by weight of admixture.

(h) Manufacturer's written confirmation of compatibility of two or more admixtures if proposed to be used in any one mix.

(i) Any deleterious effects on concrete or any increase in risk of corrosion of the reinforcement or other embedments.

(j) Product storage procedure.

(k) Precautions to be taken while using the product.

3.5 PHYSICAL REQUIREMENTS

Concrete made with admixtures when compared with identical concrete made without the admixture (Reference or Control Concrete) in accordance with clause 6.0 shall conform to the requirements given in Table-1, except in the case of Air-entraining admixture. In the case of Air-entraining admixtures, a reference admixture of approved quality shall be used in the control concrete to entrainidentical amount of air.

TABLE -1 PHYSICAL REQUIREMENTS

(Ref: Compiled From IS: 9103, BS: 5075, ASTM 494)

				Water Reducing Admixture					
Sl.NO.	Requirement	Accelerating	Retarding	Normal	Accelerating	Retarding	High range	Retarding	Air Entraining
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	Water content, % of control Sample, Max:	-	95		95	95	88	88	-
2.	Time of setting, allowable deviation from control sample hours:								
	Initial								
	Max	-3	+3	±1	-3	+3	±1	+3	-
	Min	-1	+1	-	+3	-	+1	-	-
	Final								
	Max	-2	+3	±1	-2	+3	±1	+3	-
	Min	-1	-	-	-1	-	-	-	-
3.	* Compressive strength, % of control Sample, Min:								
	3 days	125	90	110	125	110	125	125	90
	7days	100	90	110	110	110	115	115	90
	28 days	100	90	110	110	110	110	110	90
	6 months	90	90	100	100	100	100	100	90
	1 year	90	90	100	100	100	100	100	90
4.	* Flexural strength, % of control Sample, Min:								
	3 days	110	90	100	110	100	110	110	90
	7days	100	90	100	100	100	100	100	90

TABLE -1 PHYSICAL REQUIREMENTS

(Ref: Compiled From IS: 9103, BS: 5075, ASTM 494)

				Water Reducing Admixture					
Sl.NO.	Requirement	Accelerating	Retarding	Normal	Accelerating	Retarding	High range	Retarding	Air Entraining
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	28 days	90	90	100	100	100	100	100	90
5.	**Length change, Percent of control % increase over control sample, Max:	135	135	135	135	135	135	135	-
	28 days	0.01	0.010	0.010	0.010	0.01	0.010	0.01	0.01
	6 months	0.01	0.010	0.010	0.010	0.01	0.010	0.01	0.01
	1 year	0.01	0.010	0.010	0.010	0.01	0.010	0.01	0.01
6.	Bleeding, %increase over control sample, Max:	5	5	5	5	5	-	-	2
7.	Compacting factor (not more than below control mix)	-	-	0.02	0.02	0.02	-	-	-
8.	Workability (Slump mm) (not more than below control mix)	-	-	-	-	-	15	15	-

- The compressive and flexural strength of concrete containing the admixture under test at any test age shall be not less than 90 percent of that attained at any previous test age. The objective of this limit is to require that the compressive or flexural strength of concrete containing the admixture under test shall not decrease with age.

- Percent of control limit applies when length change of control is 0.030 percent or greater; increase over control limit applies when length change of control is less than 0.030 percent.

3.6 SAMPLING & TESTING

The performance and effect of admixtures for concrete shall be evaluated to conform to the physical requirements given in Table-1 by testing the concrete with admixture and comparing with reference concrete. The sampling and testing shall be in accordance with stipulations given in IS: 9103.

3.6.1 Sampling

(a) The method of sampling of admixtures and concrete for testing purpose shall be in accordance with the stipulations given in IS: 9103.

(b) Samples of admixtures shall be packed in moisture proof air containers.

(c) The admixture shall be used strictly as per the recommendations of the manufacturer.

(d) For general evaluation of admixture the cement shall conform to Portland cement to IS: 269 and aggregates shall conform to the requirements given in IS: 383.

(e) When an admixture is required to be evaluated for a specific work as directed by the Engineer the test samples shall be prepared using the materials proposed to be used on that particular work.

(f) Whenever the admixture has not been used previously with particular combination of materials and / or when special types of cements are adopted, and also when the mixing and placing temperatures are outside the normal range, then in all such cases the admixtures shall be specifically evaluated for that work.

(g) When an admixture is to be tested for air entrainment it shall be used in such a quantity that it produces air content in the range of 3.5 to 7 %.

(h) The concrete mix shall be proportioned to have the cement content specified for the work and to meet the stipulated workability and strength requirements.

3.6.2 Testing

The fresh concrete and hardened concrete shall be tested for the tests described below.

(a) Testing Of Fresh Concrete

Sampling of fresh concrete shall be done according to the requirements given in IS: 1199. The concrete shall be analyzed for the following tests.

i) Test for workability as per IS: 1199

ii) Test for air-content as per IS: 1199

iii) Test for Time of Setting as per IS: 8142

iv) Test for bleeding as per IS: 9103

v) Test for water content as per IS: 9103

The above tests shall be carried out at the time of actual concreting work at site.

(b) Testing Of Hardened Concrete

Specimens for tests on hardened concrete shall be prepared from at least three separate batches for concrete with and without the admixture. The specimen shall be analyzed for the following tests below.

i) Test for Compressive Strength as per IS: 516

ii) Test for Flexural Strength as per IS: 516

iii) Tests for Length Change (Drying Shrinkage): It shall be determined as given in IS: 1199.

The moist-curing period, including the period in moulds shall be 14 days.

3.7 USE OF ADMIXTURES

3.7.1 Admixtures shall be used strictly in accordance with the instructions provided by the Manufacturer of the admixture.

3.7.2 Intermixing of admixtures prior to introduction into the concrete should be avoided unless tests indicate that there will be no adverse effect or the manufacturer's instructions permit.

3.7.3 The time of addition of admixture into the concrete shall be clearly obtained from the manufacturer.

3.7.4 The maximum water content in the concrete mix containing super plasticiser shall be 88% to 84% of water content in control mix.

3.7.5 The admixtures shall be added precisely and mixed thoroughly. In general, the admixture should be added to the mix along with approximately 25 percent of total mixing water. First, about 50 percent of the total water is added on the dry mix of cement and aggregates for about 15 to 30 seconds, then the mixture of admixture and 25 percent of the total water is added and finally the balance 25 percent of the

total water is poured into the mix. However, careful attention should be given to the instructions provided by the manufacturer.

3.7.6 An admixture shall be compatible with other admixtures when used in the same concrete. All admixtures should be added to the concrete separately and must not be mixed together prior to addition. Also trials to assess the effects of overdosing in a particular mix are strongly recommended. Preference to Melamine-based Super plasticizer for concrete in cold weather condition and to Napthalene-based (retarding type) super plasticiser in hot weather conditions shall be given.

4.0 GROUTING

4.1 SCOPE

The works covered by this specification consists of supplying all materials; furnishing all equipments, labour etc.; performing all operations; for placing grouts at locations such as under column base plates, anchor bolt pockets, under machine or equipment bases etc. The works shall be carried out in conjunction with other contractors/vendors who are responsible for erection of their structures and equipments and maintaining the levels, alignments etc. of their bases.

4.2 TYPE OF GROUTS

There are three types of grouts to be used.

1) Standard dry pack grouts,

2) Non-shrink cementitious grouts,

3) Non-shrink epoxy grouts,

The type of grout to be used shall be as specified in the drawings/ advised by engineer.

4.2.1 Standard Dry Pack Grouts

Standard dry pack grouts are prepared by mixing of cement and sand. The proportions of grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. Quantity of water shall be such so that it is just enough for compaction and hydration and shall have the consistency of damp sand. Sand used shall meet the usual grading specification for concrete.

(a) The grout proportions shall be limited as follows:

Use	Grout thickness	Mix Proportions	W/C Ratio (Max)
a) Fluid Mix	Under 25mm	One part Portland Cement to	0.44

		one part sand	
b) General	25mm and over but less than 50mm	One part Portland Cement to 2 parts of sand	0.53
c) Stiff Mix	50mm and above	One part Portland Cement to 3 parts of sand	0.53

(b) Sand:

i) Sand shall be such as to produce a flowable grout without any tendency to segregate.

ii) Sand, for general grouting purposes, shall be graded within the following limits:

Passing IS 2.36 mm sieve 95 to 100%

Passing IS 1.18 mm sieve 65 to 95%

Passing IS 300 micron sieve 10 to 30%

Passing IS 150 micron sieve 3 to 10%

iii) Sand for fluid grouts shall have the fine material passing the 300 and 150 micron sieves at the upper limits specified above.

iv) Sand, for stiff grouts, shall meet the usual grading specifications for concrete

4.2.2 Non-Shrink Cementitious Grouts

These shall be a pre-proportioned product, obtained from approved manufacturers, containing a mixture of aggregate, cement and admixtures; pre-blended and pre-packaged requiring only the addition of water at site. Unless mentioned otherwise, it shall be used below all structural base plates and associated anchor bolt pockets. It can also be used below all static and rotating equipment bases having no or low impact loads. It should not be used in areas where the grouts are subjected to corrosive atmosphere and chemical attacks. The material shall be chloride free and must not contain expansive cements or metallic particles such as aluminium powder or iron fillings.

4.2.3 Non-Shrink Epoxy Grouts

These are two components epoxy bonding systems mixed with oven dry aggregate and other proprietary materials. It shall be obtained from approved manufacturers. The components shall be mixed in complete units in accordance with manufacturer's recommendations. If not specifically mentioned, it shall be used in areas where the grouts are subjected to corrosive atmosphere or aggressive

chemicals and/or shock or heavy impact loads below equipment bases, such as reciprocating machines, crushers, crane rails etc. Where epoxy grouts are subjected to temperature more than 50o C, manufacturer's advice shall be sought before its use, as its stiffness and strength get affected under high temperature.

4.3 GENERAL

4.3.1 The thickness of standard dry pack grouts shall be minimum 75mm. However, thickness of flowable grout can be anywhere between 20 to 50mm.

4.3.2 Generally, the type of grout selected shall have twice the strength of the base concrete on which the grout is placed.

4.3.3 The grouts shall be chloride free.

4.3.4 They shall be used following strictly the manufacturer's specification.

4.3.5 All materials shall be delivered to site in original unopened packages, clearly labelled with the manufacturer's identification and printed instructions. The contractor must submit the manufacturer's certified test data on the grout's constituents, 24 hour compressive strength and its flowability, from approved test laboratory, prior to placement of order. Manufacturers shall also give warranty saying that the nonshrink grout supplied shall never go below its initial placement volume.

4.3.6 Plain Cement Grouts:

Cement grout shall be prepared using ordinary portland cement along with an approved admixture to overcome operated shrinkage. It is recommended to use plasticised expanding grout admixture. Proportion or admixture quantity or water and type of mixing shall be as per manufacturer's instructions. Compatibility of admixture with the type of cement used shall be ascertained before use of any admixture with cement.

4.3.7 Special Grout

Ready mixed special grout shall be used wherever they are specified or called for in the drawing or as advised by the engineer. The type of grout to be used shall be as per their strength requirements and as per manufacturer's recommendation depending on the type of load they will be subjected to - light, heavy or dynamic. Generally, the type of grout selected shall have twice the strength of the base concrete. The thickness of grout shall generally vary depending on the situation and shall be in the range of 15mm to 50mm.

4.4 PREPARATION / WORKMANSHIP

4.4.1 Concrete surfaces to be grouted shall be thoroughly roughened by sand blasting or other mechanical means and cleaned of all loose materials/ foreign matter and laitanance from the surface.

4.4.2 Anchor bolts, anchor bolt holes and the bottom of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material.

4.4.3 Prior to grouting, the hardened concrete surfaces on which the cementitious grouts are to be placed shall be saturated with water. All standing water shall be removed from the concrete surface as well as from anchor bolt holes, before grouting is started. However, surface shall be absolutely dry before placing epoxy grouts.

4.4.4 Water used for mixing of grout shall be clean and free from oils, acids, alkalies, organics and other deleterious materials.

4.4.5 Forms must be rigid to completely confine and withstand the pressure of grout during placement, without any deformation. It should be tight to prevent any leakage. All cracks and joints in the form works shall be caulked with an elastomeric sealant. It shall be lined with polyethylene or such material for easy removal. Air relief holes must be provided, to remove any entrapped air below the plates during grouting. Chamfer edges shall be built in with the form works, for epoxy grouts.

4.4.6 Forms around base plates shall be reasonably tight to prevent leakage of the grout. When the base is to be flow grouted, forms shall be built and securely anchored outside the base plate so as to completely confine and withstand the pressure of liquid grout under working and rodding condition without leaking and provide a head of minimum 100 mm above the underside of the base plate to ensure the grout is in full contact with the underside of the base plate. Provisions of grout holes in base plates, rodding, arrangements shall be checked prior to commencement of grouting.

4.4.7 Adequate clearances shall be provided between forms and base plate to permit grout to be worked properly into place.

4.4.8 Grouting, once started, shall be done quickly and continuously to prevent segregation, bleeding and break down of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more complete contact between base plate and foundation and to help release of entrapped air, link chains or doubled over flexible steel strapping's may be used to work the grout into place.

4.4.9 Grouting through holes in base plates shall be by pressure grouting. The pressure to be used for grouting shall be as directed by the ENGINEER.

4.5 INSTALLATION

4.5.1 Ready mixed grouts shall be mixed in the manner and in accordance with manufacturer's recommendations and shall be used in the form of liquid. Consistency of grout shall be such so that it can maintain its flowability within the gap provided below the base plates, during its entire period of placement. Grouts shall be placed from one end to the other. Grouting, once started, shall be finished

quickly and continuously to prevent segregation, bleeding and starting of initial set. No water or solvent shall be added to change the consistency, if the grout stiffens during placement. The stiffened grouts along with other grout, in place but not completed, shall be removed.

4.5.2 All equipments and tools shall be cleaned thoroughly before use. For cementitious grouts, the mixer shall be wetted and excess water removed, before mixing begins.

4.5.3 After the bases of structures and equipments are levelled and aligned by other vendors, by using shims, the liquid grouts shall be placed by flowing or by pumping. Standard dry pack grouts, if used, shall be placed by rodding. Extreme care shall be taken to see that alignment and levels of bases are not disturbed during grouting.

4.5.4 The grouts shall be prepared only to the extent it can be used within the specific potlife by the manufacturer. Any leftover grout or grouts not consumed within the potlife time shall not be used and shall be discarded. The shelf life of the grout shall also be checked before they are used. Grouts having expired date shall not be used under any circumstances.

4.5.5 The cementitious grouts shall be cut back at an angle of 45o or vertical, as shown in the drawing, after the grout has reached its initial set.

4.5.6 Forms and shims shall not be removed and the anchor bolts shall not be tightened for at least twenty four hours after placing the grout. After removal of forms and peripheral shims, area occupied by shims shall be filled and the area between the base and the edge of the foundation shall be finished smooth to allow drainage away from the base. Interconnecting piping and machinery shall not be attached to the machinery before anchor bolts are tightened. It is desirable to make these connections at least after a minimum of seven days from the date of grouting. During this period, the grout shall be properly cured.

4.5.7 Grout shall be cured in accordance with manufacturer’s specification and recommendation.

4.6 INSPECTION

4.6.1 All materials, workmanship and finished construction shall be subject to the continuous inspection and approval of ENGINEER.

4.6.2 All materials supplied by CONTRACTOR and all works or construction performed by CONTRACTOR and rejected - as not in conformity with the specifications and drawings - shall be immediately replaced at no additional expense to the OWNER.

4.6.3 Preliminary approvals of any materials or phase of work shall in no way relieve the CONTRACTOR from the responsibility of supplying grouting materials and or producing finished grout in accordance with the specifications and drawings.

4.6.4 All grouting shall be protected against damage until final acceptance by OWNER or his representative.

4.6.5 Upon the completion of grouting work, all forms, equipment, construction tools, protective coverings and any debris shall be removed from the area as directed by the ENGINEER.

5.0 WATERSTOPS

5.1 MATERIAL

5.1.1 The material for the PVC waterstops shall be a plastic compound with the basic resin of polyvinyl chloride and additional resins, plasticizers, inhibitors, which satisfies the performance characteristics specified below as per IS:15058. Testing shall be in accordance with IS: 8543, IS 13360 and IS 9766.

(a) Tensile strength: 13.8 MPa minimum

(b) Ultimate elongation: 285% minimum

(c) Hardness (Shore A): 65, minimum

(d) Water absorption: 0.6 maximum

(e) Cold bend temp at which samples do not crack : -25oC minimum

(f) Accelerated extraction

i) Tensile strength: 10.3 MPa minimum

ii) Ultimate elongation: 280% minimum

(g) Effect of Alkali: 7 days

i) Weight increase: 0.25% maximum

ii) Weight decrease: 0.10% maximum

iii) Hardness change: ± 5 points

(h) Effect of Alkali: 28 days

i) Weight increase: 0.40% maximum

ii) Weight decrease: 0.30% maximum

iii) Dimension change: ± 1%

5.1.2 PVC water stops shall be either of the bar type, serrated with centre bulb and end grips for use within the concrete elements or of the surface (kicker) type for external use. The width, type, minimum thickness and safe hydraulic head requirements shall be as specified in the individual items of work.

5.1.3 PVC water stops shall be of approved manufacture. Samples and the test certificate shall be got approved by the ENGINEER before procurement for incorporation in the works.

5.2 WORKMANSHIP

5.2.1 Waterstops shall be laid as per IS 12200. It should be cleaned before placing them in position. Oil or grease shall be removed thoroughly using water and suitable detergents.

5.2.2 Waterstops shall be procured in long lengths as manufactured to avoid joints as far as possible. Standard L or T type of intersection pieces shall be procured for use depending on their requirement. Any non-standard junctions shall be made by cutting the pieces to profile for jointing. Lapping of waterstops shall not be permitted. All jointing shall be of fusion-welded type as per manufacturer's instructions.

5.2.3 Waterstops shall be placed at the correct location/level and suitably supported at intervals with the reinforcement to ensure that it does not deviate from its intended position during concreting and vibrating. Care shall also be taken to ensure that no honey-combing occurs because of the serrations/end grips, by placing concrete with smaller size aggregates in this region. Projecting portions of the waterstops embedded in concrete shall be thoroughly cleaned of all mortar/ concrete coating before resuming further concreting operations. The projecting waterstop shall also be suitably supported at intervals with the reinforcement to maintain its intended position during concreting so as to ensure that it does not bend leading to formation of pockets. In addition, smaller size aggregate shall be used for concreting in this region also.

6.0 PREFORMED FILLERS AND JOINT SEALING COMPOUND

6.1 MATERIALS

6.1.1 Preformed filler for expansion/isolation joints shall be non-extruding and resilient type conforming to IS: 1838 (Part II).

6.1.2 Bitumen coat to concrete/masonry surfaces for fixing the preformed bitumen filler strip shall conform to IS: 702. Bitumen primer shall conform to IS: 3384.

6.1.3 Sealing compound for filling the joints above the preformed bitumen filler shall conform to Grade 'B' as per IS: 1834.

6.2 WORKMANSHIP

6.2.1 The thickness of the preformed bitumen filler shall be as specified in the respective items of work. CONTRACTOR shall procure the strips of the desired thickness and width in lengths as manufactured. Assembly of small pieces/thicknesses of strips to make up the specified size shall not be permitted.

6.2.2 The concrete/masonry surface shall be cleaned free from dust and any loose particles. When the surface is dry, one coat of bitumen primer conforming to IS: 3384 to be applied over which one coat of industrial blown type bitumen of grade 85/25 conforming to IS: 702 shall be applied hot by brushing at the rate of 1.20 kg/sq.m. When the bitumen is still hot, the preformed bitumen filler shall be pressed and held in position till it completely adheres. The surface of the filler against which further concreting/masonry work is to be done shall similarly be applied with one coat of hot bitumen at the rate of 1.20 kg/sq.m.

6.2.3 Sealing compound shall be heated to a pouring consistency for enabling it to run molten in a uniform manner into the joint. Before pouring the sealing compound, the vertical faces of the concrete joint shall be applied with a coat of hot bitumen primer conforming to IS: 3384 in order to improve the adhesive quality of the sealing compound.

6.2.4 Expansion joints between beams/slabs shall be provided with l00mm wide x 4mm thick mild steel plate at the soffit of RCC beams/slabs to support and prevent the preformed joint filler from dislodging. This plate shall be welded to an edge angle of ISA 50 x 50 x 6mm provided at the bottom corner, adjacent to the expansion joint of one of the beams/slabs, by intermittent fillet welding. Steel surfaces shall be provided with 2 coats of red oxide zinc chrome primer and 3 coats of synthetic enamel paint finish.

7.0 INSERTS AND CUTOUTS IN CONCRETE WORK

7.1 Numerous inserts are required to be fixed/ embedded in concrete. These inserts comprise plates, angles, pipe sleeves, anchor bolt assemblies, etc. While some of the inserts may be supplied by the Owner, free of cost at his stores, for incorporation in the works, other inserts are required to be supplied and fabricated by the Contractor. These would be indicated clearly on the construction drawings.

7.2 Contractor shall accurately fix the inserts at the correct levels/alignment and shall include any temporary supports/anchors such as bars including cutting, bending, welding, etc. as required.

7.3 Steel templates shall be used by the CONTRACTOR to locate and very accurately position bolts, groups of bolts, inserts, embedded parts, etc. at his cost. Such templates shall be got previously approved by the Engineer. Templates shall invariably be supported such that the same is not disturbed due to vibration, movement of labourers, materials, shuttering work, reinforcement, etc. while concreting. The CONTRACTOR will have to suitably bend, cut or otherwise adjust the reinforcement in concrete at the location of inserts, as directed by the Engineer. If the Engineer so directs, the inserts will have to be welded to reinforcement to keep these in place. The Contractor shall be responsible for the accuracy of dimensions, levels, alignments and centre lines of the inserts in accordance with the drawings and for maintenance of the same until the erection of equipment/structure or final acceptance by the Owner.

7.4 The Contractor shall ensure proper protection of all bolts, inserts, etc. from weather by greasing or other approved means such as applying white lead putty and wrapping them with gunny bags or canvas or by other means as directed by the Engineer to avoid damage due to movement of his labourers, materials, equipment, etc. No extra claim from the Contractor on this account shall be entertained. The Contractor shall be solely responsible for all damage caused to bolts, inserts, etc. due to his negligence and in case damage does occur, they shall be rectified to the satisfaction of the Engineer at the Contractor's cost.

7.5 Cut outs, chamfers, pockets, etc. shall be left as indicated in the drawings and no extra cost shall be payable for providing these at their correct locations. The Contractor shall take all necessary precautions to protect the cut outs from accidentally getting filled up or the edges getting broken.

8.0 MISCELLANEOUS INSERTS, BOLTS ETC.

8.1 All the miscellaneous inserts such as bolts, pipes, plate embedments etc. either supplied FREE by the OWNER or to be furnished by the CONTRACTOR shall be accurately installed in the building works at the correct locations and levels, all as detailed in the construction drawings. CONTRACTOR shall prepare and use templates for this purpose, if so directed by the ENGINEER. In the event, any of the inserts are improperly installed, CONTRACTOR shall make necessary arrangements to remove and re-install at the correct locations/levels, all as directed by the ENGINEER without any extra cost to the OWNER.

9.0 ALUMINIUM PANELS:

General:

Aluminium panels shall be solid aluminium or composite panels andshall satisfy the following minimum requirements:

External Panels – minimum thickness

4mm solid aluminium

6mm composite aluminium

Internal Panels – minimum thickness

3mm solid aluminium

4mm composite aluminium

Perforated Panels- minimum thickness

1 mm perforated corrugated aluminium

10.0 COMPOSITE ALUMINIUM PANELS

The core is a fully-cured fibre-reinforced Phenolic Resin bonded under heat and pressure to the outside metal faces.

	4mm Panel	6mm Panel
Minimum Radius	450mm	600mm
Modulus of Rapture (Bending)	190 MPa	190 MPa
Bending Stiffness (EI x 1000)	245 Nmm_/mm	615 Nmm_/mm
Ultimate Shear Resistance (in plane of core)	11.5 MPa	11.5 MPa

Curved Shapes – Physical and Mechanical Properties Tensile stress in a panel under maximum wind load shall not exceed 71 MPa.

Thermal Expansion - Coefficient of thermal expansion: 22 x 10-6 mm/mm/°C

Thermal Resistance - stable up to a temperature of 150_C. 4mm - 0.018m/ºK/W

Acceptable Products / Manufacturers:

Alpolic – Mitsubishi Chemincals

Alucobond – Alcan Industries

Reynobond – Alcoa

Acoustic Properties

4mm - 29dB; 6mm - 30dB

AS1530.3 - 1989

Tests for Early Fire Hazard Properties of materials:

Ignitability Index (Range 0 - 20) - Rating 0

Spread of Flame Index (Range 0 - 10) - Rating 0

Heat Evolved Index (Range 0 - 10) - Rating 0

Smoke Developed with Index (Range 0 - 10) - Rating 0 – 1

BS476 Part 6

Method of test for fire propagation of materials.

Result : Index i1 - 0.0, Index i2 - 0.5, Index i3 - 0.2

Fire propagation Index - 0.7

BS476 Part 7 1987

Method for classification of the surface spread of flame of products.

Classification - Class 1

Durability

No change in bond strength after 1000 hours of acid salt spray exposure in accordance with ASTMB287-74.

PART – 16: ROAD WORKS

APPLICABLE CODES AND SPECIFICATIONS

The following IS (Indian Standard) Codes and IRC (Indian Road Congress) Codes, specifications etc. shall be applicable. In all cases the latest revision of the codes and specifications shall be referred to:

IS / IRC Code Nos.	**Description**
IRC : 86	Geometric Design standard for Urban roads in plans.
IRC : 92	Guidelines for the design of Interchanges for Urban areas.
IRC : 16	Specification for priming of base course with Bituminous Primers.
IRC : 29	Specification for Asphaltic Concrete.
MORT&H (5th Edition)	Standard specifications for Road and Bridge work
IS : 73	Specifications for Paving Bitumen.
IS : 454	Specification for Digboi type cut back Bitumen
IS : 217	Specification for cut back Bitumen
IS : 400	Specification for Test Sieve
IS : 2720 : (Part 5)	Method of Test for Soils: Determination of Liquid and Plastic Limit
IS : 6241	Method of Test for determination of stripping value of road aggregates.
IS: 1124	Method of Test for determination of water Absorption, apparent specific gravity & porosity of Building stone.
IS : 456	Specifications for plain and reinforced concrete.
IRC : 37	Guidelines for the Design of flexible Pavements.
IRC:109	Guidelines for Wet Mix Macadam
IRC:SP:63	Guidelines for the use of interlocking Concrete Block Pavement.
IRC:35	Code of Practice for Road Markings (with Paints)
IRC:67	Code of Practice for Road Signs

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NOTE

1. Relevant clauses of Ministry of Road Transport & Highways **(MORT&H)** Specifications for Roads and Bridges (5th Edition, 2010) relevant to this tender only are reproduced.
2. In case of any variation between the reproduced specification and the original specification of **MORT&H** publication, the reproducepublication shall prevail and shall be construed accordingly.
3. If **MORT&H**clauses referred to in the reproduced specifications herein are not included in the latter, the same shall be read from **MORT&H** specifications.

201. CLEARING AND GRUBBING

201.1. SCOPE

This work shall consist of cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil not exceeding 150 mm in thickness, rubbish etc., which in the opinion of the Engineer are unsuitable for incorporation in the works, from the area of road land containing road embankment, drains, cross drainage structures and such other areas as may be specified on the drawings or by the Engineer. It shall include necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to required compaction, handling, salvaging, and disposal of cleared materials with all leads and lights. Clearing and grubbing shall be performed in advance of earthwork operations and in accordance with the requirements of these Specifications.

201.2. PRESERVATION OF PROPERTY/AMENITIES

Roadside trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers and all highway facilities within or adjacent to the highway which are not to be disturbed shall be protected from injury or damage. The Contractor shall provide and install at his own cost, suitable safeguards approved by the Engineer for this purpose.

During clearing and grubbing, the Contractor shall take all adequate precautions against soil erosion, water pollution, etc., and where required, undertake additional works to that effect vide Clause 306. Before start of operations, the Contractor shall submit to the Engineer for approval, his work plan including the procedure to be followed for disposal of waste materials, etc., and the schedules for carrying out temporary and permanent erosion control works as stipulated in Clause 306.3.

201.3. METHODS, TOOLS AND EQUIPMENT

Only such methods, tools and equipment as are approved by the Engineer and which will not affect the property to be preserved shall be adopted for the Work. If the area has thick vegetation/roots/trees, a crawler or pneumatic tyred dozer of adequate capacity may be used for clearance purposes. The dozer shall have ripper attachments for removal of tree stumps. All trees, stumps, etc., falling within excavation and fill lines shall be cut to such depth below ground level that in no case these fall within 500 mm of the subgrade. Also, all vegetation such as roots, under-growth, grass and other deleterious matter unsuitable for incorporation in the embankment/ subgrade shall be removed between fill lines to the satisfaction of the Engineer. On areas beyond these limits, trees and stumps required to be removed as directed by the Engineer, shall be cut down below ground level so that these do not present an unsightly appearance.

All branches of trees extending above the roadway shall be trimmed as directed by the Engineer.

All excavations below the general ground level arising out of the removal of trees, stumps, etc., shall be filled with suitable material and compacted thoroughly so as to make the surface at these points conform to the surrounding area.

Ant-hills both above and below the ground, as are liable to collapse and obstruct free subsoil water flow shall be removed and their workings, which may extend to several metres, shall be suitably treated.

201.4. DISPOSAL OF MATERIALS

All materials arising from clearing and grubbing operations shall be the property of Owner and be disposed of by the Contractor as hereinafter provided or directed by the Engineer.

Trunks, branches and stumps of trees shall be cleaned of limbs and roots and stacked. Also boulders, stones and other materials usable in road construction shall be neatly stacked as directed by the Engineer. Stacking of stumps, boulders, stones, etc. shall be done at specified spots with all leads and lifts.

All products of clearing and grubbing which in the opinion of the Engineer cannot be used or auctioned shall be cleared away to waste areas and burnt, if so desired, at locations away from the road side in a manner as directed by the Engineer. Care shall be taken to see that unsuitable waste materials are disposed of in such a manner that there is no likelihood of these getting mixed-up with the materials meant for embankment, sub-grade and road construction.

EXCAVATION FOR ROADWAY AND DRAINS

301.1 SCOPE

This work shall consist of excavation, removal and disposal of materials necessary for the construction of roadway, side drains and waterways in accordance with requirements of these Specifications and the lines, grades and cross-sections shown in the drawings or as indicated by the Engineer. The scope shall include the hauling and stacking of suitable cut materials or hauling to sites of embankment and sub-grade construction, as required and also the disposal of unsuitable cut materials in specified manner, trimming and finishing of the road to specified dimensions or as directed by the Engineer.

301.2 CLASSIFICATION OF EXCAVATED MATERIAL

301.2.1 Classification:

All materials involved in excavation shall be classified by the Engineer in the following groups:

a) Soil:

This shall comprise topsoil, turf, sand, silt, loam, clay, mud, peat, black-cotton soil, soft shale or loose moorum, a mixture of these and similar material which yield to the ordinary application of pick, spade and/or shovel, rake or other ordinary digging equipment. Removal of gravel or any other modular material having dimension in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

b) Marshy Soil

This shall include soils like soft clays and peats excavated below the original ground level of marshes and swamps and soils excavated from other areas requiring continuous pumping or bailing out of water.

301.2.2 Authority for Classification

The classification of excavation shall be decided by the Engineer and his decision shall be final and binding on the Contractor. Merely the use of explosives in excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engineer.

301.3 CONSTRUCTION OPERATIONS

301.3.1 Setting Out:

After the site has been cleared as per Clause 200, the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer. The Contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete, etc., required in connection with the setting out of works and the establishment of bench marks. The Contractor shall be responsible for the

maintenance of bench marks and other marks and stakes as long as in the opinion of the Engineer, they are required for the works.

301.3.2 Stripping and Storing Top Soil

When so directed by the Engineer, the topsoil existing over the sites of excavation shall be stripped to specified depths constituting Horizon “A” and stockpiled at designated locations for re-use in covering embankment slopes, cut slopes, berms and other disturbed areas where re-vegetation is desired. Prior to stripping the topsoil, all trees, shrubs etc. shall be removed along with their roots, with approval of the Engineer

301.3.3 Excavation - General:

All excavations shall be carried out in conformity with the directions laid herein under and in a manner approved by the Engineer. The work shall be so done that the suitable materials available from excavation are satisfactorily utilised as decided upon beforehand.

While planning or executing excavations, the Contractor shall take all-adequate precautions against soil erosion, water pollution etc. as per Clause 306, and take appropriate drainage measures to keep the site free of water in accordance with Clause 311.

The excavations shall conform to the lines, grades, side slopes and levels shown on the drawings or directed by the Engineer. The Contractor shall not excavate outside the slopes or below the established grades or loosen any material outside the limits of excavation. Subject to the permitted tolerances, any excess depth excavated below the specified levels on the road shall be made good at the cost of the Contractor with suitable material of similar characteristics to that removed and compacted to the requirements of Clause 305.

All debris and loose material on the slopes of cuttings shall be removed. No backfilling shall be allowed to obtain required slopes excepting that when boulders or soft materials are encountered in cut slopes these shall be excavated to approved depth on instructions of the Engineer and the resulting cavities filled with suitable material and thoroughly compacted in an approved manner.

After excavation, the sides of excavated area shall be trimmed and the area contoured to minimise erosion and ponding, allowing for natural drainage to take place. If trees were removed, new trees shall be planted, as directed by the Engineer. The cost of planting new trees shall be deemed to be incidental to the work.

301.3.4 Methods, Tools and Equipment:

Only such methods, tools and equipment as approved by the Engineer shall be adopted / used in the work. If so desired by the Engineer, the Contractor shall demonstrate the efficacy of the type of equipment to be used before the

commencement of work. Recommended equipments for different materials are indicated in Table 300-1.

Table 300-1 Recommended Equipment

Type of Excavation	Recommended equipments
Marsh excavation	Slurry pump and hydraulic excavator
Removal of earth	Hydraulic excavator
Small excavation	Backhoe loader
Areas where vibrations are prohibited	Silent cracking

301.3.5 Rock Excavation:

Deleted.

301.3.6 Marsh Excavation:

The excavation of marshes/swamps shall be carried out as per the programme approved by the Engineer.

Excavation of marshes shall begin at one end and proceed in one direction across the entire marsh immediately ahead of back filling like boulders, sand moorum, bricks bats, dismantled concrete as approved by the Engineer. The method and sequence of excavating and back-filling shall be such as to ensure, to the extent practicable, the complete removal or displacement of all muck from within the lateral limits called for on the drawings or as staked by the Engineer, and to the bottom of the marsh, firm support or levels indicated.

301.3.7 Excavation of Road Shoulders/Verge/Median for Widening of Pavement or providing treated shoulders:

In the works involving widening of existing pavements or providing paved shoulders, the existing shoulders/verge/median shall be removed to its full width and upto top of the subgrade. The subgrade material within 0.5 m from the lowest part of the pavement crust for the widened portion or paved shoulders shall be loosened and recompacted as per Clause 305. Any unsuitable material found in its portion shall be removed and replaced with the suitable material. While doing so, care shall be taken to see that no portion of the existing pavement designated for retention is loosened or disturbed. If the existing pavement gets disturbed or loosened, it shall be dismantled and cut to a regular shape with sides vertical and the disturbed/loosened portion removed completely and relaid as directed by the Engineer, at the cost of the Contractor.

301.3.8 Excavation for Surface/Sub-surface Drains

Where the Contract provides for construction of surface/sub-surface drains, the same shall be done as per Clause 309. Excavation for these drains shall be carried out in proper sequence with other works as approved by the Engineer.

301.3.9 Slides:

If slips, slides, over-breaks or subsidence occur in cuttings during the process of construction, they shall be removed at the cost of the Contractor as ordered by the Engineer. Adequate precautions shall be taken to ensure that during construction, the slopes are not rendered unstable or give rise to recurrent slides after construction. If finished slopes slide into the roadway subsequently, such slides shall be removed and paid for at the Contract rate for the class of excavation involved, provided the slides are not due to any negligence on the part of the Contractor. The classification of the debris material from the slips, slides etc. shall conform to its condition at the time of removal.

301.3.10 De-watering:

If water is met with in the excavations due to springs, seepage, rain or other causes, it shall be removed by suitable diversions, pumping or bailing out and the excavation kept dry whenever so required or directed by the Engineer. Care shall be taken to so discharge the drained water as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair/restore to the original condition at his own cost or compensate for the damage.

301.3.11 Disposal of Excavated Materials:

All the excavated materials shall be the property of the Owner. The material obtained from the excavation of roadway, shoulders, verges, drains, cross-drainage works etc., shall be used for filling up of (i) roadway embankment, (ii) the existing pits in the right-of-way and (iii) for landscaping of the road as directed by the Engineer, including levelling and spreading with all leads and lifts .

All hard materials, such as hard murum, rubble, etc. not intended for use as above shall be stacked neatly on specified land as directed by the Engineer with all leads and lifts.

Unsuitable and surplus material not intended for use within the lead specified above shall also, if necessary, be transported with all lifts and lead beyond initial 1000 m disposed of or used as directed by the Engineer.

301.3.12 Back-filling:

Back-filling of masonry / concrete/ hume pipe drain excavation, shall be done with approved material with all lead and lifts after concrete/masonry hume pipe is fully set and carried out in such a way as not to cause undue thrust on any part of the structure and/or not to cause differential settlement. All space between the drain walls and the side of the excavation shall be refilled to the original surface making due allowance for settlement, in layers generally not exceeding 150 mm. compacted

thickness to the required density, using suitable compaction equipment such as trench compactor, mechanical tamper, rammer or plate compactor as directed by the Engineer.

301.4 PLYING OF CONSTRUCTION TRAFFIC

Construction traffic shall not use the cut formation and finished sub grade without the prior permission of the Engineer. Any damage arising out of such use shall be made good by the contractor at his own expense.

301.5 PRESERVATION OF PROPERTY

The Contractor shall undertake all reasonable precautions for the protection and preservation of any or all existing roadside trees, drains, sewers or other sub-surface drains, pipes, conduits and any other structures under or above ground, which may be affected by construction operations and which in the opinion of the Engineer, shall be continued in use without any change. Safety measures taken by the Contractor in this respect, shall be got approved by him from the Engineer. However, if any of these objects is damaged by reason of the Contractor's negligence, it shall be replaced or restored to the original condition at his expense. If the Contractor fails to do so, within the required time as directed by the Engineer or if, in the opinion of Engineer, the actions initiated by the Contractor to replace/restore the damaged objects are not satisfactory, the Engineer shall arrange the replacement/restoration directly through any other agency at the risk and cost of the Contractor after issuing a prior notice to the effect.

301.6 PREPARATION OF CUT FORMATION

The cut formation, which serves as a sub-grade, shall be prepared to receive the sub-base/base course as directed by the Engineer.

Where the material, in the sub-grade (that is within 500 mm of the lowest level of the pavement) has a density less than specific in Table 300-3, the same shall be loosened to a depth of 500 mm and compacted in 250 mm thick loose layers in accordance with the requirements of Clause 305. Any unsuitable material encountered in the sub-grade shall be removed to a depth indicated by the Engineer and replaced with suitable material compacted in accordance with clause 305.

In rocky formations, the surface irregularities shall be corrected and the levels brought up to the specified elevation with granular sub-base or base material as directed by the Engineer, laid and compacted in accordance with the respective specifications for these materials. The unsuitable material shall be disposed of in accordance with Clause 301.3.11. After satisfying the density requirements, the cut formation shall be prepared to receive the sub-base/base-course in accordance with Clause 310 and 311 to receive the sub-base/base course.

301.7 FINISHING OPERATIONS

Finishing operations shall include the work of properly shaping and dressing all excavated surfaces.

When completed, no point on the slopes shall vary from the designated slopes by more than 150 mm. measured at right angles to the slope, except where excavation is in rock (hard or soft) where no point shall vary more than 300 mm from the designated slope. In no case shall any portion of the slope encroach on the roadway.

The finished cut formation shall satisfy the surface tolerances described in Clause 902.

Where feasible and directed, the topsoil removed earlier and conserved (Clauses 301.3.2 and 305.3.3) shall be spread over cut slopes, berms and other disturbed areas. Slopes may be roughened and moistened slightly, prior to the application of topsoil, in order to provide satisfactory bond. The depth of topsoil shall be sufficient to sustain plant growth, the usual thickness being from 75 to 150 mm.

304 EXCAVATION FOR STRUCTURES

304.1 SCOPE

This Excavation for structures shall consist of the removal of material for the construction of foundations for bridges, culverts, retaining walls, head-walls, cut off walls, pipe culverts and other similar structures, in accordance with the requirements of these Specifications and the lines and dimensions shown on the drawings or as indicated by the Engineer. The work shall include construction of the necessary cofferdams and cribs and their subsequent removal; all necessary sheeting, shoring, bracing, draining, and pumping; the removal of all logs, stumps, grubs and other deleterious matter and obstructions necessary for placing the foundations; trimming bottoms of excavations; back filling and clearing up the site and the disposal of all surplus material.

304.2 CLASSIFICATION OF EXCAVATION

All materials involved in excavation shall be classified in accordance with Clause 301.2.

304.3 CONSTRUCTION OPERATIONS

304.3.1 Setting out:

After the site has been cleared to Clause 201, the limits of excavation shall be set out true to lines curves and slopes to Clause 301.3.1.

304.3.2 Excavation:

Excavation shall be taken to the width of the lowest step of the footing and the sides shall be left plumb where the nature of soil allows it. Where the nature of soil or the depth of the trench does not permit vertical sides, the Contractor at his own expense shall put up necessary shoring, strutting and planking or cut slopes to a safer angle or both width due regard to the safety of personnel and works and to the satisfaction of the Engineer.

The depth to which the excavation is to be carried out shall be as shown on the drawings, unless the type of material encountered is such as to require changes, in which case the depth shall be as ordered by the Engineer. Propping shall be undertaken when any foundation or stressed zone from an adjoining structure is within a line of 1 vertical to 2 horizontal from the bottom of the excavation.

Where blasting is to be resorted to, the same shall be carried out to Clause 302 and all pre -cautions indicated therein observed. Where blasting is likely to endanger adjoining foundations or other structures, necessary precautions such as controlled blasting, providing rubber mat cover to prevent flying of debris etc. shall be taken to prevent any damage.

304.3.3 Dewatering and Protection:

Normally, open foundation shall be laid dry. Where water is met with in excavation due to stream flow, seepage, springs, rain or other reasons, the Contractor shall take adequate measures such as bailing, pumping, constructing diversion channels, drainage channels, bunds, cofferdams and other necessary works to keep the foundation trenches dry when so required and to protect the green concrete/masonry against damage by erosion or sudden rising of water level. The methods to be adopted in this regard and other details thereof shall be left to the choice of the Contractor but subject to approval of the Engineer. Approval of the Engineer shall, however, not relieve the Contractor of the responsibility for the adequacy of dewatering and protection arrangements and for the quality and safety of the Works.

Where cofferdams are required, these shall be carried to adequate depths and heights, be safely designed and constructed and be made as watertight as is necessary for facilitating construction to be carried out inside them. The interior dimensions of the cofferdams shall be such as to give sufficient clearance for the construction and inspection and to permit installation of pumping equipments, etc. inside the enclosed area.

If it is determined beforehand that the foundations cannot be laid dry or the situation is found that the percolation is too heavy for keeping the foundation dry, the foundation concrete shall be laid under water by tremie pipe only. In case of flowing water or artesian springs, the flow shall be stopped or reduced as far as possible at the time of placing the concrete.

Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping shall be permitted during the placing of concrete or for a period of at least 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a watertight wall or other similar means.

At the discretion of the Contractor, cement grouting or other approved methods may be used to prevent or reduce seepage and to protect the excavation area.

The Contractor shall take all precautions in diverting channels and in discharging the drained water as not to cause damage to the works, crops or any other property.

304.3.4 Preparation of Foundation:

The bottom of the foundation shall be levelled both longitudinally and transversely or stepped as directed by the Engineer. Before footing is laid, the surface shall be slightly watered and rammed. In the event of excavation having been made deeper

than that shown on the drawings or as otherwise ordered by the Engineer, the extra depth shall be made up with concrete or masonry of the foundation at the cost of the Contractor as per Clause 2104.1 Ordinary filling shall not be used for the purpose to bring the foundation to level.

When rock or other hard strata is encountered, it shall be freed of all soft and loose material, cleaned and cut to a firm surface either level or stepped as directed by the Engineer. All seams shall be cleaned out and filled with cement mortar or grout to the satisfaction of the Engineer. In the case of excavation in rock, annular space around footing shall be filled with lean concrete M 15 upto the top level of rock

If the depth of fill required is more than 1.5 m. above the top of the footing, filling up to 1.5m above top of footing shall be done with lean concrete M15 followed by boulders grouted with cement.

When foundation piles are used, the excavation of each pit shall be substantially completed before beginning pit-driving operations therein. After pile driving operations in a given pit are completed, all loose and displaced materials therein shall be removed to the elevation of the bottom of the footings.

304.3.5 Slips and slip-outs:

If there are any slips or slip-outs in the excavation, these shall be removed by the Contractor at his own cost.

304.3.6 Public Safety:

Near towns, villages and all frequented places, trenches and foundation pits shall be securely fenced, provided with proper caution signs and marked with red lights at night to avoid accidents. The Contractor shall take adequate protective measures to see that the excavation operations do not affect or damage adjoining structures. For safety precautions, guidance may be taken from IS: 3764.

304.3.7 Back Filling:

Back filling shall be done with approved material after concrete or masonry is fully set and carried out in such a way as not to cause undue thrust on any part of the structure. All space between foundation masonry or concrete and the sides of excavation shall be refilled to the original surface in layers not exceeding 150 mm compacted thicknesses. The compaction shall be done with the help of suitable equipment such as trench compactor, mechanical tamper, rammer, plate vibrator etc. after necessary watering, so as to achieve a density not less than the field density before excavation.

304.3.8 Disposal of Surplus Excavated Materials:

Clause 301.3.11 shall apply.

305 EMBANKMENT CONSTRUCTION

305.1 GENERAL

305.1.1 Description:

These specifications shall apply to the construction of embankments including sub-grades, earthen shoulders and miscellaneous backfills with approved material obtained either from excavation for road construction, borrow pits or other sources. All embankments and sub-grades shall be constructed to accordance with the requirements of these specifications and in conformity with the lines, grades, and cross-sections shown on the drawings or as directed by the Engineer.

305.2 MATERIALS

305.2.1 Physical Requirements:

305.2.1.1 The materials used in embankments, sub-grades, earthen shoulders and miscellaneous backfills shall be murum, gravel, pond ash, a mixture of these or any other material approved by the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment/sub-grade.

The following types of material may be considered unsuitable for embankment:

a) Material from swamps, marshes or bogs

b) Peat, log, stump or perishable material; any soil classifies as OL, OI, OLL or Pt in accordance with IS: 1498.

c) Material susceptible to spontaneous combustions

d) Material in a frozen condition and

e) Clay of liquid limit exceeding 50 and plasticity index exceeding 25; and

f) Materials with salts resulting in leaching in the embankment.

305.2.1.2 Expansive clay exhibiting marked swell and shrinkage properties (“free swelling index” exceeding 50 per cent when tested as per IS: 2720 – Part 40) shall not be used as a fill material. Where expansive clay with acceptable “free swelling index” value is used as a fill material, sub-grade and top 500mm portion of the embankment just below sub-grade shall be non-expansive in nature.

305.2.1.3 Any fill material with a soluble sulphate content exceeding 1.9 grams of sulphate (expressed as SO3) per litre when tested in accordance with BS: 1377 Test 10, but using a 2:1 water-soil ratio shall not be deposited within 500mm.distace (or any other distance described in the Contract), of permanent works constructed out of concrete, cement bound materials or other cementitious material.

Material with a total sulphate content (expressed as SO_3) exceeding 0.5 percent by mass, when tested in accordance with BS:1377 Test 9 shall not be deposited

within 500 mm, or other distances described in the Contract, or metallic items forming part of the Permanent Works.

305.2.1.4 The size of the coarse material in the mixture of earth shall ordinarily not exceed 75 mm. when being placed in the embankment and 50 mm. when placed in the sub-grade. However, the Engineer may at his discretion permit the use of material coarser than this also if he is satisfied that the same will not present any difficulty as regards the placement of fill material and its compaction to the requirements of these specifications. The maximum particle size shall not be more than two-third of the compacted layer thickness.

305.2.1.5 Ordinarily, only the materials satisfying the density requirements given in Table 300.2 shall be employed for the construction of the embankment and the sub-grade.

Table 300.2: Density Requirements of Embankment & Sub-Grade Materials

S. No	Type of Work	Maximum laboratory dry density when tested as per IS: 2720 (Part-VIII)
1.	Embankments up to 3 m. Height not subjected to extensive flooding.	Not less than 16.00 KN/cum
2.	Embankments exceeding 3 metre height or embankments of any height subject to long periods of inundation.	Not less than 17.00 KN/cum
3.	Sub-grade and earthen shoulders /verge/backfill	Not less than 18.00 KN/cum

Note:

1) This table is not applicable for lightweight fill material e.g. cinder, fly ash etc.
2) The Engineer may relax these requirements at his discretion taking into account the availability of materials for construction and other relevant factors.
3) The material to be used in sub-grade should be satisfy design CBR at the dry unit weight applicable as per Table 300.3

305.2.2 General Requirements:

305.2.2.1 The materials for embankment shall be obtained from approved sources with preference given to materials becoming available from nearby roadway excavation or any other excavation under the same contract.

The work shall be so planned and executed that the best available materials are saved for the sub-grade and the embankment portion just below the sub-grade.

305.2.2.2 Borrow Materials:

Where the materials are to be obtained from approved borrow pits, the location, size

and shape of these pits shall be as indicated by the Engineer and the same shall not be opened without his written permission. Where specific borrow area are not designed by the Owner/the Engineer, arrangement for locating the source of supply of material for embankment and sub-grade as well as compliance to environmental requirements in respect of excavation and borrow areas as stipulated, from time to time by the Ministry of Environment and Forests, Government of India and the local bodies, as applicable, shall be the sole responsibility of the Contractor.

Area where pond ash is available for construction of embankment, borrowing of the earth shall be avoided to the extent possible. Embankment constructed out of pond ash shall be properly designed to ensure stability against uplifting etc. A suitable thick cover may preferably be provided at intervening layers of pond ash for this purpose. A thick soil cover shall bind the edge of the embankment to protect it against erosion. Minimum thickness of such soil cover shall be 500 mm.

Borrow pits along the road shall be discouraged. If permitted by the Engineer, these shall not be dug continuously. Ridges of not less than 8m width should be left at intervals not exceeding 300 m. Small drains shall be cut through the ridges to facilitate drainage. The depth the pits shall be so regulated that their bottom does not cut an imaginary line having a slope of 1 vertical to 4 horizontal projected from the edge of the final section of the bank, the maximum depth in any case being limited to 1.5 m. Also no pit shall be dug within the offset width from the toe of the embankment required as per the consideration of stability with a minimum width of 10 m.

Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction plant is operating at the place of deposition.

No excavated acceptable material other than surplus to requirements of the Contract shall be removed from the site. Should the Contractor be permitted to remove acceptable material from the site to suit his operational procedure, then he shall make good any consequent deficit of material arising there from.

Where the excavation reveals a combination of acceptable and un-acceptable materials, the Contractor shall unless otherwise agreed by the Engineer, carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

The Contractor shall ensure that he does not adversely affect the stability of excavation or fills by the methods of stockpiling materials, use of plants or sitting of temporary buildings or structures.

The Contractor shall obtain representative samples from each of the identified borrow areas and have these tested at the site laboratory following a testing programme approved by the Engineer. It shall be ensured that the sub-grade material when compacted to the density requirements as in Table 300.3 shall yield the design CBR value of the sub-grade.

Table: 300.3: Compaction Requirements for Embankment & Subgrade

Sl. No	Type of Work/ Material	Relative compaction as percentage of max. laboratory dry density as per IS : 2720 (Part VIII)	Minimum CBR %
1.	Sub-grade and earthen shoulders	Not less than 98%	5.00
2.	Embankment	Not less than 97%	5.00
3.	Expansive clays Sub-grade and 500mm. portion just below Remaining portion of embankment	 Not allowed Not less than 90%	 - 4.00

In case the sub-grade CBR is less than the specified in the Table 300-3, the sub-grade shall be stabilised with lime, cement or any other stabiliser accredited by IRC or by mechanical stabilisation so as to raise the (Field) CBR is not less than15 percent

The Contractor shall at least 7 working days before commencement of compaction submit the following to the Engineer for approval.

a) The value of maximum dry density and optimum moisture content obtained in accordance with IS: 2720 (Part VIII), as the case may be, appropriate for each of the fill materials he intends to use.

b) A graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined.

c) The dry density moisture content – CBR relationships for light, intermediate and heavy compactive efforts (light corresponding to IS: 2720 (Part VII), heavy corresponding to IS: 2720 (Part VIII) and intermediate in-between the two for each of the fill materials he intends to use in the sub-grade.

Once the above information has been approved by the Engineer, it shall form the basis for compaction.

305.3 CONSTRUCTION OPERATIONS

305.3.1 Setting Out:

After the site has been cleared to Clause 201, the work shall be set out to Clause 301.3.1. The limits of embankment/sub-grade shall be marked by fixing batter the

earthwork. The embankment/sub-grade shall be built sufficiently wider than the design dimension so that surplus material may be trimmed, ensuring that the remaining material is to the desired density and in position specified and conforms to the specified side slopes.

305.3.2 Dewatering:

If the foundation of the embankment is in an area with stagnant water, and in the opinion of the Engineer it is feasible to remove it the same shall be removed by bailing out or pumping, as directed by the Engineer and the area of the embankment foundation shall be kept dry. Care shall be taken to discharge the drained water so as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair/restore it to original condition or compensate the damage at his own cost.

If the embankment is to be constructed under water, Clause 305.4.6 shall apply.

305.3.3 Stripping and Storing Top Soil:

In localities where most of the available embankment materials are no conducive to plant growth, or when so directed by the Engineer the topsoil from all areas of cutting and from all areas to be covered by embankment foundation shall be stripped to specified depths not less than 150 mm and stored in stockpiles of height not exceeding 2 m for covering embankment slopes, cut slopes and other disturbed areas where re-vegetation is desired. Topsoil shall not be unnecessarily trafficked either before stripping or when in a stockpile. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept to a minimum.

305.3.4 Compacting Ground Supporting Embankment/Sub-grade

Where necessary, the original ground shall be levelled to facilitate placement of first layer of embankment, scarified, mixed with water and then compacted by rolling in accordance with Clauses 305.3.5 and 305.3.6 so as to achieve minimum dry density as given in Table 300-3.

In a case where the difference between the sub grade level (top of the sub-grade on which pavement rests) and ground level is less than 0.5 m and the ground does not have 98 percent relative compaction with respect to the dry density as given in Table 300-3, the ground shall be loosened up to a level 0.5 m below the sub-grade level, watered and compacted in layers in accordance with Clauses 305.3.5 and 305.3.6 to not less than 98 percent of dry density as given in Table 300.3.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation (500 mm portion just below the sub-grade) shall be

removed, suitably disposed and replaced by approved materials laid in layers to the required degree of compaction.

Embankment or sub-grade work shall not proceed until the foundations for embankment/sub-grade have been inspected by the Engineer for satisfactory condition and approved.

Any foundation treatment specified for embankments especially high embankments, resting on suspect foundations as revealed by borehole logs shall be carried out in a manner and to the depth as desired by the Engineer. Where the ground on which an embankment is to be built has any of the material types (a) to (f) in Clause 305.2.1.1, at least 500 mm of such material must be removed and replaced by acceptable fill material before embankment construction commence.

305.3.5 Spreading material in layers and bringing to appropriate moisture content.

305.3.5.1 The embankment and sub-grade material shall be spread in layers of uniform thickness not exceeding 200mm compacted thickness over the entire width of embankment by mechanical means, finished by a motor grader and compacted as per Clause 305.3.6. The motor grader blade shall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the specific slope and grade. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as in Table 300.3 and got approved by the Engineer. Each compacted layer shall be finished parallel to the final cross-section of the embankment.

305.3.5.2 Moisture content of the material shall be checked at the site of placement prior to commencement of compaction; if found to be out of agreed limits, the same shall be made good. Where water is required to be added in such constructions, water shall be sprinkled from a water tanker fitted with sprinkler capable of applying water uniformly with a controllable rate of flow to variable widths of surface but without any flooding. The water shall be added uniformly and thoroughly mixed in soil by blading, discing or harrowing until uniform moisture content is obtained throughout the depth of the layer.

If the material delivered to the roadbed is too wet, it shall be dried, by aeration and exposure to the sun, till the moisture content is acceptable for compaction. Should circumstances arise, where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, work on compaction shall be suspended.

Moisture content of each layer of soil shall be check in accordance with IS: 2720 (Part-2) and unless otherwise mentioned, shall be so adjusted, making due allowance for evaporation losses, that at the time of compaction is in the range of

1 per cent above to 2 per cent below the optimum moisture content determined in accordance with IS: 2720 (Part-7) or IS: 2720 (Part-8) as the case may be. Expansive clays shall, however, be compacted at moisture content corresponding to the specified dry density, but on the wet side of the optimum moisture content obtained from the laboratory compaction curve.

After adding the required amount of water, the soil shall be processed by means of harrows, rotary mixers or as otherwise approved by the Engineer until the layer is uniformly wet.

Clods or hard lumps of earth shall be broken to have a maximum size of 75 mm. when being placed in the embankment and a maximum size of 50 mm. when being placed in the sub-grade.

305.3.5.3 Embankment and other areas of fill shall, unless otherwise required in the Contract or permitted by the Engineer, be constructed evenly over their full width and their fullest possible extent and the Contractor shall control and direct construction plant and other vehicular traffic uniformly over them. Damage by construction plant and other vehicular traffic shall be made good by the Contractor with material having the same characteristics and strength as the material had before it was damaged.

Embankments and other areas of unsupported fills shall not be constructed with steeper side slopes, or to greater widths than those shown in the Contract, except to permit adequate compaction at the edges before trimming back, or to obtain the final profile following any settlement of the fill and the underlying material.

Whenever fill is to be deposited against the face of a natural slope, or sloping earthworks face including embankments, cuttings, other fills and excavations steeper than 1 vertical or 4 horizontal, such faces shall be benched as per Clause 305.4.1 immediately before placing the subsequent fill.

All permanent faces of side slopes of embankments and other areas of fill formed shall, subsequent to any trimming operations, be reworked and sealed to the satisfaction of the Engineer by tracking a tracked vehicle, considered suitable by the Engineer, on the slope or any other method approved by the Engineer.

305.3.6 Compaction:

Only the compaction equipment approved by the Engineer shall be employed to compact the different material types encountered during construction. Static three wheel roller, self propelled single drum vibratory roller, vibratory tandem roller, pneumatic tyred, pad foot rollers, etc., of suitable size and capacity as approved by

the Engineer shall be used for the different types and grades of materials required to be compacted either individually or in suitable combinations.

The compaction shall be done with the help of self-propelled single drum vibratory roller or pad foot vibratory roller of 80 to 100 kN static weight or heavy pneumatic tyre roller of adequate capacity capable of achieving required compaction with nine wheels and 200 to 300 kN weight with minimum tyre pressure of 0.7 MPa.

The Contractor shall demonstrate the efficacy of the equipment he intends to use by carrying out compaction trials. The procedure to be adopted for these site trials shall first be submitted to the Engineer for approval.

Earthmoving plant shall not be accepted as compaction equipment nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account.

Each layer of the material shall be thoroughly compacted to the densities specified in Table 300-2. Subsequent layers shall be placed only after the finalised layer has been tested according to Clause 903.2.2 and accepted by the Engineer. The Engineer may permit measurement of field dry density by a nuclear moisture/density gauge used in accordance with agreed procedure and the gauge is calibrated to provide results identical to that obtained from tests in accordance with IS:2720 (Part 28). The Contractor shall maintain a record of the same.

When density measurements reveal any soft areas in the embankment/sub-grade/earthen shoulders, further compaction shall be carried out as directed by the Engineer. If inspite of that the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted using appropriate mechanical means such as light weight vibratory roller, double drum walk behind roller, vibratory plate compactor, trench compactor or vibratory tamper to the density requirements and satisfaction of the Engineer.

305.3.7 Drainage:

The surface of the embankment/sub-grade at all times during construction shall be maintained at such a cross fall (not flatter than that required for effective drainage of an earthen surface) as will shed water and prevent ponding.

305.3.8 Repairing of damages caused by rain/spillage of water:

The soil in the affected portion shall be removed in such areas as directed by the Engineer before next layer is laid and refilled in layers and compacted using appropriate mechanical means such as small vibratory roller, plate compactor or power rammer to achieve the required density in accordance with Clause 305.3.6. If

the cut is not sufficiently wide for use of required mechanical means for compaction, the same shall be widened suitably to permit their use for proper compaction. Tests shall be carried out as directed by the Engineer to ascertain the density requirements of the repaired area. The work of repairing the damages including widening of the cut, if any, shall be carried out by the Contractor at his own cost, including the arranging of machinery/equipment for the purpose.

305.3.9 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders/verge road bed and side slopes to conform to the alignment, levels, cross - sections and dimensions shown on the drawings or as directed by the Engineer subject to the surface tolerances described in Clause 902. Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain.

The top soil, removed and conserved earlier (Clauses 301.3.2 and 305.3.3) shall be spread over the fill slopes as per directions of the Engineer to facilitate the growth of vegetation. Slopes shall be roughened and moistened slightly prior to the application of the topsoil in order to provide satisfactory bond. The depth of the topsoil shall be sufficient to sustain plant growth, the usual thickness being from 75mm to 150mm.

Where directed, the slopes shall be turfed with sods in accordance with Clause 307. If seeding and mulching of slopes is prescribed, this shall be done to the requirement of Clause 308.

When earthwork operations have been substantially completed the road area shall be cleared of all debris, and ugly scars in the construction area responsible for objectionable appearance eliminated.

305.4 CONSTRUCTION OF EMBANKMENT AND SUB-GRADE UNDER SPECIAL CONDITIONS

305.4.1 Earthwork for Widening Existing Road Embankment:

When an existing embankment and/or sub-grade is to be widened and its slopes are steeper than 4:1, continuous horizontal benches, each at least 300mm. wide, shall be cut into the old slope for ensuring adequate bond with the fresh embankment /sub-grade material to be added. The material obtained from cutting of benches could be utilised in the widening of the embankment/sub-grade. However, when the existing slope against which the fresh material is to be placed is flatter than 4:1 the slope surface may only be ploughed or scarified instead of resorting to benching.

Where the width of the widened portions is insufficient to permit the use of conventional rollers, compaction shall be carried out with the help of light weight

vibratory roller, double drum walk behind roller, vibratory plate compactor or vibratory tamper or any other appropriate equipment approved by the Engineer. End dumping of material from trucks for widening operations shall be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other types of hauling equipment.

305.4.2 Earthwork for Embankment and Sub-grade to be Placed against Sloping Ground:

Where an embankment/sub-grade is to be placed against sloping ground, the latter shall be appropriately benched or ploughed/scarified as required in Clause 305.4.1, before placing the embankment/sub-grade material. Extra earthwork involved in benching or due to ploughing/scarifying etc. shall be considered incidental to the work.

For wet conditions, benches with slightly inward fall and subsoil drains at the lowest point shall be provided as per the drawings before the fill is placed against sloping ground.

Where the contract requires construction of transverse sub-surface drain at the cut-fill interface, work on the same shall be carried out to Clause-309 in proper sequence with the embankment and sub-grade work as approved by the Engineer.

305.4.3 Earthwork over Existing Road Surface:

Where the embankment is to be placed over an existing road surface, the work shall be carried out as indicated below:

i) If the existing road surface is of granular type and lies within 1 m of the new sub-grade level. The existing granular base/sub-base, as the case, may be, shall be scarified to a depth of 50 mm or as directed so as to provide ample bond between the old and new material ensuring that at least 500 mm portion below the top of new sub-grade level is compacted to the desired density.

ii) If the existing road surface is of bituminous type and lies within 1 m of the new sub-grade level, the bituminous layer shall be removed completely, so as to avoid presence of impermeable layer beneath the new thin earthen layer and also provide ample bond between the old and new material ensuring that at least 500 mm portion below the top of new subgrade level is compacted to the desired density.

iii) If the existing road surface is of cement concrete type and lies within 1 m of the new sub-grade level, the same shall be removed completely.

iv) If the level difference between the existing road surface and the new sub-grade level is more than 1m the existing surface shall be permitted to stay in place without any modification.

305.4.4 Embankment and Sub-grade around Structures:

To avoid interference with the construction abutments, wing walls or return walls of culvert/bridge structures, the Contractor shall, at points to be determined by the Engineer suspend work on embankments forming approaches to such structures, until such time as the construction of the letter is sufficiently advanced to permit the completion of approaches without the risk of interference of damage to the structure.

Unless directed otherwise, the filling around culverts, bridges and other structures up to distance of twice the height of the road from the back of the abutment shall be carried out independent of the work on the main embankment. The fill material shall not be placed against any abutment or wing wall unless permission has been given by the Engineer but in any case not until the concrete or masonry has been in position for 14 days. The embankment and sub-grade shall be brought up simultaneously in equal layers on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be got approved from the Engineer.

The material used for backfill shall not be an organic soil or highly plastic clay having plasticity index and liquid limit more than 20 and 40 respectively when tested according to IS : 2720 (Part-5). Filling behind abutments and wing walls for all structures shall conform to the general guidelines given in Appendix 6 of IRC: 78-1983 (Standard Specifications and Code of Practice for Road Bridges-Section VII) in respect of the type of material, the extend of backfill, its laying and compaction etc. The fill material shall be deposited in horizontal layers not exceeding 150mm in loose thickness and compacted thoroughly to the requirements of Table 300-3.

Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter shall conform to the requirements for filter medium spelt out in Clause 2502/309.3.2 (B) unless otherwise specified in the contract.

Where it may be impracticable to use conventional rollers, the compaction shall be carried out by appropriate mechanical means such as small vibratory roller, plate compactor or power rammer. Care shall be taken to see that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to them or excessive pressure against the structure.

305.4.5 Construction of embankment over ground incapable of supporting construction equipment

Where embankment is to be constructed across ground which will not support the weight of repeated heavy loads of construction equipment, the first layer of the fill

may be constructed by placing successive loads of material in a uniformly distributed layer of a minimum thickness required to support the construction equipment as permitted by the Engineer. The Contractor, if so desired by him, may also use suitable geo-synthetic material to increase the bearing capacity of the foundation. This exception to normal procedure will not be permitted where, in the opinion of the Engineer, the embankments could be constructed in the approved manner over such ground by the use of lighter or modified equipment after proper ditching and drainage have been provided. Where this exception is permitted, the selection of the material and the construction procedure to obtain an acceptable layer shall be the responsibility of the Contractor. The cost of providing suitable traffic conditions for construction equipment over any area of the Contractor will be the responsibility of the Contractor and no extra payment will be made to him. The remainder of the embankment shall be constructed as specified in Clause 305.3.

305.4.6 Embankment Construction under Water:

Where filling or backfilling is to be placed under water, only acceptable granular material or rock shall be used unless otherwise approved by the Engineer. Acceptable granular material shall be of GW, SW, GP, SP as per IS:1498 and consist of graded, hard durable particles with maximum particle size not exceeding 75 mm. The material should be non-plastic having uniformity coefficient of not less than 10. The material placed in open water shall be deposited by end tipping without compaction.

Coarse sand blanket layer in accordance with the provision of IRC:34 shall be made for construction of embankment in water logged and marshy areas

305.4.7 Earthwork for high embankment

In the case of high embankments (more than 6 m), the Contractor shall normally use the material from the specified borrow area. In case he desires to use different material for his own convenience, he shall have to carry out necessary soil investigations and redesign the high embankment at his own cost. The Contractor shall then furnish the soil test data and design of high embankment for approval of the Engineer, who reserves the right to accept or reject it.

If necessary, stage construction of fills and any controlled rates of filling shall be carried out in accordance with the Contract including installation of instruments and its monitoring.

Where required, the Contractor shall surcharge embankments or other areas of fill with approved material for the periods specified in the contract. If settlement of surcharged fill results in any surcharging material, which is unacceptable for use in the fill being surcharged, lying below formation level, the Contractor shall remove the

unacceptable material and dispose it as per direction of the Engineer. He shall then bring the resultant level up to formation level with acceptable material.

305.4.8 Settlement Period

Where settlement period is specified in the Contract, the embankment shall remain in place for the required settlement period before excavating for abutment, wing wall, retaining wall, footings, etc. or driving foundation piles. The duration of the required settlement period at each location shall be as provided for in the contract or as directed by the Engineer.

305.5 PLYING OF CONSTRUCTION TRAFFIC

Construction traffic shall not use the prepared surface of the embankment and / or sub-grade without the prior permission of the Engineer. Any damage arising out of such use shall, however, be made good by the Contractor at his own expense as directed by the Engineer.

305.6 SURFACE FINISH AND QUALITY CONTROL OF WORK

The surface finish of construction of sub-grade shall conform to the requirements of Clause 902. Control on the quality of materials and works shall be exercised in accordance with Clause 903.

305.7 SUB-GRADE STRENGTH

305.7.1 It shall be ensured prior to actual execution that the borrow area material to be used in the sub-grade satisfies the requirement of design CBR.

305.7.2 Sub-grade shall be compacted and finished to the design strength consistent with other physical requirements. The actual laboratory CBR values of constructed sub-grade shall be determined on undisturbed samples cut out from the compacted sub-grade in CBR mould fitted with cutting shoe or on remoulded samples, compacted to the field density at the field moisture content.

401 GRANULAR SUB-BASE

401.1 SCOPE

This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub base hereinafter) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

401.2 MATERIALS

401.2.1 The material to be used for the work shall be natural sand, crushed gravel, crushed stone, or combination thereof depending upon the grading required. The material shall be free from organic or other deleterious constituents and shall conform to the quality standards as prescribed in the specifications.

Table 400-1 prescribes four gradings for Granular Sub-Base (GSB). Gradings I and II in Table 400-1 are well graded granular sub-base materials. These can be used at locations where drainage requirement are not predominant. Gradings III and IV are gap graded and addresses to the concern of the drainage requirements. These can be used at location experiencing heavy rainfall, flooding etc. Cases where GSB is to be provided in two layers, it is recommended to adopt either grading III or grading IV for lower layer and either grading I or grading II for upper layer. Minimum thickness of lower layer at locations where drainage requirements are predominant shall not be less than 200 mm. The grading to be adopted for a project shall be as specified in the Contract.

401.2.2 Physical Requirement :

The material shall have a 10 percent fines value of 50kN or more (for sample in soaked condition) when tested in compliance with IS:2386 (Part IV) 1963. The water absorption value of the coarse aggregate shall be determined as per IS:2386 (Part 3). If this value is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS:383. For Gradings II and IV materials, the CBR shall be determined at the density and moisture content likely to be developed in the field

TABLE 400-1 GRADING FOR GRANULAR SUB-BASE MATEIRALS

IS Sieve Designation	Percent by weight passing the Sieve			
	Grading-1	Grading-2	Grading-3	Grading-4
75.0mm.	100	--	100	--
53.0 mm.	80-100	100	100	--
26.5 mm	55-90	70-100	55-75	50-80

IS Sieve Designation	Percent by weight passing the Sieve			
	Grading-1	Grading-2	Grading-3	Grading-4
9.50 mm.	35-65	50-80	--	--
4.75 mm.	25-55	40-65	10-30	15-35
2.36 mm.	20-40	30-50	--	--
0.425 mm.	10-25	15-25	--	--
0.075 mm.	<5	<5	<5	<5
CBR Value (Minimum)	30	25	30	25

Note:

The material passing 425 micron (0.425mm) sieve for all gradings when tested according to IS : 2720 (Part 5) shall have liquid limit and plasticity index of not more than 25 per cent and 6 percent respectively.

The material passing 425 micron (0.425mm) sieve for all gradings shall confirm to IS: 1498.

401.3 STRENGTH OF SUB-BASE

It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies the requirements of CBR and other physical requirements when compacted and finished.

When directed by the Engineer, this shall be verified by performing CBR tests in the laboratory as required on specimens remoulded at field dry density and moisture content and any other tests for the “quality” of materials, as may be necessary.

401.4 CONSTRUCTION OPERATIONS

401.4.1 Preparation of Sub-grade:

Immediately prior to the laying of sub-base, the subgrade already finished to Clause 301 or 305 as applicable shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water, if necessary and rolled with two passes of 80–100 kN smooth wheeled roller.

401.4.2 Spread and Compacting:

The sub-base material of grading specified in the Contract shall be spread on the prepared subgrade with the help of a motor grader of adequate capacity, its blade

having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation or other means as approved by the Engineer.

When the sub-base material consists of combination of materials mentioned in Clause 401.2.1, mixing shall be done mechanically. Mixing shall be done in a separate yard by pugmill or other approved mechanical means so as to issue homogenous & uniform mix.

Moisture content of the loose material shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS:2720 (Part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be started. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer upto 200 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight with plain drum or pad foot-drum or heavy pneumatic tyred roller of minimum 200 to 300 kN weight having a minimum tyre pressure of 0.7 MPa or equivalent capacity roller capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional crossfall and super-elevation shall commence at the edges and progress towards the centre for portions having crossfall on both sides.

Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. During rolling, the grade and crossfall (camber) shall be checked and any high spots or depressions which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour.

Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material determined as per IS:2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

401.5 SURFACE FINISH AND QUALITY CONTROL OF WORK

The surface finish of construction shall conform to the requirements of Clause 902. Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

401.6 ARRANGEMENT FOR TRAFFIC

During the period of construction, arrangements for the traffic shall be provided and maintained in accordance with Clause 112.

406 WET MIX MACADAM SUB-BASE/BASE COURSE

406.1 SCOPE

This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared sub-grade/sub-base/base or existing pavement as the case may be in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the Engineer.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub-base course may be upto 200 mm with the approval of the Engineer

406.2 MATERIALS

406.2.1 Aggregate:

406.2.1.1 Physical Requirements – Coarse aggregates shall be crushed stone. If crushed gravel/shingle is used, not less than 90 percent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table 400-9.

If the water absorption value of the coarse aggregate is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS:2386 (Part-5).

Table 400-9Physical Requirements of Coarse Aggregates for Wet Mix Macadam for Sub-base/Base Courses

Sr. No.	Test	Test Method	Requirements
1.	Loss Angeles Abrasion value	IS:2386 (Part-4)	40 percent (Max.)
	Aggregate Impact value	IS:2386 (Part-4) or IS:5640	30 percent (Max.)
2.	Combined Flakiness and Elongation indices (Total)	IS:2386 (Part-1)	30 percent (Max.)*

* To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is

weight of elongated particles divided by total non-flaky particles. The values of flakiness index and elongation index so found are added up.

406.2.1.2 Grading Requirement:

The aggregates shall conform to the grading given in Table 400-10

TABLE – 400-10: Grading Requirements of Aggregates for Wet-Mix-Macadam

IS Sieve Designation	**Percent by weight Passing the IS Sieve**	
	Grade 1 layer thickness ≥ 100mm	**Grade 2<100 mm**
53mm.	100	--
45mm.	95-100	--
26.5mm.	--	100
22.4mm.	60-80	50-100
11.2mm.	40-60	--
4.75mm.	25-40	35-55
2.36mm.	15-30	--
600 micron	8-22	10-30
75micron	0-5	2-5

Note:

Material finer than 425 micron shall have Plasticity Index (PI) not exceeding 6.

The material passing 425 micron (0.425mm) sieve for all gradings shall confirm to IS: 1498.

The final gradation approved within these limits shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa.

406.3 CONSTRUCTION OPERATIONS

406.3.1 Preparation of Base: Clause 404.3.1 shall apply.

406.3.2 Provision of Lateral Confinement of aggregates:

While constructing wet mix macadam, arrangement shall be made for the lateral confinement of wet mix. This shall be done by laying materials in adjoining shoulders along with that of wet mix macadam layer and following the sequence of operations described in Clause 407.4.1.

406.3.3 Preparation of Mix:

Wet mix macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement like pug mill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers.

The plant shall have following features:

i) Cold aggregates with minimum four bin feeders with variable speed motor

ii) Vibrating screen for removal of oversize aggregates

iii) Conveyor Belt

iv) Controlled system for addition of water

v) Forced/positive mixing arrangement like pug-mill or pan type

vi) Anti-segregation hydraulically operated gob/surge hopper

vii) Centralized control panel for sequential operation of various devices and precise process control

viii) Safety devices

Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part-8) after replacing the aggregate fraction retained on 22.4mm sieve with material of 4.75mm to 22.4mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

406.3.4 Spreading of Mix:

Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared sub-grade/sub-base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid not shall their hauling over a partly completed stretch be permitted.

The paver finisher shall be self-propelled, of repute make, proven design and adequate capacity with following features:

i) Tractor unit shall have crawler tracks or pneumatic tyre.

ii) Racks provide greater traction and suitable to work on soft or loose sub-bases and laying large width up to 10 m or more. Wheeled paver is faster and normally preferred to work on hard surfaces with width up to 8 m.

iii) Material distribution system comprising of hopper, two conveyor belts each working independently, conveyor speed adjustable with limit switches and

auger system easily capable of raising and lower; to provide a smooth uninterrupted material flow for different layer thicknesses from the tipper to the screed.

iv) Hydraulically operated telescopic screed for paving width upto to 8.5 m and fixed screed beyond this. The screed shall have tamping and vibrating arrangement for initial compaction of the layer.

v) The drive shall be hydrostatic with infinite variable speed.

vi) Automatic leveling control system with electronic sensing device to maintain mat thickness and cross slope of mat during laying procedure.

In exceptional cases where it is not possible for the paver to be utilized, mechanical means like motor grader may be used with the prior approval of the Engineer. The motor grader shall be capable of spreading the material uniformly all over the surface. For portions where mechanical means cannot be used, manual means as approved by the Engineer shall be used only in restricted areas.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

The Engineer may permit manual mixing and /or laying of wet mix macadam where small quantity of wet mix macadam is to be executed. Manual mixing/laying in inaccessible/ remote locations and in situations where use of machinery is not feasible can also be permitted. Where manual mixing/laying is intended to be permitted, the same shall be indicated in the Contract.

406.3.5 Compaction:

After the mix has been laid to the required thickness, grade and cross-fall /camber the same shall be uniformly compacted, to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 200mm, a smooth wheel roller of 80 to 100 kN weight may be used. For compacted single layer upto 200mm, the compaction shall be done with the help of vibratory roller of minimum static weight of 80 to 100 kN with on amplitude not exceeding 0.7 mm or equivalent capacity roller. The speed of the roller shall not exceed 5 km./hr.

In portions having unidirectional cross fall / superelevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, roller should progress parallel to the centre line of the road, uniformly over-lapping each preceding track by at least one third width until the entire surface has been

rolled. Alternate trips of the roller shall be terminated in stops at least 1m away from any preceding stop.

In portions in camber, rolling should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the center parallel to the center line of the road uniformly overlapping each of the preceding track by at least one-third width until the entire surface has been rolled.

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.

Along forms, kerbs, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching of an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

Rolling should not be done when the sub-grade is soft or yielding or when it causes a wave-like motion in the sub-base/base course or sub-grade. If irregularities develop during rolling which exceeds 12 mm when tested with a 3 m straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and crossfall. In no case shall the use of unmixed material be permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material as determined by the method outlined in IS:2720 (Part-8).

After completion, the surface of any finished layer shall be well-closed, free from movement under compaction equipment or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and recompacted.

406.3.6 Setting and Drying :

After final compaction of wet-mix macadam course, the road shall be allowed to dry for 24 hours.

406.4 OPENING TO TRAFFIC

No vehicular traffic of any kind should be allowed on the finished wet-mix macadam surface till it has dried and the wearing course laid.

406.5 SURFACE FINISH AND QUALITY CONTROL OF WORK

406.5.1 Surface Evenness:

The surface finish of construction shall conform to the requirements of Clause 902.

406.5.2 Quality Control:

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

406.6 RECTIFICATION OF SURFACE IRREGULARITY

Where the surface irregularity of the wet mix macadam course exceeds the permissible tolerances or where the course is otherwise defective due to sub-grade soil getting mixed with the aggregates, the full thickness of the layer shall be scarified over the affected area, re-shaped with added premixed material or removed and replaced with fresh premixed material as applicable and recompacted in accordance with Clause 406.3. The area treated in the aforesaid manner shall not be less than 5 m long and 2 m wide. In no case shall depressions be filled up with unmixed and ungraded material or fines.

406.7 ARRANGEMENT FOR TRAFFIC

During the period of construction, arrangement of Traffic shall be done as per Clause 112.

407. SHOULDERS, ISLANDS AND MEDIAN

407.1. SCOPE

The work shall consist of constructing shoulder (earthen/hard/pave with brick or stone block edging) on either side of the pavement, median in the road dividing the carriageway into separate lanes and Islands for channelising the traffic at junctions in accordance with the requirements of these specifications and in conformity with the lines, grades and cross sections shown on the drawings or as directed by the Engineer.

407.2. MATERIALS

Shoulder on either side of the road may be of selected earth/granular material/paved conforming to the requirements of Clause 305/401 and the median may be of selected earth conforming to the requirements of Clause 305.

Median/Traffic islands shall be raised and kerbed at the perimeter and the enclosed area filled with earth and suitably covered with grass turf/shrubs as per Clause 307 and/or paved as per Clause 409.3.4 or 409.3.5.

Paved shoulders shall consist of sub-base, base and surfacing courses, as shown in the drawings and materials for the same shall conform to relevant Specifications of the corresponding items. Where paved or hard shoulders are not provided, the pavement shall be provided with brick/stone block edgings as shown in the drawings. The brick shall conform to Clause 1003 of these Specifications. Stone blocks shall conform to Clause 1004 of these Specifications and shall be of size 225 mm x 110 mm x 75 mm.

407.3. SIZE OF SHOULDER/MEDIAN/ISLANDS

Shoulder (earthen/hard/paved)/median/traffic island dimensions shall be as shown on the drawings or as directed by the Engineer.

407.4. CONSTRUCTION OPERATIONS

407.4.1. Shoulders:

The sequence of operations shall be such that the construction of paved shoulder is done in layers each matching the thickness of adjoining pavement layer. Only after a layer of pavement and corresponding layers in paved and earth shoulder portion have been laid and compacted, the construction of next layer of pavement and shoulder shall be taken up.

Where the materials in adjacent layers are different, these shall be laid together and the pavement layer shall be compacted first. The corresponding layer in paved

shoulder portion shall be compacted thereafter, which shall be followed by compaction of each shoulder layer. The adjacent layers having same material shall be laid and compacted together.

In all cases where paved shoulders have to be provided along side of existing carriageway, the existing shoulders shall be excavated in full width and to the required depth as per Clause 301.3.7. Under no circumstances, box cutting shall be done for construction of shoulders.

Compaction requirement of earthen shoulder shall be as per Table 300-2. In the case of bituminous courses, work on shoulder (earthen/hard/paved), shall start only after the pavement course has been laid and compacted.

During all stages of shoulder (earthen/hard/paved) construction, the required crossfall shall be maintained to drain off surface water.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed, without damage to the pavement, and the area so affected thoroughly cleaned.

407.4.2. Median and Island:

Median and islands shall be constructed in a manner similar to shoulder up to the road level. Thereafter, the median and islands, if raised, shall be raised at least 300 mm by using kerb stones of approved material and dimensions and suitably finished and painted as directed by the Engineer. If not raised, the median and islands shall be differentiated from the shoulder/pavement as the case may be, as directed by the Engineer. The confined area of the median and islands shall be filled with local earth or granular material or any other approved material and compacted by plate compactor/power rammer. The confined area after filling with earth shall be turfed with grass or planted with shrubs and in case of granular fill it can be finished with tiles/slabs as directed by the Engineer.

407.4.3. Brick/stone Block Edging:

The brick/stone blocks shall be laid on edge, with the length parallel to the transverse direction of the road. They shall be laid on a bed of 25 mm sand, set carefully rolled into position by a light roller and made flush with the finished level of the pavement.

407.5. SURFACE FINISH AND QUALITY CONTROL OF WORKS

The surface finish of construction shall conform to the requirements of Clause 902. Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

408. CEMENT CONCRETE KERB AND KERB WITH CHANNEL

408.1 SCOPE

This work shall consist of constructing cement concrete kerbs and kerbs with channel in the central median and/or along the footpaths or separators in conformity with the lines, levels and dimensions as specified in the drawings or as directed by the Engineer.

408.2 MATERIALS

Kerbs and kerb with channel shall be provided in cement concrete of grade M20 in accordance with clause 1700 of these specifications.

408.3 TYPE OF CONSTRUCTION

These shall be cast-in-situ construction with suitable kerb casting machine in all situations except at locations where continuous casting with equipment is not practicable. In those situations pre-cast concrete blocks shall be used.

408.4 EQUIPMENT

A continuous kerb casting equipment of adequate capacity and controls, capable of laying the kerbs in required cross-sections and producing a well-compacted mass of concrete free of voids and honeycombs, shall be used

408.5 CONSTRUCTION OPERATIONS

408.5.1 Kerbs shall be laid on firm foundation of minimum 150mm thickness of cement concrete of M15 grade cast in situ or on extended width of pavement. The foundation shall have a projection of 50mm beyond the kerb stone. Before laying the foundation of lean concrete, the base shall be levelled and slightly watered to make it damp.

408.5.2 In the median portions in the straight reaches, the kerb shall be cast in continuous lengths. In the portions where footpath is provided and/or the slope of the carriageway is towards median (as in case of superelevated portion), there shall be sufficient gap/recess left in the kerb to facilitate drainage openings.

408.5.3 After laying the kerbs and just prior to hardening of the concrete, saw-cut grooves shall be provided at 5m intervals up to FRL or as specified by the Engineer.

408.5.4 Kerbs on the drainage ends such as along the footpath or the median in super elevated portions shall be cast with monolithic concrete channels as indicated in drawings. The slope of the channel towards drainage pipes shall be ensured for efficient drainage of the road surface.

408.5.5 Vertical and horizontal tolerance with respect to true line and level shall be +6mm.

501. GENERAL REQUIREMENTS FOR BITUMINOUS PAVEMENT LAYERS

501.1. GENERAL

Bituminous pavement courses shall be made using the materials described in the Specifications.

The use of machinery and equipment mentioned in various Clauses of these Specifications is mandatory. Details of the machinery and equipment are available in the Manual for Construction and Supervision of Bituminous Works..

501.2. MATERIALS

501.1.1 Binder:

The binder shall be an appropriate type of bituminous material complying with the relevant Indian Standard (IS), as defined in the appropriate Clauses of these Specifications, or as otherwise specified herein. The choice of binder shall be stipulated in the Contract or by the Engineer. Where viscosity grades of bitumen are specified, they are referred to by a designation in accordance with IS:73. Where Modified Binder is specified, the provision of IS: 15462 shall apply.

501.1.2 Coarse Aggregates:

The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm sieve. They shall be clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious matter. Where the Contractor's selected source of aggregates has poor affinity for bitumen, as a condition for the approval of that source, the bitumen shall be treated with approved anti-stripping agents, as per the manufacturer's recommendations, without additional payment to the Contractor. Before approval of the source, the aggregates shall be tested for stripping.

The aggregates shall satisfy the physical requirements set forth in the individual relevant clause for the material in question.

Where crushed gravel is proposed for use as aggregate for bituminous concrete, not less than 95 percent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces. However for use in other (LBM, BM, DBM, etc.) specifications not less than 90 percent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractures faces.

501.1.3 Fine Aggregates:

Fine aggregates shall consist of crushed or naturally occurring material, or a combination of the two, passing 2.36 mm sieve and retained on the 75 micron sieve.

They shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter. Natural sand shall not be allowed in binder and wearing courses. However, natural sand upto 50 percent of the fine aggregates may be allowed in base courses. Fine aggregates shall have a sand equivalent not less than 50 when tested in accordance with the requirement of IS:2720 Part 37. The plasticity index of the fraction passing 0.425 mm shall not exceed 4 when tested in accordance with IS:2720 Part 5.

501.1.4 Source of material:

The sources of all materials propose to be used on the project by the Contractor shall be tested to the satisfaction of and receive express approval of the Engineer. The Engineer may from time to time withdraw approval of a specific source, or attach conditions to the existing approval. Any change in aggregate source for bituminous mixes, will require a new mix design, and laying trials, where the mix is based on a job mix design. Stockpiles from different sources, approved or otherwise, shall be kept separate, such that there is no contamination between one material and another. Each source submitted for approval shall contain material sufficient for at least 5 days work.

501.3. MIXING

Pre-mixed bituminous materials, including bituminous macadam, dense bituminous macadam, bituminous concrete, etc. shall be prepared in a hot mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates. Appropriate mixing temperatures are given in Table 500-15 of these Specifications. The difference in temperature between the binder and aggregate should at no time exceed 14°C. In order to ensure uniform quality of the mix and better coating of aggregates, the hot mix plant shall be calibrated from time to time. The essential features of the hot mix plants are given in Annexure A of IRC:27.

If a continuous mixing plant is to be used for mixing the bituminous bound macadam, the Contractor must demonstrate by laboratory analysis that the cold feed combined grading is within the grading limits specified for that bituminous bound material. In the case of a designed job mix, the bitumen and filler content shall be derived using this combined grading. Further details are available in the IRC Manual for Construction and Supervision of Bituminous Works.

501.4. TRANSPORTING

Bituminous materials shall be transported in clean insulated and covered vehicles. An asphalt release agent, such as soap or lime water, which does not adversely

affect the bituminous mixes may be applied to the interior of the vehicle to prevent sticking and to facilitate discharge of the material.

501.5. LAYING

501.5.1. Weather and seasonal limitations:

Laying shall be suspended

i) In presence of standing water on the surface;

ii) When rain is imminent and during rains, fog or dust storm;

iii) When the base / binder course is damp;

iv) When the air temperature on the surface on which it is to be laid is less than 10oC for mix with conventional bitumen as binder and is less than 15oC for mix with modified bitumen as binder;

v) When the wind speed at any temperature exceeds the 40 km per per hr at 2 m height.

501.5.2. Cleaning of surface:

The surface on which the bituminous work is to be laid shall be cleaned of all loose and extraneous matter by means of a mechanical broom or any other approved equipment/method as specified in the contract. The use of a high pressure air jet from a compressor to remove dust or loose matter shall be available full time at the site, unless otherwise specified in the Contract.

501.5.3. Spreading :

Prior to spreading the mix, the base shall be prepared by carrying out all or some of the operations as per Clause 501.8 depending upon the site conditions. Except in areas where paver cannot get access, bituminous materials shall be spread, leveled and tamped by an approved self-propelled paving machine preferably with sensor. As soon as possible after arrival at site, the materials shall be supplied continuously to the paver and laid without delay. The rate of delivery of material to the paver shall be regulated to enable the paver to operate continuously. The travel rate of the paver, and its method of operations, shall be adjusted to ensure an even and uniform flow of bituminous material across the screed, free from dragging, tearing and segregation of the material. In areas with restricted space (such as confined space, foot base, irregular shape and wearing thickness, approaches to expansion joints, etc.) where paver cannot be used, the material shall be spread, raked and leveled with suitable hand tools by trained staff. The minimum thickness of material laid in each paver pass shall be in accordance with the minimum values given in the relevant parts of these Specifications. When laying binder course or wearing course approaching an expansion joint of a structure, machine laying shall stop 300 mm short of the joint. The remainder of the pavement up to the joint, and the

corresponding area beyond it, shall be laid by hand, and the joint or joint cavity shall be kept clear of surfacing material.

Bituminous material, with a temperature greater than 145°C, shall not be laid or deposited on bridge deck water-proofing systems, unless precautions against heat damage have been approved by the Engineer.

501.5.4. Cleanliness and overlaying:

Bituminous material shall be kept clean and uncontaminated. The only traffic permitted run on bituminous material to be overlaid shall be that engaged in laying and compacting the next course or, where a binder course is to be sealed or surface dressed, that engaged on such surface treatment. Should any bituminous material become contaminated, the Contractor shall make it good to the satisfaction of the Engineer, in compliance with Clause 501.8.

Binder course material shall not remain uncovered by either the wearing course or surface treatment, whichever is specified in the Contract, for more than three consecutive days after being laid. The Engineer may extend this period, by the minimum amount of time necessary, because of weather conditions or for any other reason. If the surface of the base course is subjected to traffic or not covered within three days, a tack coat shall be applied as directed by the Engineer.

501.6. COMPACTION

Bituminous materials shall be laid and compacted in layers, which enable the specified thickness, surface level, regularity requirements and compaction to be achieved.

Compaction of bituminous materials shall commence as soon as possible after laying. Compaction shall be substantially completed before the temperature falls below the minimum rolling temperatures stated in the relevant part of these Specifications. Rolling of the longitudinal joints shall be done immediately behind the paving operation. After this, rolling shall commence at the edges and progress towards the center longitudinally except that on super elevated and unidirectional cambered portions, it shall progress from the lower to the upper edge parallel to the center line of the pavement. Rolling shall continue until all roller marks have been removed from the surface. All deficiencies in the surface after laying shall be made good by the attendants behind the paver, before initial rolling is commenced. The initial or breakdown rolling shall be done with 8–10 tonne dead weight smooth-wheeled rollers. The intermediate rolling shall be done with 8–10 tonne dead weight or vibratory roller or with a pneumatic tyred roller of 12 to 15 tonne weight having nine wheels, with a tyre pressure of at least 5.6 kg/sq.cm. The finish rolling shall be done with 6 to 8 tonne smooth wheeled tandem rollers.

Where compaction is to be determined by density of cores, the requirements to prove the performance of rollers shall apply in order to demonstrate that the specified density can be achieved. In such cases the Contractor shall nominate the plant, and the method by which he intends to achieve the specified level of compaction and finish at temperatures above the minimum specified rolling temperature. Laying trials shall then demonstrate the acceptability of the plant and method used.

Bituminous materials shall be rolled in a longitudinal direction, with the driven rolls nearest the paver. The roller shall first compact material adjacent to joints and then work from the lower to the upper side of the layer, overlapping on successive passes by at least one-third of the width of the rear roll or, in the case of a pneumatic-tyred roller, at least the nominal width of 300 mm.

In portions with super-elevated and uni-directional camber, after the edge has been rolled, the roller shall progress from the lower to the upper edge.

Rollers should move at a speed of not more than 5 km per hour. The roller shall not be permitted to stand on pavement which has not been fully compacted, and necessary precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign matter on the pavement either when the rollers are operating or standing. The wheels of rollers machine shall be in good working order, to prevent the mixture from adhering to the wheels. Only sufficient moisture to prevent adhesion between the wheels of rollers and the mixture should be used. Surplus water shall not be allowed to stand on the partially compacted pavement.

501.7. JOINTS

a) Where joints are made, the material shall be fully compacted and the joint made flush in one of the following ways; All joints shall be cut vertical to the full thickness of the previously laid mix. All loosened material shall be discarded and the vertical face be coated with any viscosity grade bitumen, or cold applied emulsified bitumen. While spreading the material along the joint the material spread shall overlap 25 mm to 50 mm on the previously laid mix beyond the vertical face of the joint. The thickness of the loose overlap material should be approximately a quarter more than the final compacted thickness. The overlapped mix should be dragged back to the hot lane so that the roller can press the small excess into the hot side of the joint to obtain a high joint density.

b) By using two or more pavers in echelon, where this is practicable and in sufficient proximity for adjacent widths to be fully compacted by continuous rolling.

All joints shall be offset at least 300 mm from parallel joints in the layer beneath or as directed, and in a layout approved by the Engineer. Joints in the wearing course shall coincide with either the lane edge or the lane marking, whichever is appropriate. Longitudinal joints shall not be situated in wheel track zones.

For transverse joints method a) above shall apply. Transverse joints in the successive and adjoining layers shall have a minimum offset of 2 meters.

501.8. PREPARATION OF BASE

501.8.1. Scope

This work shall consist of preparing an existing granular or wet mix macadam or black-topped surface bituminous course. The work shall be performed on such widths and lengths as shown on the drawings or as instructed by the Engineer. The existing surface shall be firm and clean, and treated with Prime or Tack coat as shown on the drawings as otherwise stated in the Contract.

501.8.2. Materials

501.8.2.1. For Scarifying and Re-laying the Granular Surface:

The materials used shall be coarse aggregates salvaged from scarification of the existing granular base course supplemented by fresh coarse aggregates and screenings so that aggregates and screenings thus supplemented correspond Clause 406 wet mix macadam as the case may be.

501.8.2.2. For Patching Potholes and Sealing Cracks:

Where the existing surface to be overlaid is bituminous, any existing potholes and cracks shall be repaired and sealed in accordance with Clauses 3004.2 and 3004.3, or as directed by the Engineer.

501.8.2.3. For Profile Corrective Course :

A profile corrective course for correcting the existing pavement profile shall be laid to varying thickness as shown on the Drawings, or as indicated in the Contract Documents. The profile corrective course shall be laid to tolerances and densities as specified for wearing course in a single layer, or base course, if it is to be covered with a wearing course layer.

501.8.2.4. Profile Corrective Course Material and their Application:

The type of material for use as profile corrective course shall be as shown on the drawings or as directed by the Engineer. Where it is to be laid as part of the overlay/ strengthening course, the profile corrective course material shall be of the same specification as that of the overlay/ strengthening course. However, if

provided as a separate layer, it shall be of the specification and details given in the contract drawings.

i) Any high spots in the existing surface shall be removed by a milling machine or other approved method, and all loose material shall be removed to the satisfaction of the Engineer.

ii) Where the maximum thickness of profile corrective course will be not more than 40 mm, the profile corrective course shall be constructed as an integral part of the overlay course. In other cases, the profile corrective course shall be constructed as a separate layer, adopting such construction procedures and using such equipment as approved by the Engineer, to lay the specified type of material, to thickness and tolerance as specified for the course to be provided.

501.8.3. Construction Operations

501.8.3.1. Preparing Existing Granular Surface:

Where the existing surface is granular, all loose materials shall be removed, and the surface lightly watered where the profile corrective course to be provided as a separate layer is also granular. Where the profile corrective course of bituminous material is to be laid over the existing granular surface, the latter shall, after removal of all loose material, be primed in accordance with Clause 502.

The surface finish of all granular layers on which bituminous works are to be placed, shall, unless otherwise specifically instructed by the Engineer, be free from dust. All such layers must be capable of being swept, after the removal of any non-integral loose material, by means of a mechanical broom, without shedding significant quantities of material and dust removed by air jet, washing, or other means approved by the Engineer.

After cleaning the surface shall be correct to line and level, within the tolerances specified for base course

501.8.3.2. Scarifying existing bituminous Surface:

Where specified or shown on the drawings, the existing bituminous layer in the specified width shall be removed with care and without causing undue disturbance to the underlying layer, by a suitable method approved by the Engineer. After removal, all loose and disintegrated material, the underlying layers which might have been disturbed should be suitable reworked and compacted to line and level. After supplementing the base material as necessary with suitable fresh stone, the compacted finished surface shall be primed in accordance with Clause 502. Reusable materials shall be stacked as directed by the Engineer within 1000m of their origin.

501.8.3.3. Patching of Pot Holes & Sealing of Cracks

Where the existing surface to be overlaid is bituminous, any existing potholes and cracks shall be repaired and sealed in accordance with Clauses 3004.2 and 3004.3, or as directed by the Engineer.

501.8.3.4. Laying the Profile Corrective Course:

501.8.3.4.1. Laying on granular base

After preparing the granular surface in accordance with Clauses 501.8.3.1 and 501.8.3.2, the profile corrective course shall be laid using material as described in Clauses 501.8.2.3 and 501.8.2.4, or as otherwise described in the Contract, and compacted to the requirements of the particular Specification.

501.8.3.4.2. Laying on existing bituminous surface

The existing bituminous surface shall be prepared in accordance with Clause 501.8.3.3, and after applying a tack coat conforming to Clause 503, the bituminous profile corrective course shall be laid and compacted to the requirements of the particular Specification.

501.8.3.4.3. Correction of local depressions

Where local sags or depressions occur in the existing pavement, a specific filling operation shall be instructed by the Engineer, which should be laid in accordance with Figure 500-1. Normally, the maximum layer thickness at any point should not exceed 100 mm. In placing multiple lifts, they should be arranged according to the correct method as illustrated.

For correction of camber or super-elevation of the existing carriageway, the method shown in Figure, 500-2 shall be adopted, depending on the profile of the existing carriageway.

501.8.3.5. Covering the Profile Corrective Course:

Work of Profile Corrective Course shall be so planned that it shall be covered by the designed base/wearing course at the earliest, before opening to regular traffic.

501.8.4. Surface Finish and Quality Control of Work

Relevant Provisions of Section 900 shall be exercised by the Engineer.

501.8.5. Arrangement for Traffic

During construction operations, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

501.8.6. Environmental protection

The provisions of Clause 111 and the provision of Appendix A to Clause 501 shall apply.

Appendix 'A' to Clause 501

Appendix 'A'

PROTECTION OF THE ENVIRONMENT

1. General

1.1. This Appendix sets out limitations on the Contractor's activities specifically intended to protect the environment.

1.2. The Contractor shall take all necessary measures and precautions and otherwise ensure that the execution of the works and all associated operations on or off site are carried out in conformity with statutory and regulatory environmental requirements including those prescribed elsewhere in these Specifications.

1.3. The Contractor shall take all measures and precautions to avoid any nuisance or disturbance arising from the execution of the Works. This shall wherever possible be achieved by suppression of the nuisance at source rather than abatement of the nuisance once generated.

1.4. In the event of any spoil, debris, waste or any deleterious substance from the Site being deposited on any adjacent land, the Contractor shall immediately remove all such material and restore the affected area to its original state to the satisfaction of the Engineer.

2. Water Quality

2.1. The Contractor shall prevent any interference with the supply to or abstraction from, and prevent any pollution of, water resources (including underground percolating water) as a result of the execution of the Works.

2.2. Areas where water is regularly or repetitively used for dust suppression purposes shall be laid to fall to specially-constructed settlement tanks to permit sedimentation of particulate matter. After settlement, the water may be re-used for dust suppression and rinsing.

2.3. All water and other liquid waste products arising on the Site shall be collected and disposed of at a location on or off the Site and in a manner that shall not cause nuisance or pollution.

2.4. The Contractor shall not discharge or deposit any matter arising from the execution of the Works into any waters except with the permission of the Engineer and the regulatory authorities concerned.

2.5. The Contractor shall at all times ensure that all existing stream courses and drains within, and adjacent to, the Site are kept safe and free from any debris and any materials arising from the Works.

2.6. The Contractor shall protect all watercourses, waterways, ditches, canals, drains, lakes and the like from pollution as a result of the execution of the Works.

3. Air Quality

3.1. The Contractor shall devise and arrange methods of working to minimize dust, gaseous or other air-borne emissions and carry out the Works in such a manner as to minimize adverse impacts on air quality.

3.2. The Contractor shall utilize effective water sprays during delivery manufacture, processing and handling of materials when dust is likely to be created, and to dampen stored materials during dry and windy weather. Stockpiles of friable materials shall be covered with clean tarpaulins, with application of sprayed water during dry and windy weather. Stockpiles of material or debris shall be dampened prior to their movement, except where this is contrary to the Specifications.

3.3. Any vehicle with an open load-carrying area used for transporting potentially dust producing material shall have properly fitting side and tail boards. Materials having the potential to produce dust shall not be loaded to a level higher than the side and tail boards, and shall be covered with a clean tarpaulin in good condition. The tarpaulin shall be properly secured and extended at least 300 mm over the edges of the side and tail boards.

3.4. In the event that the Contractor is permitted to use gravel or earth roads for haulage, he shall provide suitable measures for dust palliation, if these are, in the opinion of the Engineer, necessary. Such measures may include sprinkling water on the road surface at regular intervals.

4. Noise

4.1. The Contractor shall consider noise abutment measures in his planning and execution of the Works.

4.2. The Contractor shall take all necessary measures so that the operation of all mechanical equipment and construction processes on and off the Site shall not cause any unnecessary or excessive noise, taking into account applicable environment requirements. The Contractor shall use all necessary measures and shall maintain all plant and silencing equipment in good condition so as to minimize the noise emission during construction works.

5. Control of Wastes

5.1. The Contractor shall control the disposal of all forms of waste generated by the construction operations and in all associated activities. No

uncontrolled deposition or dumping shall be permitted. Wastes to be so controlled shall include, but shall not be limited to, all forms of fuel and engine oils, all types of bitumen, cement, surplus aggregates, gravels, bituminous mixtures etc. The Contractor shall make specific provision for the proper disposal of these and any other waste products, conforming to local regulations and acceptable to the Engineer.

6. Emergency Response

6.1. The Contractor shall plan and provide for remedial measures to be implemented in the event of occurrence of emergencies such as spillages of oil or bitumen or chemicals.

6.2. The Contractor shall provide the Engineer with a statement of the measures he intends to implement in the event of such an emergency, which shall include a statement of how he intends to provide personnel adequately trained to implement such measures.

502. PRIME COAT OVER GRANULAR BASE

502.1. SCOPE

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to a porous granular surface preparatory to the superimposition of bituminous treatment or mix.

502.2. MATERIALS

The bituminous material to be used as primer shall be such that it can penetrate about 10 mm deep into base course. Bitumen emulsion SS1 grade conforming to IS: 8887 / ASTM D2397 or medium curing cutback bitumen conforming to IS:2177 can be used as primer.

Quantity of SS1 grade bitumen emulsion for various types of granular surface shall be as per Table 500-1.

Table 500-1 Quantity of Bitumen Emulsion for Various Types of Granular Surface

Type of Surface	Rate of Spray (Kg/Sqm)
WMM/WBM	0.7–1.0
Mechanically lime/cement stabilized soil bases, lime cement bases	0.9–1.2
Gravel bases, Crusher run Macadam and crushed rock bases	1.2–1.5

Cutback when used as primer shall not be prepared in field. Type and & quantity of cutback bitumen for various types of granular surface shall be as per Table 500-2.

Table 500-2 Type and Quantity of Cutback Bitumen for Various Types of Granular Surface

Type of Surface	Type of Cutback	Rate of Spray (Kg/Sqm)
WMM/WBM	MC 30	0.6–0.9
Mechanically lime / cement stabilized soil bases, lime cement bases	MC 70	0.9–1.2
Gravel bases, Crusher run Macadam and crushed rock bases	MC 250	1.2–1.5

The correct quantity of primer shall be decided by the Engineer and shall be such that the maximum amount that can be absorbed by the surface without causing run-off of excessive primer and to achieve desired penetration of 10 mm.

502.3. WEATHER AND SEASONAL LIMITATIONS

Cutback bitumen as primer shall not be applied to a wet surface. Bitumen emulsion shall be applied on a damp surface. Surfaces which are to receive emulsion primer should be damp, but no free or standing water shall be present. Surface can be just wet by very light sprinkling of water. Primer shall not be applied during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10°C.

502.4. CONSTRUCTION

502.4.1. Equipment:

The primer distributor shall be a self-propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at specified rates and temperatures. Hand spraying shall not be allowed except in small areas, inaccessible to the distributor, or in narrow strips where primer shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

502.4.2. Preparation of road surface:

The surface to be primed shall be prepared in accordance with Clauses 501.8 and 902 as appropriate. Immediately prior to applying the primer, the surface shall be swept clean of dust and loose and other foreign particles using power broom or mechanical sweepers, care being taken not to disturb the interlocked aggregates.

This is best achieved when the surface layer is slightly moist (lightly sprayed with water and the surface allowed to dry) and the surface should be kept moist until the primer is applied.

502.4.3. Application of bituminous primer:

After preparation of base as per 502.4.2, the primer shall be sprayed uniformly in accordance with Clause 501. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

No heating or dilution of SS1 emulsion and preparation of cutback bitumen shall be permitted at site. Temperature of cutback bitumen shall be high enough to permit the primer to be sprayed effectively.

502.4.4. Curing of primer and opening to traffic:

A primed surface shall be allowed to cure for at least 24 hours or such other higher period as is found to be necessary to allow all the moisture/volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with an application of sand, using the minimum quantity possible. A primed surface shall not be opened to traffic other than that necessary to lay the next course.

A very thin layer of clean sand may be applied to the surface of the primer, to prevent the primer picking up under the wheels of the paver and the trucks delivering bituminous material to the paver.

502.5. TACK COAT:

Over the primed surface, a tack coat should be applied in accordance with Clause 503.

502.6. QUALITY CONTROL OF WORK

For control on the quality of materials supplied and the works carried out, the relevant provisions of Section 900 shall apply.

502.7. ARRANGEMENTS FOR TRAFFIC

During the construction operations, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

503 TACK COAT

503.1 SCOPE

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to an existing bituminous, cement concrete or primed granular surface preparatory to the superimposition of a bituminous mix, when specified in the Contract or instructed by the Engineer.

503.2 MATERIALS

The binder used for tack coat shall be either Cationic bitumen emulsion (RS 1) complying with IS 8887 / ASTM D 2397 or suitable low viscosity paving bitumen of VG 10 grade conforming to IS:73. The use of cutback bitumen RC:70 as per IS:217 shall be restricted only for sites at sub-zero temperatures or for emergency applications as directed by the Engineer. The type and grade of tack coat shall be as specified in the Contract or as directed by the Engineer.

503.3 WEATHER AND SEASONAL LIMITATIONS

Bituminous material shall not be applied during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10°C. Where the tack coat consists of emulsion, the surface shall be slightly damp, but not wet. Where the tack coat is of cutback bitumen, the surface shall be dry.

503.4 CONSTRUCTION OPERATION

503.4.1 Equipment:

The tack coat shall be applied by a self-propelled or towed bitumen pressure sprayer, equipped for spraying the material uniformly at a specified rate. Hand spraying shall not be permitted except in small areas, inaccessible to the distributor, or narrow strips, shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

503.4.2 Preparation of Base:

The surface on which the tack coat is to be applied shall be clean and free from dust, dirt, and any extraneous material, and be otherwise prepared in accordance with the requirements of Clauses 501.8 and 902 as appropriate. The granular or stabilized surfaces shall be primed as per Clause 502. Immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom, and high pressure air jet, or by other means as directed by the Engineer.

503.4.3 Application of tack coat:

The application of tack coat shall be at the rate specified in the Contract, and shall be applied uniformly. If rate of application of Tack Coat is not specified in the contract, then it shall be the rate specified in Table 500-3. No dilution or heating at site of RS1 emulsion shall be permitted. Paving grade of bitumen if used for tack coat shall be heated in bitumen boilers to achieve viscosity less than 2 poise. The normal range of spraying temperature for a bituminous emulsion shall be 20°C to 70°C and for a cutback, 50°C to 80°C if RC-70/MC-70. Where a geosynthetic is proposed for use,

the provisions of Clauses 703.3.2 and 703.4.4 shall apply. The method of application of tack coat will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar, and speed or forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

Where the material to receive an overlay is a freshly laid bituminous layer, that has not been subjected to traffic, or contaminated by dust, a tack coat is not mandatory where the overlay is completed within two days.

Table 500-3 Rate of Application of Tack Coat

Type of Surface	Rate of spray of emulsion /cutback Kg per sq m	Rate of spray of bitumen Kg per sq m
Bituminous Surfaces	0.20 – 0.30	0.30 – 0.40
Granular surfaces treated with primer	0.25 – 0.30	0.35 – 0.45
Cement Concrete Pavement	0.30 – 0.35	0.40 – 0.50

503.4.4 Curing of tack coat

The tack coat shall be left to cure until all the volatiles have evaporated before any subsequent construction is started. No plant or vehicles shall be allowed on the tack coat other than those essential for the construction.

503.5 QUALITY CONTROL OF WORK

For control of the quality of materials and the works carried out, the relevant provisions of Section 900 shall apply.

503.6 ARRANGEMENTS FOR TRAFFIC

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

505.0. DENSE GRADED BITUMINOUS MACADAM

505.1. SCOPE

This clause specified the construction of Dense Bituminous Macadam, (DBM), for use mainly, but not exclusively, in base/binder and profile corrective courses. The work shall consist of construction in a single or multiple layers of DBM on a previously prepared base or sub-base. The thickness of a single layer shall be 50 mm to 100 mm

505.2. MATERIALS

505.2.1. Bitumen:

The bitumen for dense bituminous macadam shall comply with the Indian Standard Specification for viscosity graded bitumen, IS:73 modified bitumen complying with IS:15462 or as otherwise specified in the Contract. Guidelines for selection of viscosity graded bitumen and modified bitumen are given in Table 500-5 and Table 500-6 respectively.

The type and grade of modified bitumen to be used shall be specified in the Contract. The use of modified bitumen is recommended for very heavy traffic roads in very hot climate.

Both the highest daily mean air temperature and the lowest daily mean air temperatures mentioned in Tables 500-5 and 500-6 can be obtained for the weather station nearest to the project site from the Indian Meteorological Organization (IMO). The IMO has data on daily mean high temperature for all 365 days in a year for all weather stations based on historical records of the last 30-40 or more years. This daily mean high temperature on a specific day is the same as daily “normal” high temperature for that day as usually reported in some newspapers. The highest of the 365 daily mean high air temperatures (which usually occurs on some day in May or June) is used in Tables 500-5 and 500-6. Likewise the lowest daily mean air temperature (which usually occurs on some day in January) can also be obtained from the IMO. Since these are mean temperatures based on the average of 30-40 years data, these temperatures are significantly lower than the absolute maximum temperatures, which may have occurred in a specific year.

Table 500-5 Selection Criteria for Viscosity-graded (VG) Paving Bitumen’s based on Climatic Conditions

	Highest Daily Mean Air Temperature, °C		
Lowest Daily Mean Air Temperature, °C	**Less than 20°C**	**20 to 30°C**	**More than 30°C**

	Highest Daily Mean Air Temperature, °C		
Lowest Daily Mean Air Temperature, °C	**Less than 20°C**	**20 to 30°C**	**More than 30°C**
More than –10°C	VG-10	VG-20	VG-30
-10°C or lower	VG-10	VG-10	VG-20

Table 500-6: Selection Criteria for Grade of Modified Bitumen

Lowest Daily Mean Air Temperature, °C	**Highest Daily Mean Air Temperature, °C**		
	Less than 20°C	**20 to 30°C**	**More than 30°C**
	Grade of Modified Bitumen		
More than -10°C	PMB/NRMB 120 CRMB 50	PMB/NRMB 70 CRMB 55	PMB/NRMB 40 CRMB 60
-10°C or lower	PMB/NRMB 40 CRMB 50	PMB/NRMB 120 CRMB 55	PMB/NRMB 70 CRMB 50

PMB = Polymer modified bitumen

NRMB= Natural rubber modified bitumen

CRMB= Crumb rubber modified bitumen

505.2.2. Coarse aggregates:

The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on 2.36 mm sieve. They shall be clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious substances. Where the Contractor's selected source of aggregates have poor affinity for bitumen, as a condition for the approval of that source, the bitumen shall be treated with an approved anti-stripping agent, as per the manufacturer's recommendations, without additional payment to the Contractor. Before approval of the source, the aggregates shall be tested for stripping. The aggregates shall satisfy the requirements specified in Table 500-7.

Where crushed gravel is proposed for use as aggregate, not less than 90 percent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

Table 500-7: Physical Requirements for Coarse Aggregate for Dense Graded Bituminous Macadam

Property	Test		Specification
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve	IS 2386 Part I
Particle shape	Flakiness Index elongation Index	Max 15% Max 20%	IS 2386 Part I
Strength	Los Angeles Abrasion Value	Max 35%	IS 2386 Part IV
	Aggregate Impact Value	Max 27%	
Durability	Soundness either Sodium Sulphate or	Max 12%	IS 2386 Part V
	Magnesium Sulphate	Max 18%	
Water Absorption	Water Absorption	Max 2%	IS 2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate Mixtures	Minimum retained coating 95%	IS 6241
Water Sensitivity	Retained Tensile Strength*	Min 80%	ASHTO 283

*If the minimum retained tensile test strength falls below 80 percent, use of anti stripping agent is recommended to meet the requirement

505.2.3. Fine aggregates:

Fine aggregates shall consist of crushed or naturally occurring mineral material, or a combination of the two, passing the 2.36 mm sieve and retained on the 75 micron sieve. Natural sand shall not be allowed in binder courses. However, natural sand upto 50 percent of the fine aggregate may be allowed in base courses. They shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or

other deleterious matter. The fine aggregate shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS:2720 (Part 37). The plasticity index of the fraction passing the 0.425 mm sieve shall not exceed 4, when tested in accordance with IS: 2720 (Part 5).

505.2.4. Filler:

Filler shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement approved by the Engineer. The use of hydrated lime should be encouraged because of its very good anti-stripping and antioxidant properties. The filler shall be graded within the limits indicated in Table 500-8.

Table 500-8: Grading Requirements for Mineral Filler

IS Sieve (mm)	Cumulative per cent passing by weight of total aggregate
0.6	100
0.3	95 – 100
0.075	85 – 100

The filler shall be free from organic impurities and have a Plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filler is cement or lime. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-7, then 2 per cent by total weight of aggregate, of hydrated lime shall be used and percentage of fine aggregate reduced accordingly

505.2.5. Aggregate grading and binder content:

When tested in accordance with IS:2386 Part 1 (wet sieving method), the combined grading of the coarse and fine aggregates and added filler for the particular mixture shall fall within the limits given in Table 500-9 for dense bituminous macadam grading 1 or 2 as specified in the Contract. To avoid gap grading, the combined aggregate gradation shall not vary from the lower limit on one sieve to higher limit on the adjacent sieve. The quantity of bitumen, and appropriate thickness, are also indicated for each mixture type.

Table 500-9: Composition of Dense Graded Bituminous Macadam Pavement Layers

Grading	**1**	**2**
Nominal aggregate size*	**37.5 mm**	**26.5 mm**
Layer Thickness	**75 – 100 mm**	**50 – 75 mm**
IS Sieve[1] (mm)	**Cumulative % by weight of total aggregate passing**	

Grading	1	2
Nominal aggregate size*	**37.5 mm**	**26.5 mm**
Layer Thickness	**75 – 100 mm**	**50 – 75 mm**
IS Sieve[1] (mm)	**Cumulative % by weight of total aggregate passing**	
45	100	-
37.5	95 – 100	100
26.5	63 – 93	90 – 100
19	-	71 – 95
13.2	55 – 75	56 – 80
9.5	-	-
4.75	38 – 54	38 – 54
2.36	28 – 42	28 – 42
1.18	-	-
0.6	-	-
0.3	7 – 21	7 – 21
0.15	-	-
0.075	2 – 8	2 – 8
Bitumen content % by mass of total mix**	Min 4.0	Min 4.5

Notes:

* The nominal maximum particle size is the largest specified sieve size upon which any of the aggregate is retained.

** Corresponds to specific gravity of aggregates being 2.7. In case aggregate have specific gravity more than 2.7, the bitumen content can be reduced proportionately. Further the region where highest daily mean air temperature is 30oC or lower and lowest daily air temperature is – 10oC or lower, the bitumen content may be increased by 0.5 percent

505.3. MIX DESIGN

Bitumen content indicated in the Table 500-9 is the minimum. The exact bitumen content required shall be determined following the Marshall mix design procedure contained in Asphalt Institute Manual MS–2.

The fines to bitumen F/B ratio by weight of total mix shall range from 0.6 to 1.2.

505.3.1. Requirement for the mixture:

Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 500-10.

Table 500-10 Requirements for Dense Graded Bituminous Macadam

Properties	Viscosity Graded Bitumen	Modified Bitumen		Test Method
		Hot climate	Cold climate	
Compaction level (Number of blows)	75 blows on each of the two faces of the specimen			
Minimum stability (kN at 60^0C)	9.0	12.0	10.0	AASHTO T245
Marshall flow (mm)	2-4	2.5 - 4	3.5 - 5	AASHTO T245
Marshall Quotient	2-5	2.5 - 5		MS -2 & ASTM D2041
% air voids	3 – 5			
% voids filled with bitumen (VFB)		65 – 75		
Coating of aggregate particle		95% minimum		IS 6241
Tensile strength ratio		80% Minimum		AASHTO T 283
% voids in mineral aggregate (VMA)	Minimum per cent voids in mineral aggregate (VMA) are set out in aggregate VMA Table 500-11.			

Table 500-11: Minimum Per Cent Voids In Mineral Aggregate (VMA)

Nominal Maximum	Minimum VMA, Per cent Related to Design Air voids, Percent[2]		
Particle Size	3.0	4.0	5.0

Nominal Maximum	Minimum VMA, Per cent Related to Design Air voids, Percent[2]		
[1](mm)			
26.5	11.0	12.0	13.0
37.5	10.0	11.0	12.0

Notes:

1) The normal maximum particle size is one size larger than the first sieve to retain more than 10 percent.

2) Interpolate minimum voids in the mineral aggregate (VMA) for design air voids values between those listed.

505.3.2. Binder content:

The binder content shall be optimized to achieve the requirements of the mix set out in Table 500-10. The Marshall method for determining the optimum binder content shall be adopted as described in the asphalt institute Manual MS-2.

Where maximum size of the aggregate is more than 26.5 mm, the modified Marshall method using 150 mm diameter specimen described in MS-2 and ASTM D 5581 shall be used. This method requires modified equipment and procedures. When the modified Marshall test is used, the specified minimum stability values in Table 500-10 shall be multiplied by 2.25, and the minimum flow shall be 3 mm.

505.3.3. Job mix formula:

The Contractor shall submit to the Engineer for approval at least 20 days before the start the work, the job mix formula proposed for use in the works, together with the following details.

(i) Source and location of all materials;

(ii) Proportions of all materials expressed as follows where each is applicable:

(a) Binder type, and percentage by weight of total mix;

(b) Coarse aggregate/Fine aggregate/Mineral filler as percentage by weight of total aggregate including mineral filler;

(iii) A single definite percentage passing each sieve for the mixed aggregate;

(iv) The individual gradings of the individual aggregate fractions, and the proportion of each in the combined grading.

(v) The results of mix design such as maximum specific gravity of loose mix (Gmm), compacted specimen densities, Marshall stability,flow, air voids, VMA, VFB and related graphs and test results of AASHTO T 283 Moisture susceptibility test.

(vi) Where the mixer is a batch mixer, the individual weights of each type of aggregate, and binder per batch;

(vii) Test results of physical characteristics of aggregates to be used;

(viii) Mixing temperature and compacting temperature.

While establishing the job mix formula, the Contractor shall ensure that it is based on a correct and truly representative sample of the materials that will actually be used in the work and that the mixture and its different ingredients satisfy the physical and strength requirements of these Specifications.

Approval of the job mix formula shall be based on independent testing by the Engineer for which samples of all ingredients of the mix shall be furnished by the Contractor as required by the Engineer.

The approved job mix formula shall remain effective unless and until a revised Job Mix Formula is approved. Should a change in the source of materials be proposed, a new job mix formula shall be forwarded by the Contractor to the Engineer for approval before the placing of the material.

505.3.4. Plant trials - permissible variation in job mix formula:

Once the laboratory job mix formula is approved, the Contractor shall carry out plant trials to establish that the plant can produce a uniform mix conforming to the approved job mix formula. The permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used shall be within the limits as specified in Table 500-12 and shall remain within the gradation band. These variations are intended to apply to individual specimens taken for quality control tests in accordance with Section 900.

Table 500-12: Permissible Variations from the Job Mix Formula

Description	Base / binder course
Aggregate passing 19 mm sieve or larger	± 8 %
Aggregate passing 13.2 mm, 9.5 mm	± 7 %
Aggregate passing 4.75 mm	± 6 %
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	± 5 %
Aggregate passing 0.3 mm, 0.15 mm	± 4 %
Aggregate passing 0.075 mm	± 2 %
Binder content	± 0.3 %
Mixing temperature	± 10^0C

505.3.5. Laying Trials:

Once the plant trials have been successfully completed and approved, the Contractor shall carry out laying trials, to demonstrate that the proposed mix can be successfully laid, and compacted all in accordance with Clause 501. The laying trial shall be carried out on a suitable area which is not to form part of the works, unless specifically approved in writing by the Engineer. The area of the laying trials shall be a minimum of 100 sqm of construction similar to that of the project road, and it shall be in all respects, particularly compaction, the same as the project construction, on which the bituminous material is to be laid.

The Contractor shall previously inform the Engineer of the proposed method for laying and compacting the material. The plant trials shall then establish if the proposed laying plant, compaction plant, and methodology is capable of producing satisfactory results. The density of the finished paving layer shall be determined by taking cores, no sooner than 24 hours after laying, or by other approved method. The compacted layers of Dense Graded Bituminous Macadam (DBM) shall have a minimum field density equal to or more than 92% of the average theoretical maximum specific gravity (Gmm) obtained on the day of compaction in accordance with ASTM D2041.

Once the laying trials have been approved, the same plant and methodology shall be applied to the laying of the material on the project, and no variation of either shall be acceptable, unless approved in writing by the Engineer, who may at his discretion require further laying trials.

505.4. CONSTRUCTION OPERATIONS

505.4.1. Weather and seasonal limitations:

The provisions of Clause 501.5.1 shall apply.

505.4.2. Preparation of base:

The base on which Dense Graded Bituminous Material is to be laid shall be prepared in accordance with Clause 501 and 902 as appropriate, or as directed by the Engineer. The surface shall be thoroughly swept clean by a mechanical broom, and the dust removed by compressed air. In locations where mechanical broom cannot get access, other approved methods shall be used as directed by the Engineer.

505.4.3. Geosynthetics:

Where Geosynthetics are specified in the Contract, this shall be in accordance with the requirements stated in Clause 703.

505.4.4. Stress absorbing layer:

Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of Clause 517.

505.4.5. Prime coat:

Where the material on which the dense bituminous macadam is to be laid is other than a bitumen bound layer, a prime coat shall be applied, as specified, in accordance with the provisions of Clause 502, or as directed by the Engineer.

505.4.6. Tack coat:

Where the material on which the dense bituminous macadam is to be laid is either bitumen bound layer or primed granular layer, tack coat shall be applied, as specified, in accordance with the provisions of Clause 503, or as directed by the Engineer.

505.4.7. Mixing and transportation of the mixture:

The provisions as specified in Clauses 501.3 and 501.4 shall apply. Table 500-15 gives the mixing, laying and rolling temperature for dense mixes using viscosity graded bitumen. In case of modified bitumen, the temperature of mixing and compaction shall be higher than the mix with viscosity graded bitumen. The exact temperature depends upon the type and amount of modifier used and shall be adopted as per the recommendations of the manufacturer. In order to have uniform quality, the plant shall be calibrated from time to time.

505.4.8. Spreading:

The provisions of Clauses 501.5.3 and 501.5.4 shall apply.

505.4.9. Rolling:

The general provisions of Clauses 501.6 and 501.7 shall apply, as modified by the approved laying trails. The compaction process shall be carried out by the same plant, and using the same method, as approved in the laying trials, which may be varied only with the express approval of the Engineer in writing.

505.5. OPENING TO TRAFFIC

It shall be ensured that the traffic is not allowed without the express approval of the Engineer in writing, on the surface until the paved mat has cooled below 60^0C in its entire depth

505.6. SURFACE FINISH AND QUALITY CONTROL OF WORK

The surface finish of the completed construction shall conform to the requirements of Clause 902. All materials and workmanship shall comply with the provisions set out in Section 900 of these Specifications.

505.7. ARRANGEMENTS FOR TRAFFIC

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

508 BITUMINOUS CONCRETE

508.1 SCOPE

This work shall consist of construction of Bituminous Concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single layer of bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 25mm/40 mm/50 mm thick.

508.2 MATERIAL

508.2.1 Bitumen

The bitumen shall conform to Clause 505.2.1.

508.2.2 Course Aggregates:

The coarse aggregates shall be generally as specified in Clause 505.2.2, except that the aggregates shall satisfy the physical requirements of Table 500-18 and where crushed gravel is proposed for use as aggregate, not less than 95 percent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

Table 500-18: Physical Requirements for Coarse Aggregate for Bituminous Concrete

Property	Test		Specification
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve	IS:2386 Part I
Particle shape	Flakiness Index Elongation index	Max 15% Max 20%	IS:2386 Part I
Strength	Los Angeles Abrasion Value Aggregate Impact Value	Max 30% Max 24%	IS:2386 Part IV
Durability	Soundness either: Sodium Sulphate or Magnesium Sulphate	 Max 12% Max 18%	IS:2386 Part V
Polishing	Polished stone value	Min 55	IS:2386 Part IV
Water Absorption	Water Absorption	Max 2%	IS:2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate Mix	Minimum retained coating 95%	IS:6241

Property	Test		Specification
Water Sensitivity	Retained Tensile Strength*	Min 80%	AASHTO 283

* If the minimum retained tensile test strength falls below 80 percent, use of anti stripping agent is recommended to meet the requirement.

508.2.3 Fine Aggregates:

The fine aggregates shall be all as specified in Clause 505.2.3.

508.2.4 Filler:

Filler shall be as specified in Clause 505.2.4.

508.2.5 Aggregates Grading and binder content:

When tested in accordance with IS:2386 Part 1 (Wet grading method), the combined grading of the coarse and fine aggregates and added filler shall fall within the limits shown in Table 500-19 for grading 1 or 2, as specified in the Contract.

Table 500-19: Composition of Bituminous Concrete Pavement Layers

Grading	**1**	**2**
Nominal aggregate size*	**19 mm**	**13.2 mm**
Layer thickness	**50 mm**	**25/40 mm**
IS Sieve1 (mm)	**Cumulative % by weight of total aggregate passing**	
45	-	-
37.5	-	-
26.5	100	-
19	79-100	100
13.2	59-79	79-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-27	26-38
0.3	10-20	18-28
0.15	5-13	12-20

Grading	**1**	**2**
Nominal aggregate size*	**19 mm**	**13.2 mm**
Layer thickness	**50 mm**	**25/40 mm**
IS Sieve1 (mm)	**Cumulative % by weight of total aggregate passing**	
0.075	2-8	4-10
Bitumen content % by mass of total mix**	5.2	5.4

*The nominal maximum particle size is the largest specified sieve size up on which any of the aggregate is retained.

**Corresponds to specific gravity of aggregate being 2.7. In case aggregate have specific gravity more than 2.7, the bitumen content can be reduced proportionately. Further the region where highest daily mean air temperature is 30oC or lower and lowest daily air temperature is – 10^{o}C or lower, the bitumen content may be increased by 0.5 percent.

508.3 MIX DESIGN

508.3.1 Requirement of Mix:

Clause 505.3.1 shall apply.

508.3.2 Binder Content:

Clause 505.3.2 shall apply.

508.3.3 Job Mix Formula:

Clause 505.3.3 shall apply.

508.3.4 Plant trials – permissible variation in job mix formula:

The requirements for plant trials shall be as specified in Clause 505.3.4, and permissible limits for variation as given in Table 500-20.

Table 500-20: Permissible Variations from the Job Mix Formula

Description	**Bituminous concrete**
Aggregate passing 19 mm sieve or larger	± 7 %
Aggregate passing 13.2 mm, 9.5 mm	± 6 %

Description	Bituminous concrete
Aggregate passing 4.75 mm	± 5 %
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	± 4 %
Aggregate passing 0.3 mm, 0.15 mm	± 3 %
Aggregate passing 0.075 mm	± 1.5 %
Binder content	± 0.3 %
Mixing temperature	± 10^0C

508.3.5 Laying trials

The requirements for laying trials shall be as specified in Clause 505.3.5. The compacted layers of bituminous concrete (BC) shall have a minimum field density equal to or more than 92 percent of the average theoretical maximum specific gravity (Gmm) obtained on the day of compaction in accordance with ASTM D2041.

508.4 CONSTRUCTION OPERATION

508.4.1 Weather and Seasonal Limitations:

The provisions of Clause 501.5.1 shall apply.

508.4.2 Preparation of Base:

The surface on which the bituminous concrete is to be laid shall be prepared in accordance with Clauses 501 and 902 as appropriate, or as directed by the Engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot get access, other approved methods shall be used as directed by the Engineer.

508.4.3 Geosynthetics

Where Geosynthetics are specified in the Contract, this shall be in accordance with the requirements stated in Clause 703.

508.4.4 Stress absorbing layer

Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of Clause 517.

508.4.5 Tack Coat:

The provisions as specified in Clause 505.4.5 shall apply.

508.4.6 Mixing and transportation of the mix:

The provisions as specified in Clauses 501.3, 501.4 and 505.4.7 shall apply.

508.4.7 Spreading:

The general provisions of Clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials.

508.4.8 Rolling:

The general provisions of Clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials.

508.5 OPENING TO TRAFFIC

Provisions in Clause 505.5 shall apply.

508.6 SURFACE FINISH AND QUALITY CONTROL OF WORK

The surface finish of the completed construction shall conform to the requirements of Clause 902. All materials and workmanship shall comply with the provisions set out in Section 900 of these Specifications.

508.7 ARRANGEMENTS FOR TRAFFIC

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

801. TRAFFIC SIGNS

801.1 GENERAL

801.1.1 The colour, configuration, size and location of all traffic signs for highways (other than Expressways for which the size of the signs, letters and their placement shall be as specified in the drawings and relevant Specifications or as directed by the Engineer) and for other roads, shall be in accordance with the Code of Practice for Road Signs, IRC:67:2001, or as shown on the drawings. In the absence of any details or for any missing details (for example, chevron signs etc.), the signs shall be provided in accordance with international standards and/or as directed by the Engineer.

801.1.2 Unless otherwise specified, the signs shall be reflectorised as shown on the drawings or as directed by the Engineer. They shall be of retro-reflectorised type and made of enclosed lens / encapsulated lens / micro-prismatic type reflective sheeting vide Clause 801.3, fixed over a substrate vide Clause 801.2.5 of these Specifications.

801.1.3 In general, cautionary and mandatory signs shall be fabricated through process of screen printing. In regard to informatory signs with inscriptions or cut letters of, coloured retroreflective sheeting comprising unmetalised microprismatic element material vide Clause 801.3 or durable transparent, coloured overlay film shall be used which must be bonded well on the base sheeting, as directed by the Engineer.

801.2 MATERIALS

The various materials and fabrication of the traffic signs shall conform to the following requirements:

801.2.1 Concrete:

Concrete shall be of the grade shown on the Contract drawings or otherwise as directed by the Engineer.

801.2.2 Reinforcing Steel:

Reinforcing steel shall conform to the requirement of IS: 1786 unless otherwise shown on the drawing.

801.2.3 Bolts, Nuts, Washers:

High strength bolts shall conform to IS: 1367 whereas precision bolts, nuts, etc., shall conform to IS: 1364.

801.2.4 Plates and Supports:

Plates and support sections for the sign posts shall conform to IS: 226 and IS: 2062 or any other relevant IS Specifications.

801.2.5 Substrate

Sign panels may be fabricated on aluminium sheet, aluminium composite panel, fibre glass sheeting, or sheet moulding compound. Aluminum sheets used for sign boards shall be of smooth, hard and corrosion resistant aluminium alloy conforming to IS:736-Material designation 24345 or 1900. Aluminium Composite Panel and other materials shall meet the relevant ASTM (D903, E8, E393, E732)/BS/BIS requirements

801.2.6 Signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick made of aluminium and shall not be less than 4 mm thick made out of other materials vide Clause 801.2.5. All others shall be at least 2 mm thick made of aluminium and shall not be less than 4 mm thick made out of other materials vide Clause 801.2.5. The thickness of the sheet shall be related to the size of the sign and its support and shall be such that it does not bend or deform under the prevailing wind and other loads.

801.2.7 In respect of sign sizes not covered by IRC: 67, the structural details (thickness, etc.) shall be as per the approved drawings or as directed by the Engineer.

801.3 TRAFFIC SIGNS HAVING RETRO-REFLECTIVE SHEETING

801.3.1 General Requirements:

The retro-reflective sheeting used on the sign shall consist of the white or coloured sheeting having a smooth outer surface which has the property of retro-reflection over its entire surface. It shall be weather-resistant and show colour fastness. It shall be new and unused and shall show no evidence of cracking, scaling, pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for co-efficient of retro-reflection, day/night time colour luminous, shrinkage, flexibility, linear removal, adhesion, impact resistance, specular gloss and fungus resistance and its having passed these tests shall be obtained from a Government Laboratory, by the manufacturer of the sheeting. The retro- reflective sheeting shall be either of Engineering Grade material with enclosed lens, High Intensity Grade with encapsulated lens or Micro-prismatic Grade retro-reflective element material as given in Clauses 801.3.2 to 801.3.7.

801.3.2 Engineering Grade Sheeting:

This medium intensity retro reflective sheeting shall be typically enclosed lens glass-bead sheeting. Typical applications for this material are on Rural Roads The retro-reflective surface after cleaning with soap and water and in dry condition shall have

the minimum co-efficient of retro-reflection (determined in accordance with ASTM Standard D: 4956-07) as indicated in Table 800-1.

Table: 800-1: Acceptable Minimum Coefficient of Retro-Reflection[A] for High Intensity Grade Sheeting (Candelas Per Lux Per Square Meter)

Observation angle (in degree)	Entrance Angle (in degrees)	White	Yellow	Orange	Green	Red	Blue	Brown
0.2^0	-4^0	70	50	25	9.0	14.5	4.0	1.0
0.2^0	$+30^0$	30	22	7	3.5	6.0	1.7	0.3
0.5^0	-4^0	30	25	13	4.5	7.5	2.0	0.3
0.5^0	$+30^0$	15	13	4	2.2	3.0	0.8	0.2

[A] Minimum Coefficient of Retro reflection (R_A) cd/fc/ft^2 (cd-lx^{-1}.m^2)

When totally wet, the sheeting shall show not less than 90 percent of the values of retro-reflection indicated in Table 800-1. At the end of 5 years, the sheeting shall retain at least 50 percent of its original retro-reflectance.

801.3.3 Super Engineering Grade Sheeting:

This medium-high intensity retro reflective sheeting shall be typically enclosed lens glass-bead sheeting. Typical applications for this material are on Rural Roads. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM Standard D: 4956-07) as indicated in Table 800-2.

Table: 800-2: Minimum Coefficient of Retro-ReflectionA For Super Engineering Grade Sheeting (Candelas Per Lux Per Square Metre)

Observation angle (in degree)	Entrance Angle(in degrees)	White	Yellow	Orange	Green	Red	Blue	Brown
0.2^0	-4^0	140	100	60	30	30	10	5

Observation angle (in degree)	Entrance Angle(in degrees)	White	Yellow	Orange	Green	Red	Blue	Brown
0.2^0	$+30^0$	60	36	22	10	12	4	2
0.5^0	-4^0	50	33	20	9	10	3	2
0.5^0	$+30^0$	28	20	12	6	6	2	1

[A] Minimum Coefficient of Retro reflection (R_A) cd/fc/ft^2 (cd-lx^{-1}.m^2)

When totally wet, the sheeting shall show not less than 90 percent of the values of retro reflection indicated in Table 800-2. At the end of 5 years, the sheeting shall retain at least 65 percent of its original retro-reflectance.

801.3.4 High intensity grade

This high intensity retro reflective sheeting shall be of encapsulated lens type consisting of spherical glass lens, elements adhered to a synthetic resin and encapsulated by a flexible, transparent waterproof plastic having a smooth surface. Typical applications for this material are on Rural Roads and on Major District Roads The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM Standard D: 4956-07) as indicated in Table 800-3.

Table: 800-3: Acceptable Minimum Coefficient of Retro-reflection for High Intensity Grade Sheeting (Encapsulated Lens Type) (Candelas Per Lux Per Square Metre)

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown
0.1^{oB}	-4^0	300	200	120	54	54	24	14
0.1^{oB}	$+30^0$	180	120	72	32	32	14	10
0.2^o	-4^0	250	170	100	45	45	20	12
0.2^o	$+30^0$	150	100	60	25	25	11	8.5
0.5^o	-4^0	95	62	30	15	15	7.5	5.0
0.5^o	$+30^0$	65	45	25	10	10	5.0	3.5

[A] Minimum Coefficient of Retro reflection (R_A) cd/fc/ft^2 (cd-lx^{-1}.m^2).

[B] Values for 0.1^o observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order.

When totally wet, the sheeting shall show not less than 90 percent, of the values of retro-reflectance indicated in Table 800-3. At the end of 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

801.3.5 High intensity micro-prismatic grade sheeting

This sheeting shall be of high intensity retro-reflective sheeting made of unmetallized micro-prismatic retro-reflective element material coated with pressure sensitive adhesive. Typical applications for this material are for traffic signs on National Highways and State Highways. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM Standard :D: 4956-07) as indicated in Table 800-4 of MORT&H specifications

When totally wet, the sheeting shall show not less than 90 percent of the values of retroreflection indicated in Table 800-4. At the end of 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

801.3.6 Super high intensity micro-prismatic grade sheeting

This sheeting shall be of super high intensity retro-reflective sheeting made of unmetallized micro prismatic retro-reflective element material having highest retro reflectivity characteristics at long and medium road distances as determined by the R_A values of Table 800-5 at 0.1^o and 0.2^o observation angles. Typical applications for this material are cautionary, mandatory signs and for delineators. On National Highways and State Highways expressways and Urban Arterials. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM Standard: D: 4956-07) as indicated in Table 800-5 of MORT&H specifications

When totally wet, the sheeting shall show not less than 90 percent of the values of retro-reflection indicated in Table 800-5. At the end of 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

801.3.7 Very high intensity micro-prismatic grade sheeting

This sheeting shall be of very high intensity retro-reflective sheeting made of unmetallized micro-prismatic retro-reflective element material having highest retro-reflectivity characteristics at short road distances as determined by the RAvalues of

Table 800-6 at 0.1o and 0.2o observation angles. Typical applications for this material are for overhead signs on National Highways, State Highways, expressways and on Urban Arterials. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM Standard: D: 4956-07) as indicated in Table 800-6 of MORT&H specifications

When totally wet, the sheeting shall show not less than 90 percent of the values, of retro-reflection indicated in Table 800-6. At the end of 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

801.3.8 Messages/borders:

The messages (legends, letters, numerals etc.) and borders shall either be screen-printed or of cut-outs from durable transparent overlay or cut-out from same type of reflective sheeting (excluding for black colour) for the cautionary/ mandatory signs. Screen printing shall be processed and finished with materials and in a manner specified by the sheeting manufacturer. For the information and other signs, the messages (legends, letters, numerals etc.) and borders shall be cut-out from durable transparent overlay film or cut out from same reflective sheeting only. Cut-outs shall be bonded with the sheeting in the manner specified by the manufacturer. Both the screen printed areas and cut-out messages sheetings and cut-out durable transparent overlay film shall be covered under the warranty period of the sheeting type, issued by the sheeting manufacturer.

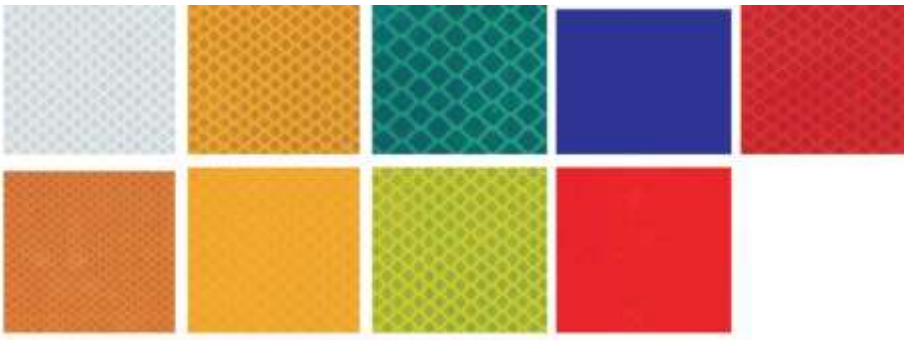
801.3.9 For screen-printed transparent coloured areas on white sheeting, the coefficient of retro-reflection shall not be less than 50 per cent of the values of corresponding colour in Tables 800-1, 800-2, 800-3, 800-4, 800-5 and 800-6, as applicable.

801.3.10 Cut-out messages and borders, wherever used, shall be made out of retroreflective sheeting (as per Clauses 801.3.2/801.3.3/801.3.4/801.3.5/801.3.6/ 801.3.7) as applicable), except those in black which shall be of non-reflective sheeting.

801.3.11 Colour:

Unless otherwise specified, the general colour scheme and properties shall be as stipulated in ASTM 4956–07. The colours shall be durable and uniform in acceptable hue when viewed in day light or under normal headlights at night and in inclement weather conditions. The indicative pictorial depiction is given in Table 800-7.

Table 800-7: Indicative Pictorial Depiction of Colours of Sheetings



801.3.12 Adhesives :

The sheeting shall have either a pressure-sensitive adhesive of the aggressive-tack type requiring no heat, solvent or other preparation for adhesion to a smooth clean surface, or a tack free adhesive activated by heat, applied in a heat-vacuum applicator, in a manner recommended by the sheeting manufacturer. The adhesive shall be protected by an easily removable liner (removable by peeling without soaking in water or other solvent) and shall be suitable for the type of material of the base plate used for the sign. The adhesive shall form a durable bond to smooth, corrosion and weather resistant surface of the base plate such that it shall not be possible to remove the sheeting from the sign base in one piece by use of sharp instrument. In case of pressure-sensitive adhesive sheeting, the sheeting shall be applied in accordance with the manufacturer's Specifications. Sheeting with adhesives requiring use of solvents or other preparation for adhesive shall be applied strictly in accordance with the manufacturer's instructions.

801.3.13 Refurbishment:

Where existing signs are specified for refurbishment, the sheeting shall have a semi-rigid aluminium backing or materials as per Clause 801.2.5, pre-coated with aggressive-tack type pressure sensitive adhesive. The adhesive shall be suitable for the type of material used for the sign and should thoroughly bond with that material.

801.3.14 Fabrication:

801.3.14.1 Surface to be reflectorised shall be effectively prepared to receive the retro-reflective sheeting. The sheeting of the material as per Clause 801.2.5 shall be de-greased either by acid or hot alkaline etching and all scale/dust/ coating of any type removed/ scrubbed to obtain a smooth plain surface before the application of retro-reflective sheeting. If the surface is rough, approved surface primer may be used. After cleaning, metal shall not be handled, except by suitable device or clean canvas gloves, between all cleaning and preparation operation and application of reflective sheeting/primer. There shall be no opportunity for the substrate to come in contact with grease, oil or other contaminants prior to the application of retro-reflective sheeting.

801.3.14.2 Complete sheets of the material shall be used on the signs except where it is unavoidable; at splices, sheeting with pressure sensitive adhesives shall be overlapped not less than 5 mm. Where screen printing with transparent colours is proposed, only butt jointing shall be used. The material shall cover the sign surface evenly and shall be free from twists, cracks and folds. Cut-outs to produce legends and borders shall be bonded with the sheeting in the manner specified by the manufacturer.

801.3.15 Warranty and durability:

The Contractor shall obtain from the manufacture a ten year warranty for satisfactory field performance including stipulated retro-reflectance of the retro-reflective sheeting of micro-prismatic sheeting, a seven-year warranty for high intensity grade and a five year warranty for the sheeting of engineering grade and submit the same to the Engineer. In addition, a ten year, seven year and a five year warranty for satisfactory in-field performance of the finished sign with retro-reflective sheeting of micro prismatic, high intensity grade and engineering grade respectively, inclusive of the screen printed or cut out letters/legends and their bonding to the retro-reflective sheeting shall be obtained from the contractor/supplier and submitted to the Engineer. The Contractor/ supplier shall also furnish the LOT numbers and certification that the signs and materials supplied against the assigned work meets all the stipulated requirements and carry the stipulated warranty and that the contractor/supplier is the authorized converter of the particular sheeting.

All signs shall be dated during fabrication with indelible markings to indicate the start of warranty. The warranty shall also cover the replacement obligation by the sheeting manufacturer as well as contractor for replacement/repair/restoration of the retro-reflective efficiency.

A certificate in original shall be given by the sheeting manufacturer that its offered retro-reflective sheeting has been tested for various parameters such as co-efficient of retro-reflection, day/night time colour and luminance, shrinkage, flexibility, linear removal, adhesion, impact resistance, specular gloss and fungus resistance; the tests shall be carried out by a Government Laboratory in accordance with various ASTM procedures and the results must show that the sheeting have passed the requirements for all the above mentioned parameters. A copy of the test reports shall be attached with the certificate

801.4 INSTALLATION

801.4.1 The traffic signs shall be mounted on support posts, which may be of GI pipes conforming to IS:1239, Rectangular Hollow Section conforming to IS :4923 or Square Hollow Section conforming to IS:3589. Sign posts, their foundations and sign

mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally, signs with an area up to 0.9 sqm shall be mounted on a single post, and for greater area two or more supports shall be provided. Post-end(s) shall be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant Specifications as specified.

801.4.2 All components of signs (including its back side) and supports, other than the reflective portion and G.I. posts shall be thoroughly de scaled, cleaned, primed and painted with two coats of epoxy/ fibre glass/ powder coated paint. Any part of support post below ground shall be painted with protective paint.

801.4.3 The signs shall be fixed to the posts by welding in the case of steel posts and by bolts and washers of suitable size. After the nuts have been tightened, the tails of the bolts shall be furred over with a hammer to prevent removal.

803. ROAD MARKINGS

803.1. GENERAL

The colour, width and layout of road markings shall be in accordance with the Code of Practice for Road Markings with paints, IRC:35 :1997, and as specified in the drawings or as directed by the Engineer.

803.2. MATERIALS

Road markings shall be hot applied thermoplastic compound, reflectorised paint or cold applied reflective paint as specified in the item and the material shall meet the requirements as specified in these Specifications.

803.3. ORDINARY ROAD MARKING PAINT

803.3.1. Ordinary paint used for road marking shall conform to Grade I as per IS: 164.

803.3.2. The road marking shall preferably be laid with appropriate road marking machinery.

803.3.3. Laying thickness of road marking paint shall be as specified by the Engineer.

803.4. HOT APPLIED THERMOPLASTIC ROAD MARKING

803.4.1. General

i. The work under this section consists of marking traffic stripes using a thermoplastic compound meeting the requirements specified herein.

ii. The thermoplastic compound shall be screeded / extruded on to the pavement surface in a molten state by suitable machine capable of controlled preparation and laying with surface application of glass beads at a specific rate. Upon cooling to ambient pavement temperature, it shall produce an adherent pavement marking of specified thickness and width and be capable of resisting deformation by traffic.

iii. The colour of the compound shall be white or yellow (IS colour No. 356) as specified in the drawings or as directed by the Engineer.

iv. Where the compound is to be applied to cement concrete pavement, a sealing primer as recommended by the manufacturer, shall be applied to the pavement in advance of placing of the stripes to ensure proper bonding of the compound. On new concrete surface any laitance and/or curing compound shall be removed before the markings are applied.

803.4.2. Thermoplastic material

803.4.2.1. General :

The thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorizing beads.

803.4.2.2. Requirements:

i. Composition: The pigment, beads, and aggregate shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt and foreign objects and shall comply with requirements indicated in Table 800-8

Table 800-8: Proportions of Constituents of Marking Material (Percentage by Weight)

Component	White	Yellow
Binder	18.0 min.	18.0 min.
Glass Beads	30-40	30-40
Titanium Dioxide	10.0 min.	—
Calcium Carbonate and Inert Fillers	42.00 max.	See Note below
Yellow Pigments	—	See Note below

Note: Amount of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, provided all other requirements of this Specification are met.

ii. Properties: The properties of thermoplastic material, when tested in accordance with ASTM D36/BS-3262-(Part I), shall be as below:

a. Luminance:

White: Daylight luminance at 45°-65 percent min. as per AASHTO M 249

Yellow: Daylight luminance at 45°-45 percent min. as per AASHTO M 249.

b. Drying time: When applied at a temperature specified by the manufacturer and to the required thickness, the material shall set to bear traffic in not more than 15 minutes.

c. Skid resistance: not less than 45 as per BS:6044.

d. Cracking resistance at low temperature: The material shall show no cracks on application to concrete blocks.

e. Softening point: 102.5oC + 9.5oC as per ASTM D 36.

f. Yellowness index (for white thermoplastic paint) : not more than 0.12 as per AASHTO M 249

iii. Storage life: The material shall meet the requirements of these Specifications for a period of one year. The thermoplastic material must also melt uniformly with no evidence of skins or unmelted particles for the one year storage

period. Any material not meeting the above requirements shall be replaced by the manufacturer/ supplier/Contractor.

iv. Reflectorisation: Shall be achieved by incorporation of beads, the grading and other properties of the beads shall be as specified in Clause 803.4.3.

v. Marking: Each container of the thermoplastic material shall be clearly and indelibly marked with the following information;

1. The name, trade mark or other means of identification of manufacturer
2. Batch number
3. Date of manufacture
4. Colour (white or yellow)
5. Maximum application temperature and maximum safe heating temperature.

vi. Sampling and testing: The thermoplastic material shall be sampled and tested in accordance with the appropriate ASTM/BS method. The Contractor shall furnish to the Engineer a copy of certified test reports from the manufacturers of the thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification.

803.4.3. Reflectorizing glass beads

803.4.3.1. General :

This Specification covers two types of glass beads to be used for the production of reflectorised pavement markings.

Type 1 beads are those which are a constituent of the basis thermoplastic compound vide Table 800-8 and Type 2 beads are those which are to be sprayed on the surface vide Clause 803.5.1.3.

803.4.3.2. The glass beads shall be transparent, colourless and free form milkiness, dark particles and excessive air inclusions. These shall conform to the requirements spelt out in Clause 803.4.3.3.

803.4.3.3. Specific requirements

a. Gradation:

The glass beads shall meet the gradation requirements for the two types as given in Table 800-9.

Table 800-9: Gradation Requirements for Glass Beads

Sieve size	**Per cent retained**	
	Type 1	**Type 2**

Sieve size	Per cent retained	
	Type 1	Type 2
1.18 mm	0 to 3	-
850 micron	5 to 20	0 to 5
600 –do-	—	5 to 20
425 –do-	65 to 95	—
300 –do-	—	30 to 75
180 –do-	0-10	10 to 30
Below 180 micron	—	0 to 15

b. Roundness: The glass beads shall have a minimum of 70 per cent true spheres.

c. Refractive index : The glass beads shall have a minimum refractive index of 1.50.

d. Free flowing properties: The glass beads shall be free of hard lumps and clusters and shall dispense readily under any conditions suitable for paint striping. They shall pass the free flow-test.

803.4.3.4. Test methods:

The specific requirements shall be tested with the following methods;

i. Free-flow test : Spread 100 grams of beads evenly in a 100 mm diameter glass dish. Place the dish in a 250 mm inside diameter desiccator which is filled within 25 mm of the top of a desiccator plate with sulphuric acid water solution (specific gravity 1.10). Cover the desiccator and let it stand for 4 hours at 20°C to 29°C. Remove sample from desiccator, transfer beads to a pan and inspect for lumps or clusters. Then pour beads into a clean, dry glass funnel having a 100 mm stem and 6 mm orifice. If necessary, initiate flow by lightly tapping the funnel. The glass spheres shall be free of lumps and clusters and shall flow freely through the funnel.

ii. The requirements of gradation, roundness and refractive index of glass beads and the amount of glass beads in the compound shall be tested as per BS:6088 and BS:3262 (Part I).

iii. The Contractor shall furnish to the Engineer a copy of certified test reports from the manufacturer of glass beads obtained from a reputed laboratory showing results of all tests specified herein and shall certify that the material meets all requirements of these Specifications. However, if so required, these tests may be carried out as directed by the Engineer.

803.4.4. Application properties of thermoplastic material

803.4.4.1.1. The thermoplastic material shall readily get screeded/extruded at temperatures specified by the manufacturers for respective method of application to produce a line of specified thickness which shall be continuous and uniform in shape having clear and sharp edges.

803.4.4.1.2. The material upon heating to application temperatures shall not exude fumes, which are toxic, obnoxious or injurious to persons or property

803.4.5. Preparation

i. The material shall be melted in accordance with the manufacturer's instructions in a heater with a mechanical stirrer to give a smooth consistency to the thermoplastic material to avoid local overheating. The temperature of the mass shall be within the range specified by the manufacturer, and shall on no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material should be used as expeditiously as possible and for thermoplastic material which has natural binders or is otherwise sensitive to prolonged heating, the material shall not be maintained in a molten condition for more than 4 hours.

ii. After transfer to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.

803.4.6. Properties of finished road marking

a) The stripe shall not be slippery when wet.

b) The marking shall not lift from the pavement in freezing weather.

c) After application and proper drying, the stripe shall show no appreciable deformation or discoloration under traffic and under road temperatures upto 60oC.

d) The marking shall not deteriorate by contact with sodium chloride, calcium chloride or oil dripping from traffic.

e) The stripe or marking shall maintain its original dimensions and position. Cold ductility of the material shall be such as to permit normal movement with the road surface without chopping or cracking.

f) The colour of yellow marking shall conform to IS Colour No. 356 as given in IS: 164.

803.5. <u>REFLECTORISED PAINT</u>

Reflectorised paint, if used, shall conform to the Specification by the manufacturers and approved by the Engineer. Reflectorising glass beads for reflectorising paints where used shall conform to the requirements of Clause 803.4.3.

803.5.1. Application

803.5.1.1. Marking shall be done by machine. For locations where painting cannot be done by machine, approved manual methods shall be used with prior approval of the Engineer. The Contractor shall maintain control over traffic while painting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.

803.5.1.2. The thermoplastic material shall be applied hot either by screeding or extrusion process. After transfer to the laying apparatus, the material shall be laid at a temperature within the range specified by the manufacturer for the particular method of laying being used. The paint shall be applied using a screed or extrusion machine.

803.5.1.3. The pavement temperature shall not be less than 10oC during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign matter before application of the paint.

The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line. Such new material shall so bond itself to the old line that no splitting or separation takes place.

Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise. Where arrows or letters are to be provided, thermoplastic compound may be hand-sprayed. In addition to the beads included in the material, a further quantity of glass beads of Type 2, conforming to the above noted Specification shall be sprayed uniformly into a mono-layer on to the hot paint line in quick succession of the paint spraying operation. The glass beads shall be applied at the rate of 250 grams per square metre area.

803.5.1.4. The minimum thickness specified is exclusive of surface applied glass beads. The method of thickness measurement shall be in accordance with Appendices B and C of BS: 3262 (Part 3).

803.5.1.5. The markings shall be done to accuracy within the tolerances given below

i. Width of lines and other markings shall not deviate from the specified width by more than 5 percent.

ii. The position of lines, letters, figures, arrows and other markings shall not deviate from the position specified by more than 20 mm

iii. The alignment of any edge of a longitudinal line shall not deviate from the specified alignment by more than 10 mm in 15 m.

iv. The length of segment of broken longitudinal lines shall not deviate from the specified length by more than 150 mm

In broken lines, the length of segment and the gap between segments shall be indicated on the drawings if these lengths are altered by the Engineer, the ratio of the lengths of the painted sections shall remain the same.

803.5.1.6. The finished lines shall be free from ruggedness on sides and ends and be parallel to the general alignment of the carriageway. The upper surface of the lines shall be level, uniform and free from streaks.

900. QUALITY CONTROL

901. GENERAL

901.1. All materials incorporated and all works performed shall be strictly in conformity with the Specification requirements. All works shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as approved by the Engineer subject to the permitted tolerances described hereinafter. The Contractor shall be fully responsible for the quality of the work in the entire construction within the Contract. He shall, therefore, have his own independent and adequate set-up for ensuring the same.

901.2. The Contractor shall carry out quality control tests on the materials and work to the frequency specified. In the absence of clear indications about method and/or frequency of tests for any item, the approval of the Engineer shall be obtained and he shall provide necessary co-operation and assistance in obtaining the samples for test and carrying out the field test as required by the Engineer from time to time. This may include provision of Labour, attendance, assistance in packing and despatching and any other assistance considered necessary in connection with the test.

901.3. For the work of embankment, Sub-grade and construction of subsequent layer of same or other material over the finished layer shall be done after obtaining approval from the Engineer. Similar approval from the Engineer shall be obtained in respect of all other items of works prior to proceeding with the next stage of construction.

901.4. The Contractor shall carry out modification in the procedure of work, if found necessary, as approved by the Engineer during inspection. Works falling short of quality shall be rectified by the Contractor as approved by the Engineer.

The Contract rate quoted for various items of works in the Bill of Quantities or the lump sum amount tendered shall be deemed to be inclusive of all costs of the quality control tests and operations necessary for ensuring quality of the material and work so as to be in conformity with the specification requirement.

902. PERMITTED TOLERANCES

902.1. Horizontal Alignments

Horizontal alignments shall be reckoned with respect to the centre line of the carriage way as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ±25 mm there from. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be ±40 mm.

902.2. Longitudinal Profile

The levels of the Sub-grade and different pavement courses as constructed shall not vary from those calculated with reference to the longitudinal and cross- profile of the road shown on the drawings or as approved by the Engineer beyond the tolerances mentioned below:

Sub-grade	±15 mm

Sub-base	±20 mm
Base Course	±15 mm
Wearing Course	±10 mm

Provided, however, that the negative tolerance for wearing course shall not be permitted in conjunction with the positive tolerance for base course if the thickness of the former is thereby reduced by more than 6 mm.

902.3. Surface Regularity

The surface regularity of completed Sub-grade, sub-bases, base courses and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table 901.1

The longitudinal profile shall be checked with a 3 metre long straight edge, at the middle of each traffic lane along a line parallel to the centre line of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10 metres.

902.4. Rectification

Where the surface irregularity of Sub-grade and the various courses fall outside the specified tolerances, the Contractor shall be liable to rectify these in the manner described below and to the satisfaction of the Engineer

i. Sub-grade

Where the surface is high, it shall be trimmed and suitably compacted. Where the same is low, the deficiency shall be corrected by adding fresh material. The degree of compaction and the type of material to be used shall conform to the Clauses 1.2 and 1.6

ii. Water Bound Macadam

Where the surface is high or low, the top 75 mm shall be scarified, reshaped with added material as necessary and re-compacted. The area treated at a place shall not be less than 5 metres long and 2 metres wide.

iii. Bituminous Constructions

For bituminous construction other than wearing course, where the surface is low, the deficiency shall be corrected by adding fresh material and re-compacting to Specifications. Where the surface is high, the full depth of the layer shall be removed and replaced with fresh material and compacted to Specifications.

For wearing course, where the surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to Specifications. In all cases where the removal and replacement of a bituminous layer is involved, the area treated shall not be less than 5 metre long and not less than 1 lane wide.

Table 901.1: Permitted Tolerance of Surface Regularity for Sub-grade and Pavement Courses

Sr. No	Type of Construction	Longitudinal profile with 3 metre Cross profile straight edge					
		Maximum permissible undulation mm	Maximum number of undulations permitted in any 300 metres length exceeding : mm				Maximum permissible variation from specified profile under camber template: mm
			18	12	10	6	
1	2	3	4	5	6	7	8
1	Earthen Sub-grade	24	30	-	-	-	15
2	Granular/Lime / Cement/stabilised sub base	15	-	30	-	-	12
3	Water Bound Macadam with over size metal (45-90 mm size) or Wet Mix Macadam	15	-	30	-	-	12
4	Water Bound Macadam with normal size metal (22.4-53 mm and 45-63 mm size) or Wet Mix Macadam	12	-	-	30	-	8
5	Bituminous concrete	8	-	-	-	10 @	4

Notes:

1. @ These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance up to 50 percent above these values in this column may be permitted at the discretion of the Engineer. However, this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned

in columns 3 and 8 on the Table 901.1.

2. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

903. TESTS

903.1. General

For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control tests, as described hereinafter. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to increase the frequencies of tests as he may deem necessary to satisfy himself that the materials and works comply with the appropriate Specifications.

Test procedures for the various quality control tests are indicated in the respective Sections of these Specifications or for certain tests within this Section. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the approval of the Engineer.

903.2. Tests on Earthwork for Embankment and Sub-grade Construction

a) Borrow material

1) Sand content [IS: 2720(Part IV)]

1-2 tests per 8000 cu. metres of soil

2) Plasticity Test [IS: 2720(Part V)]

Each type to be tested, 1-2 tests per 8000 cu. metres of soil.

3) Density Test [[IS: 2720(Part VII)].

Each soil type to be tested, 1-2 tests per 8000 cubic metres of soil.

4) Deleterious Content Test [IS: 2720(Part XXVII)]

As and when required by the Engineer

5) Moisture Content Test [IS: 2720(Part II)]

One test for every 250 cubic metres of soil

6) CBR Test on materials to be incorporated in the Sub-grade on soaked/ unsoaked samples [[IS: 2720(part XVI)]

One test for every 3000 m3 at least or closer as and when required by the Engineer

Compaction control:

Control shall be exercised by taking at least one measurement of density for each 1000 square metres of compacted area, or closer as required to yield the minimum number of test results for evaluation a day's work on statistical basis. The determination of density shall be in accordance with IS: 2720 (part XXVIII).Tests locations shall be chosen only through random sampling techniques. Control shall not be based on the result of any one test but on the mean value of a set of 5-10 density determinations. The number of tests in

one test in one set of measurements shall be 5 as long as it is felt that sufficient control over borrow material and the method of compaction is being exercised. If considerable variations are observed between individual density results, the minimum number of tests in one set of measurement shall be increased to 10. The acceptance of work shall be subject to the condition that the mean dry density equals or exceeds the specified density and the standard deviation for any set of results is below 0.08 gm/cc.

However, for earthwork in shoulders (earthen) and in top 500 mm portion of the embankment below the Sub-grade, at least one density measurement shall be taken for every 50 square metres of the compacted area provided further `that the number of tests in each set of measurements shall be at least 10. In other respects, the control shall be similar to that described earlier.

903.3. Tests on Sub-bases and Bases

(Excluding bitumen bound bases)

The tests and their frequencies for the different types of bases and sub-base shall be as given in Table 900.3. The evaluation of density results for compaction control shall be on lines similar to those set out in clause 903.2

Table –900.3 Control Tests and Their Frequencies for Sub-Bases and Bases (Excluding Bitumen Bound Bases)

Sr No.	Types of Construction	Test	Frequency
1.	Granular sub-base	Gradation	One test per 200 m^3
		Atterbergs limit	One test per 200 m^3
		Moisture content prior to compaction	One test per 250 m^2
		Density of compacted layer	One test per 500 m^2
		Deleterious constituents	As required
		C.B.R	As required
2.	Lime/Cement Stabilised	Purity of lime (for lime-soil stabilization	One test for each consignment subject to a minimum of one test per 5 tonnes of lime.
		Lime/Cement content	Regularly, through procedural checks.
		Degree of pulverisation	Periodically as considered necessary.
		CBR test on a set of 3 specimens	As required

Sr No.	Types of Construction	Test	Frequency
		Moisture content prior to compaction	One test per 250 m^3.
		Density of compacted layer	One test per 500 m^2
		Deleterious constituents	As required
3	Water Bound Macadam or Wet Mix Macadam	Aggregate Impact Value	One test per 200m^3 of aggregate
		Grading	One test per 100 m^3 of aggregate
		Flakiness Index	One test per 200 m^3 of aggregate
		Atterbergs limits of binding material.	One test per 25 m^3 of binding material

903.4. Tests on Bituminous Constructions

The tests and their frequencies for the different types of bituminous works shall be as given in Table 900.4 hereunder.

Table – 900.4 Control Tests and Their Frequency for Bituminous Works

Type of Construction	Test	Frequency (min.)
Prime Coat / Tack Coat / Fog Spray	(i) Quality of binder (ii)	Number of samples per lot and tests as per IS:73,IS:217andIS:8887 as applicable
	(ii) Binder temperature for application	At regular close intervals
	(iii) Rate of spread of Binder	One test per 500m^2 and not less than two tests per day
Seal Coat / Surface Dressing	(i) Quality of binder	Same as mentioned under Serial No.1
	(ii) Aggregate Impact Value	One test per 50m^3 of aggregate
	(iii) Flakiness Index and Elongation Index	- do-

Type of Construction	Test	Frequency (min.)
	(iv) Stripping value of aggregates	Initially one set of 3 representative specimens for each source of supply. Subsequently when warranted by changes in the quality of aggregates
	(v) Water absorption of aggregates	- do-
	(vi) Water sensitivity of mix	Initially one set of 3 representative specimens for each source of supply. Subsequently when warranted by changes in the quality of aggregates (if required)
	(vii) Grading of aggregates	One test per 25m^3 of aggregate
	(viii) Soundness (Magnesium and Sodium Sulphate)	Initially, one determination by each method for each source of supply, then as warranted by change in the quality of the aggregates.
	(ix) Polished Stone value	As required
	(x) Temperature of binder at application	At regular close intervals
	(xi) Rate of spread of materials	One test per 500m^2 of work, and, not less than two tests per day

Type of Construction	Test	Frequency (min.)
	(xii) Percentage of fractured faces	When gravel is used, one test per 50m^{3}of aggregate
Open-graded Premix Surfacing / Close-graded Premix Surfacing	(i) Quality of binder	Same as mentioned under Serial No.1
	(ii) Aggregate Impact Value / Los Angeles Abrasion value	Same as mentioned under Serial No.2
	(iii) Flakiness Index and Elongation Index	- do-
	(iv) Stripping value	Same as mentioned under Serial No.2
	(v) Water absorption of aggregates	Same as mentioned under Serial No.2
	(vi) Water sensitivity of mix	Same as mentioned under Serial No.2
	(vii) Grading of aggregates	Same as mentioned under Serial No.2
	(viii) Soundness (Magnesium and Sodium Sulphate)	Same as mentioned under Serial No.2
	(ix) Polished Stone value	As required
	(x) Temperature of binder at application	At regular close intervals
	(xi) Binder content	One test per 500m^3 and not less than two tests per day.
	(xii) Rate of spread of mixed material	Regular control through checks of layer thickness
	(xiii) Percentage of fractured faces	Same as mentioned under Serial No.2

Type of Construction	Test	Frequency (min.)
Dense Bituminous Macadam / Semi Dense Bituminous Concrete / Bituminous Concrete	(i) Quality of binder	Same as mentioned under Serial No.1
	(ii) Aggregate Impact value / Los Angeles Abrasion value	Same as mentioned under Serial No.2
	(iii) Flakiness Index and Elongation Index	- do-
	(iv) Stripping value	Same as mentioned under Serial No.2
	(v) Soundness (Magnesium and Sodium Sulphate)	Same as mentioned under Serial No.2
	(vi) Water absorption of aggregates	As in Serial No. 2
	(vii) Sand equivalent test	As required
	(viii) Plasticity Index	As required
	(ix) Polished Stone value	As required, for Semi Dense Bituminous Concrete/ Bituminous Concrete
	(x) Percentage of fractured faces	Same as mentioned under Serial No.2
	(xi) Mix grading	One set of tests on the individual constituents and mixed aggregate from the dryer for each 400 tonnes of mix subject to a minimum of two tests per plant per day

Type of Construction	Test	Frequency (min.)
	(xii) Stability of Mix	For each 400 tonnes of mix produced, a set of 3 Marshall specimens to be prepared and tested for stability, flow value, density and void content subject to a minimum of two sets being tested per plant per day.
	(xiii) Water sensitivity of mix(Retained Tensile Strength)	Same as mentioned under Serial No.2
	(xiv) Swell test on the mix	As required for the Bituminous Concrete
	(xv) Control of temperature of binder in boiler, aggregate in the dryer and mix at the time of laying and rolling	At regular close intervals
	(xvi) Control of binder content and grading of the mix	One test for each 400 tonnes of mix subject to a minimum of two tests per day per plant
	(xvii) Rate of spread of mixed material	Regular control through checks on the weight of mixed material and layer thickness
	(xviii) Density of compacted layer	One test per 250m^2 area

APPENDIX - A: ADDITIONAL TECHNICAL SPECIFICATIONS FOR PAVER BLOCKS

1. **RAW MATERIALS**

1.1. Cement:

The cement used in the manufacture of high quality precast concrete paving block shall be conforming to IS 12269 (53 grade) ordinary Portland cement or IS 8112 (43 grade ordinary Portland cement). The minimum cement content in concrete used for making paver blocks should be 380 kg/cu.m.

1.2. Aggregates:

The fine and coarse aggregates shall consist of naturally occurring crushed or uncrushed materials which apart from the grading requirements comply with IS 383-1970. The fine aggregates used shall contain a minimum of 25 % natural silicon sand. Lime stone aggregates shall not be used. Aggregates shall contain no more than 3 % by weight of clay and shall be free from deleterious salts and contaminants.

1.3. Water:

The water shall be clean and free from any deleterious matter. It shall meet the requirements stipulated in IS: 456-2000.

1.4. Other materials:

Any other material/ingredients used in the concrete shall conform to latest IS specifications.

2. **PAVER BLOCKS CHARACTERISTICS:**

2.1. The concrete pavers should have perpendicularities after release from the mould and the same should be retained until the laying.

2.2. The surface should be of anti-skid and anti-glare type.

2.3. The paver should have uniform chamfers to facilitate easy drainage of surface run off.

2.4. The pavers should have uniform interlocking space of 2 mm to 3 mm to ensure compacted sand filling after vibration on the paver surface.

2.5. The concrete mix design should be followed for each batch of materials separately and automatic batching plant is to be used to achieve uniformity in strength and quality.

2.6. The pavers shall be manufactured in single layer only.

2.7. Skilled labour should be employed for laying blocks to ensure line and level for laying, desired shape of the surface and adequate compaction of the sand in the joints.

2.8. The pavers are to be skirted all round with kerbing using solid concrete blocks of size 100 mm x 200 mm x 400 mm or as directed by the engineer. The kerbing should be

embedded for 100 mm depth. The concrete used for kerbing shall be cured properly for 7 days minimum.

3. **LAYING OF PAVER BLOCKS:**

3.1. Priming:

It will be the responsibilities of the contractors to ensure that the manhole/pipeline cable trenches/circular drainage system etc. raised to driveway level using the requisite materials as per instruction of Engineer. The areas of potholes/deep depressions at the isolated locations also have to be filled up before laying the paver blocks. No extra pavements will be made for this purpose.

It will be the responsibility of the contractors to ensure that undulations on the paver's blocks are eliminated after the traffic is allowed on it. Proper slope for drainage of water needs to be ensured by the Contractor. All necessary materials, tools, tackles are required to be arranged by the Contractor.

3.2. Bedding sand course:

The bedding sand shall consist of clean well graded sand passing through 4.75 mm sieve and suitable for concrete. The bedding should be from either a single source or blended to achieve the following grading;

Sieve size	% Passing
9.5 mm	100
4.75 mm	95-100
2.36 mm	80-100
1.18 mm	60-100
600 microns	25-60
300 microns	10-30
150 microns	5-15
75 microns	0-10

Contractor shall be responsible to ensure that single-sized, gap-graded sands or sands containing an excessive amount of fines or plastic fines are not used. The sand particles should preferably be sharp (not rounded) as sharp sand possess higher strength and resist the migration of sand from under the block to less frequency areas even though sharp sands are relatively more difficult to compact than rounded sands, the use of sharp sands is preferred for the more heavily trafficked driveways. The sand used for bedding shall be free of any deleterious soluble salts or other contaminants likely to cause efflorescence.

The sand shall be of uniform moisture content and within 4 % - 8 % when spread and shall be protected against rain when stock piled prior to spreading. Saturated sand

shall not be used. The bedding sand shall be spread loose in a uniform layer as per drawing. The compacted uniform thickness shall be of 45 mm and within +/- 5 mm. Thickness variation shall not be used to correct irregularities in the base course surface.

The spread sand shall be carefully maintained in a loose dry condition and protected against pre-compaction both prior to and following screeding. Any pre-compacted sand or screeded sand left overnight shall be loosened before further laying of paving blocks take place.

Sand shall be slightly screeded in a loose condition to the predetermined depth only slightly ahead of the laying of paving unit.

Any depressions in the screeded sand exceeding 5 mm shall be loosened, raked and rescreeded before laying of paving blocks.

3.3. Laying of interlocking paver blocks:

Paver blocks shall be laid in herringbone laying pattern throughout the pavement. Once the laying pattern has been established, it shall continue without interruption over the entire pavement surface. Cutting of blocks, the use of infill concrete or discontinuities in laying pattern is not to be permitted in other than approved locations.

Paver blocks shall be placed on the uncompacted screeded sand bed to the nominated laying pattern, care being taken to maintain the specified bond throughout the job. The first row shall be located next to an edge restraint. Specially manufactured edge paving blocks are permitted or edge blocks may be cut using a power saw, a mechanical or hydraulic guillotine, bolster or other approved cutting machine.

Paver blocks shall be placed to achieve gaps nominally 2 to 3 wide between adjacent paving joints. No joint shall be less than 1.5 mm not more than 4 mm. Frequent use of string lines shall be used to check alignment. In this regard the “laying face” shall be checked at least every two metres as the face proceeds. Should the face become out of alignment, it must be corrected prior to initial compaction and before further laying job is proceeded with.

In each row, all full blocked shall be laid first. Closure blocks shall be cut and fitted subsequently. Such closer blocks shall consist of not less than 25 % of full blocks.

To infill spaces between 25 mm and 50 mm wide concrete having screened sand, coarse aggregate mix and strength of 45 N/sq.mm shall be used. Within such mix the nominal aggregate size shall not exceed one third the smallest dimension of the infill space. For smaller spaces dry packed mortar shall be used.

Except where it is necessary to correct any minor variations occurring in the laying bond, the paver blocks shall not be hammered into position. Where adjustment of paver blocks, necessary care shall be taken to avoid the premature compaction of the sand bedding.

3.4. Initial Compaction:

After laying the paver blocks, they shall be compacted to achieve consolidation of the sand bedding and brought to design levels and profiles by not less than two (2) passes of a suitable plate compactor.

The compactor shall be a high-frequency, low amplitude mechanical flat plate vibrator having plate area sufficient to cover a minimum of twelve paving blocks. Prior to compaction all debris shall be removed from the surface.

Compaction shall proceed as closely as possible following laying and prior to any traffic. Compaction shall not, however, be attempted within one metre of the laying face. Compaction shall continue until lipping has been eliminated between adjoining blocks. Joints shall then be filled and recompacted as described in Clause 3.5

All work further than one metre from the laying face shall be left fully compacted at the completion of each day's laying.

Any blocks that are structurally damaged prior to or during compaction shall be immediately removed and replaced.

Sufficient plate compactors shall be maintained at the paving site for both bedding compaction and joint filling.

3.5. Joint filling and final compaction:

As soon as possible after compaction and in any case prior to the termination of work on that day and prior to the acceptance of vehicular traffic, sand for joint filling shall be spread over the pavement.

Joint sand shall pass a 2.36 mm (No. 8) sieve and shall be free of soluble salts or contaminants likely to cause efflorescence. The same shall comply with the following grading limits

Sieve size	**% Passing**
2.36 mm	100
1.18 mm	90-100
600 microns	60-90
300 microns	30-60
150 microns	15-30
75 microns	10-20

The Contractor shall supply a sample of the jointing sand to be used in the contract prior to delivery and such materials to site for incorporation into the works. Certificates of test results issued by a recognized testing laboratory confirming that the samples conform to the requirements of this specifications shall accompany the sample.

The jointing sand shall be broomed to fill the joints. Excess sand shall then be removed from the pavement surface and the jointing sand shall be compacted with not less than one (1) Pass by the plate vibrator and joints refilled with sand to full depth. This procedure shall be repeated until all joints are completely filled with sand. No traffic shall be permitted to use the pavement until all joints have been completely filled with sand and compacted.

Both the sand and paver blocks shall be dry when sand is spread and broomed into the joints to prevent premature setting of the sand.

The difference in level (lipping) between adjacent blocks shall not exceed 3 mm with not more than 1 % in any 3 m x 3 mm area exceeding 2 mm. Pavement which is deformed beyond above limits after final compaction shall be taken out and reconstructed to the satisfaction of the Engineer.

3.6. Edge Restraint:

Edge restrains need to be sufficiently robust to withstand override by the anticipated traffic to withstand thermal expansion and to prevent loss of the laying course material from beneath the surface course. The edge restraint should present a vertical face down t the level of the underside on the laying course.

The surface course should not be vibrated until the edge restraint together with any bedding or concrete hunching has gained sufficient strength. It is essential that edge restraints are adequately secured.

4. **CONCRETE BLOCK MAKING MACHINE**

4.1 The block making machine should ensure the following:

4.1.1 High degree of dimensional accuracy (± 3 mm)

4.1.2 Precast blocks with spacer nibs (23 mm to ensure uniform joints)

4.1.3 High compaction energy (to produce blocks with high compressive strength)

The above can be generally achieve by machine with following feature –

Block making machine should have simultaneously application of high intense vibration to moulds at 3000 V.P.M. and hydraulic pressure 800 psi

4.2 Concrete Batching & Mixing Plant

The concrete Mix design should be followed for each batch of materials. The concrete ingredient should be mixed in concrete Batching & Mixing plant with suitable capacity. The plant should be equipped with automatic control panel for maintaining water cement ratio from batch to batch to obtain concrete of uniform quality and strength. The plant should be equipped with adequate mechanism for mechanized loading on raw materials into mixer and conveyor belt for transportation of concrete from mixer to concrete block making machine.

5. **SAMPLING AND TESTING PROCEDURES FOR PAVER BLOCKS**

5.1. Sample size

Internal –Average of minimum 3 samples per 5000 blocks – for paver block manufacturers.

Internal –Minimum 9 blocks per 5000 blocks. Average of minimum 9 blocks per site – for captioned contractors.

5.2. Sampling for testing:

Sampling for testing of paver blocks shall be done in accordance with Clause 5.5

5.3. Compressive Strength:

Testing for compressive strength shall be undertaken in accordance with Appendix-B. The average compressive strength of the 80 mm. thick paver blocks tested shall be 50 N/Sq.mm and average compressive strength of the 60 mm. thick paver blocks tested shall be 45 N/Sq.mm.

5.4. Water Absorption:

Testing for water absorption shall be in accordance with IS: 2185: 1979: Part-(Specifications for Concrete Masonry Blocks) Appendix C.

5.5. Sampling of Paver Blocks

5.5.1. Method of sampling:

Before laying paver blocks, each designated section comprising not more than 50,000 blocks shall be divided into ten approximately equal groups. Nine blocks shall be drawn from each group.

5.5.2. Marking and Identification:

All samples shall be clearly marked at the time of sampling in such a way that the designated section of part thereof and the consignment represented by the sample are clearly defined.

The sample shall be dispatched to the approved test laboratory taking precaution to avoid damage to the paving in transit. Protect the paving from damage and contamination until they have been tested. The samples shall be stored in water at 20 ºC + 5 ºC for 24 hours prior to testing.

APPENDIX – B: PROCEDURE FOR TESTING OF COMPRESSIVE STRENGTH FOR PAVER BLOCKS (Reference: BS 6717 Part-I (1993) Specification for Paver Blocks)

1. **TESTING MACHINE:**

The testing machines shall be of suitable capacity for the test and capable of applying the load at the rate specified. It shall comply as regards repeatability and accuracy with the requirements of relevant IS Specification.

2. **PROCEDURE:**

The sample specimens shall be tested in wet condition after being stored for at least 24 hours in water maintained at a temperature of 20 °C + 5 ºC before the specimens are submerged in water, the necessary area shall be determined.

The plates of the testing machine shall be wiped clean and any loose girt or other material removed from the contact faces of the specimen. Plywood normally 4 mm. thick shall be used as packing between the upper and lower faces of the specimen and the machine plates and these boards shall be larger than the specimen by a margin of at least 5 mm at all points. Fresh packing shall be used for each specimen tested. The specimen shall be placed in the machine with the wearing surface in a horizontal plane and in such a way that the axes of the specimen are aligned with those of the machine plates. The load shall be applied without shock and increased continuously at the rate of Approximately 15 N/sq.mm per minute until no greater load can be sustained. The maximum load applied to the specimen shall be recorded.

3. **CALCULATION OF CORRECTED STRENGTH:**

The compressive strength of each block specimen shall be calculated by dividing the maximum load by full cross section area and multiplying by appropriate factors.

Thickness and chamfer correction factors for compressive strength

Work size thickness (mm)	Correction Factors	
	Plain block	Chamfered block
60	1.00	1.06
80	1.12	1.18
100	1.18	1.24

4. **COMPRESSIVE STRENGTH CALCULATION:**

The average corrected compressive strength for the designed block section shall be calculated.

APPENDIX – C: METHOD FOR THE DETERMINATION OF WATER ABSORPTION

1. The test specimens shall be completely immersed in water at room temperature for 24 hours.
2. The specimens shall then be weighed, while suspended by a metal wire and completely submerged in water.
3. They shall be removed from the water and allowed to drain for one minute.
4. Visible surface water should be removed with a damp cloth and immediately weighed.
5. Subsequent to saturation, all specimens shall be dried in a ventilated oven at 100 to 115 ºC for not less than 24 hours and until two successive weightings at intervals of 2 hours show an increment of loss not greater than 0.2 percent of the last previously determined mass of the specimen.
6. Calculate the absorption as follows -

Absorption, kg/cum = $\frac{A - B}{A - C} \times 1000$

Absorption, percent = $\frac{A - B}{B} \times 100$

Where;

A = Wet mass of unit in Kg.

B = Dry mass of unit in Kg and

C = Suspended immersed mass of unit in Kg

TECHNICAL SPECIFICATIONS (MECHANICAL)

1. SOLID WASTE FEEDING SYSTEM

The waste collection system shall be capable to collect and deliver waste of ordinary mix in an automatic, safe and effective way. The ordinary mixed waste includes newspapers, magazines, plastics, cans, glass bottles, metal, organics etc.

1.1 Vertical Pipe Chute:

1.1.1 Precast chutes (vertical chutes) shall be provided at the location indicated for the disposal of solid waste from the upper floors. Each chute shall start from the floor above the discharge valve to upper most floors and shall be provided with volume control hopper (solid waste inlet) at each floor. Both items shall be provided by the building Contractor.All other equipment and system shall be provided by the Bidder.

1.1.2 Riser pipe shall be constructed of carbon steel pipe with scheduled thickness of minimum 6.35mm which shall be welded to station connections. The Pipework, Fittings & Joints material shall be:

- American Petroleum Institute (API) 5L Grade B, scheduled thickness of 6.35-9.52mm,

1.1.3 The vertical garbage chutes shall have a spray cleaning systems consisting of water and a suitable sanitizing chemical agent to prevent any odor problems. Operation of this shall be automatic. The automated vacuum waste collection systems shall be suitably provided with a drain above the discharge valve so that this water and waste is not allowed into the horizontal transport pipe for hygiene and other reasons.

1.1.4 Support and restrain system shall be provided at each floor penetration to prevent movement as material passes through system by the use of welded brace frames.

1.1.5 Intermediate joints, bends, Y-pipe connections are normally, mild or could be of alloyed steel and the pipe design should be fit for purpose and designed to cater to the design life of the pipe.

1.1.6 All bends shall be scheduled thickness of 9.5mm. The pipe bracket shall be constructed of Galvanized Mild Steel and shall be provided with hanger rod. All underground buried pipe shall be coated with 3LPE coating & encase by water proof concrete 200mm all round.

2. PRIMARY HOLDING CHAMBER/SOLID WASTE STORAGE SECTION WITH DISCHARGE AND AIR INLET VALVE

2.1 PRIMARY HOLDING CHAMBER/SOLID WASTE STORAGE SECTION

2.1.1 A Primary holding chamber/ solid waste storage section shall be provided just above the discharge valve for the temporary storage of solid waste thrown down the solid waste chute

2.1.2 The top end of the storage section shall be connected to the underside of the vertical solid waste chute to provide a connection between the solid waste chute and the AWCS.

2.1.3 The upper portion of the storage section shall include the air intake for the discharge valve.The valve feeds the waste into a network of mild steel pipes.

2.1.4 All pipe sizes shall be confirmed by the Tenderer who shall be held responsible for the proper operation of the system.

2.1.5 The storage section shall be of min 5 mm (t) Stainless Steel construction with reinforcement at the impact areas. As with the discharge valve, it shall be of sufficient design and strength to withstand the high impact load of solid waste falling from high levels.

2.1.6 The storage section design shall provide for the smooth, efficient and complete discharge of solid waste to the solid waste transport pipe, via the discharge valve. It shall be provided with an inspection opening for maintenance purposes. A drainage outlet shall be provided for the discharge of wastewater to a gully or floor drain.

2.1.7 The Primary collection chamber/storage section shall be constructed and installed in a manner allowing for easy and quick removal of the entire section, for unforeseen maintenance purposes or future equipment replacement.

2.1.8 The Primary collection chamber/ storage section shall be equipped with a high level switch to indicate that the section has reached the full capacity.

2.2 DISCHARGE VALVE AND AIR INTAKE VALVE

2.2.1 The air inlet valves (AV) shall be provided to create an air flow in the pipe system and Discharge valves (DV) shall be provided for controlling the input of waste into the pipe system

2.2.2 The air inlet valve shall be pneumatically operated (open/close) actuation. The signal to actuate the valve is received from the PLC situated in the centralized solid

wastecollection station. This signal shall be relayed to the air inlet valve via the Remote Terminal Unit (RTU).

2.2.3 The valve housing/frame and valve plate shall be of mild steel construction. The valve plate shall be provided with suitable sealing gasket to ensure that the valve remains airtight when closed. The air inlet throttle disc shall be sized to provide the required vacuum depression in the solid waste transport pipe.

2.2.4 Each air inlet valve shall be provided with an integrated silencer to reduce the air suction noise level to an acceptable level. The silencer shall be constructed of mild steel with suitable acoustic treatment material and its design shall not impede the smooth intake of air into the solid waste transport pipe. The silencer design and construction shall allow for easy and quick maintenance of the air inlet valve.

2.2.5 The air inlet valve shall be normally installed at basement level in buildings, in close proximity to the discharge valve. The valve shall remain open less than 1 minute per individual collection time.

2.3 DISCHARGE VALVE

2.3.1 The discharge valve shall be pneumatically operated (open/close actuation). The signal to actuate the valve shall be received from the PLC situated in the centralized solid waste collection station.

2.3.2 The valve housing and secondary components shall be of mild steel construction. The main valve plate shall be Stainless Steel and provided with suitable sealing gasket to ensure that the valve remains airtight when closed. The discharge valve construction and its components shall be of sufficient design and strength to withstand the high impact load of solid waste falling from high levels at all times.

2.3.3 The discharge valve shall provide for the smooth, efficient and complete discharge of solid waste into the solid waste transport pipe.

2.3.4 For ease of maintenance and part replacement the discharge valve shall be made in 2 main separable sections, each section having a flange end connection held together by bolts and nuts. For ease of maintenance, the discharge valve must be capable of being dismantled to allow for valve plate replacement on site.

2.3.5 All valves are heavy duty to remain air tight during the lifetime of the installation. Discharge valves (DV) shall be dimensioned to withstand the impact from falling waste in high rise buildings.

3. SOLID WASTE CONVEYANCE PIPE (PIPE NETWORK)

3.1 PIPE NETWORK

3.1.1 All straight solid waste conveyance pipes shall be of spiral or longitudinal welded carbon steel for ordinary duty.

3.1.2 Pipe work, Fittings & Joints material shall be as per:

- American Petroleum Institute (API) 5L Grade B, scheduled thickness of 6.35-9.52mm.

3.1.3 The transport pipe shall nominally vary in thickness. This is due to the abrasion experienced through wear and tear at intermediate joints or bends and from varying waste loads. Each fitting shall be designed to stand erosion and abrasion produced by the waste.

3.1.4 Method of examination and testing of pipe installation shall be visual as per ASMI specifications 831.9.2008 Clause 936.4.1 as follows :

"Visual examinations are observation of the portion of material, components, joints, supports and other piping elements that are or can be exposed to view before, during, or after manufacture, fabrication, assembly or erection. This examination includes verification of codes and engineering design requirements for material and components, dimensions, joint preparation, alignment, joining practices, assembly, and erection.

Pipe leak testing to network shall be done by pneumatic testing at 0.2 bar pressure.

3.1.5 Whenever the pipe shall cross a road where heavy traffic load is expected an adequate concrete sleeve shall be provided.

3.1.6 Special bends of abrasion resistant steel as required based on the pipe profile as per the design calculation confirmation submittal will be installed in desired locations as per the requirement.

3.1.7 Pipe shall be supplied in lengths no shorter than 5.8 meters.

3.1.8 Pipe branches shall be located in a manner ensuring the smooth flow of solid waste from one branch to another. The maximum branch angle shall not exceed more than 30 degrees.

3.1.9 Air Pipe shall be constructed of stainless steel with thickness of 1.5mm to 3.0mm as per ASTM A312 TP304, it shall be installed with flanges and gasketed joints with horizontal run supported at each joint. Air Pipe shall be fabricated in 15 degree segment and continuously welded with a turn radius of 2-1/2 times the pipe diameter for material lines and 1-1/2 times the pipe diameter for air lines.

3.1.10 All piping shall be free of burrs, beads, or protrusions into the air stream.

3.1.11 The air pipe system shall be provided with all necessary sectioning valves, non-return valves, silencer and sleeves. The brackets shall be made in mild steel and hot dipped galvanized.

3.1.12 Buried pipes shall be corrosion protected with factory coating comprising 3-Layers PE coating. All pipe joints and pipe to fitting joints shall be fully welded. The maximum internal protrusion of all weld joints shall not exceed 3mm. Pipe supports shall be provided as and when required for stable and sufficient support of the solid waste conveyance pipe. The average distance between supports shall not exceed 3m. All buried pipe supports shall be encased in the water proof concrete and shall be supported, unless otherwise specified. Exposed supports shall be painted only. Suitable vibration isolation pads shall be provided to isolate the pipe from building structure where necessary.

3.1.13 Pipe running at high level should be acoustically insulated to control noise level below NEA Noise Criteria (NC).

3.1.14 All pipe joints will be welded to achieve air tightness.

3.1.15 Bidder to refer the utility corridor drawings for the laying the waste transportation pipes in Volume 5 of the bid document.

3.2 Clean out points/Inspection openings

3.2.1 Inspection openings shall be provided in the solid waste transport pipe network to allow for future maintenance. These inspection openings shall be located at strategic locations in the solid waste pipe network for easy and quick access to the solid waste pipe for the clearing of any solid waste blockage that may occur.

3.2.2 The pipe for the feeder building network interfaces shall have the same material as the public network pipeline, that is, mild carbon steel.

3.2.3 The interface process is very important. So, the supplier of the network shall send technical staff to the site for supervisions on the whole construction to avoid the damages of primary network due to unsatisfactory process or construction.

4. CENTRAL WASTE HANDLING FACILITY (WHF)

4.1 High Volume exhausters/fans for creating the suction pressure

4.1.1 Exhausters are installed to create the required air flow and negative pressure for the waste transport. The number of exhausters required for the system shall be to suit and optimize energy efficiency.

4.1.2 The exhauster shall be a single stage centrifugal type designed for high suction capacity. The fan housing and exhauster frame shall be constructed of painted steel material with stiffeners. The impeller of the exhauster shall be constructed of SS 304 Stainless Steel. The fan housing shall include an inspection opening for accessing the impeller during maintenance service.

4.1.3 The impeller and motor assembly shall be dynamically balanced to achieve minimum vibration. Adequate vibration isolators shall be provided to isolate exhauster vibrations from the building. Silencers shall be installed to attenuate the air noise to an acceptable level, shall be provided at the exhauster inlet and outlet.The Exhauster shall be driven by Variable Speed Drive (VSD) to ensure energy efficiency.

4.1.4 One unit of standby exhauster-fan shall be provided. The exhauster shall operate in alternate-sequence to minimize wear and tear of mechanical parts. Upon failure on the duty exhauster-fan, the system should automatically switch-over to the standby exhauster-fan.

4.2 Exhaust Air Pipe

4.2.1 The exhaust air pipe shall be constructed of stainless steel of minimum 3mm thickness. Segmented bends shall be provided for pipe turns. The exhaust air pipe network design, construction and welding shall be in a manner ensuring the smooth flow of air inside with minimum turbulence. Where necessary, silencers shall be provided to attenuate any air noise to an acceptable level.

4.2.2 Pipe supports shall be provided as required for stable and sufficient support of the exhaust air pipe. All pipe supports shall be painted unless otherwise specified with adequate vibration isolation pads.

4.3 Air Waste Separator

4.3.1 The air waste separator is used to separate the waste and air and shall be installed on the upper level ofthe WHF.

4.3.2 Solid waste and air transported in the transport pipe shall be separated by the air waste separator in the collection station. The cyclone air waste separator shall be used for the

primary separation of waste from transport air. The air waste separator shall be of cyclone-type in order to maximize separation efficiency. The separator casing shall be fabricated of mild steel. The separator shall be equipped with anti vibration mountings for noise reduction. The separator shall be equipped with at least 2 nos. of inspection opening.

4.3.3 The cyclone shall be made from mild steel.

4.4 Segregator

4.4.1 The solid waste contains recyclable fractions such as plastics, paper, carton and cardboard as well as metals.

4.4.2 This recyclable waste shall be sorted out automatically with the help of automatic sorting machine.

4.4.3 An automatic sorting machine shall be placed after the air waste separator. It shall be able to sort out paper, metal, organic matter, plastic items.

4.4.4 The sorted material shall be collected in the bins.

4.4.5 The material of construction of the machine parts shall be suitable to the waste handled.

4.5 Air Compressor

4.5.1 Air compressor shall be provided to generate the compressed air required to operate the discharge and air valves pneumatically

4.5.2 A central air compressor unit shall be provided to supply compressed air via SS 304 tube network to operate the pneumatically actuated valves. The air compressor output flow rate& pressure shall be sufficient to ensure the uninterrupted operation of all pneumatically operated valves during an operating cycle.

4.5.3 Compressed air tubing within discharge valve room & Bin Centre shall be 15mm dia. Copper Pipe to local standard/ requirement.

4.5.4 Air compressor type shall be either reciprocating or screw type compressor.

4.5.5 Air compressor shall be provided with air dryer, FRL unit.

4.6 Compaction System

The compaction system shall consist of following equipments.

4.6.1 Compactor

4.6.2 Container body & ejector plate

4.6.3 Tailgate

4.6.4 Ejector System

4.6.5 Hydraulic System

4.6.1 Compactor :-

4.6.1.2 The compacter shall comprise of two moving plates the packing plate and the sweeping plate. The packing plate shall travel on cured track. At the end of this track the sweeping plate will be activated and clean the hopper. At the end of its travel the packing plate will reverse its travel thus drawing and compressing the solid waste into the body. The entire compaction system should be capable of being operated at idle speed without increasing the throttle.

4.6.2 The Container Body & Ejector plate :-

4.6.2.1 The body shall be of suitable capacity to carry 5 TPD garbage.The body shall be reinforced with equitable size channel at appropriate distance so as to with stand thecompression force of the garbage. The complete structure shall be fully welded to with stand thecompaction. The body shall be open at the rear end. The material of the body shall be Mild Steel.

4.6.2.2 The waste container shall be for general solid waste. It shall be of mild steel construction for its body, frame and stiffeners. The body shall be constructed of steel plate with minimum 4.5mm thickness and shall be provided with sufficient body stiffeners of thickness 4-6mm to ensure a structurally strong container. The container frame shall be designed to accept the standard hook-lift equipment of solid waste disposal trucks.

4.6.2.3 The container shall be of airtight construction. The rear gable door shall come complete with a suitable gasket all-round to maintain airtight closure of the door. A solid waste inlet opening complete with suitable gasket seal shall be provided at the rear gable door for interfacing the solid waste transport pipe. These openings shall be provided with a self-closing cover that closes the opening when the container is pulled out.

4.6.2.4 Full waste containers, which are stored for transport to the final waste disposal site, remain closed. The only time that the waste in the container is in contact with the air in the collection station is when the container is disconnected from the compactor docking unit and until the container opening has been closed, i.e. during approximately 2-3 min.

4.6.2.5 The container shall be provided with an opening for interfacing the container docking device for the discharge of solid waste transport air. Maintenance access hatch doors shall be provided at the sides and top. A cat ladder shall be provided on one side of the container for easy access to the container top.

4.6.3 Tailgate:-

Suitable tailgate with hopper shall be provided to collect the garbage and push it inside the body.

4.6.4 Ejector System:-

Suitable Ejector Plate of high tensile steel with bronze pads shall be provided.

4.6.5 Hydraulic System:-

Hydraulic power pack with suitable motor & pumps, valves shall be provided for better operation of the system.

4.6.6 Specific Requirement:

4.6.6.1 The compactor body shall be designed to handle 5 TPD garbage .

4.6.6.2 The container shall be rear loading type

The garbage from the hopper shall be swept bysweeping plate fitted at the end of packing plate and pushed inside the body and then compressedagainst the ejection plate.

4.6.6.3 The tailgate shall be equipped with heavy duty turn buckle one on each side to hold tailgate and body together.

4.6.6.4 Grab handles shall be located on each side of the tailgate. The tailgate shall be fixed with heavyduty pins at the top with the compactor body. The tailgate shall be provided with sturdy arrangement for raising and controlling of descent.

4.6.6.5 Hose burst non return valves shall be provided to prevent the tailgate descending in the event ofhydraulic failure.

4.6.6.6 Automated lever shall be provided on the rear side of the compactor to start packing mechanism. Arrangementshall be provided to stop the system instantaneously with the help of limit switches provided.

4.6.6.7 There shall be arrangement to prevent packing/occurring when the hopper is raised.

4.6.6.8 Arrangement shall be provide to control the speed of the compactor automatically at the time of operation of Compacting system.

4.6.6.9 The ejector plate shall be suitably angled & so that proper ejection takes place when operated.

4.6.6.10 Arrangement shall be provided such that the tailgate will not come down even in case of hydraulicfailure.

4.7 Dust and Deodorizing Filters

4.7.1 The dust filters shall be designed to enable an efficient two-stage dust filtration capability and shall have holding frames made of steel. The final filtration efficiency shall not be less than 85% (as per ASHRAE). The dust filter media shall be of a type that is easily replaced during maintenance service.

4.7.2 Activated carbon filters shall be provided to remove the foul smell/odour of the solid waste transport air before it is discharge to the surrounding. The fitter shall be of cartridge design with steel holding frame and base plate. The cartridge shall be easily removed to facilitate replacement of cartridge or filter media.

4.7.3 The active carbon filter reduces the content of gases and aromatic aerosols (and odours) by 90-95%. Following this treatment, offensive odour in the transport air hardly detected.

4.7.4 There shall be the air purification system in the WHF. The air purification system shall include the moister, dust removal device and deodorization device.

4.7.5 The Dust filter shall be installed downstream of the exhausters. The dust filter and active carbon filter shall be enclosed in an air-tight chamber including air-tight doors.

4.7.6 Filtration room's door shall be air-tight to prevent untreated air from escaping out of the room.

4.7.7 Two step dust filters shall be installed to clean the transport air from dust and to protect the carbon filter.

Before being released back into the atmosphere the air shall be passed through the following treatment:

Step 1	Separation of large particles
Step 2	Sound damping
Step 3	Separation of fine dust
Step 4	First odour filtration
Step 5	Second odour filtration

4.7.8 The dust and deodorizing filters shall be sized and provided in such quantities to handle the anticipated volume and velocity of the air to be filtered. It shall also provide for a reasonable lifespan of the filter media before replacement is necessary. A differential air pressure meter shall be provided to monitor the lifespan of the dust filters.

4.7.9 Noise Control System

Before being released back into the open atmosphere, the transport air shall be passed through a sound damper. Measured at 5 - 7 m from the air outlet, the noise level of the exhaust air should be generally lower than the background noise in residential areas.

4.8 Metallic Hot Dip Galvanized Bins

4.8.1 The Hot Dip Galvanized bins of suitable capacity after the segregator shall be provided.Bins shall be fabricated of steel sheets with suitableforming to give proper strength to the bin.

4.8.2 Reinforcement shall be done at all corners on internal sides of the bin for better strength.

4.8.3 The metallic bin shall have a cover of Plastic Injection Molded High Density Polyethylene (HDPE) hinged at one end, which shall open freely while unloading. The material shall be resistant to heat and chemicals.

4.8.4 The bin shall have four wheels made of heavy duty forged steel swivel type castor of 200 mm dia. and shall have swiveling through 360 deg.

4.8.5 The bin shall have lifting trunnion made of metal compatible for being lifted by bin lifters of EN /DIN standard and handles for easy transportation.

4.8.6 The bins shall be designed to be lifted by compactors having UNIVERSAL Bin Lifters of ENstandards.

4.8.7 The bin shall be Hot Dip Galvanized to prevent corrosion.

5. TRUCK FOR LOADING,UNLOADING & TRANSPORTATION OF THE CONTAINER:

5.1 The contractor shall supply two nos. detachable type container carrying garbage trucks for loading, unloading & transportation of the containers. These trucks shall have the container locking system on its chassis. The filled container after compaction, shall be loaded on the truck with the help of EOT crane and thereafter the truck shall carry the waste to the unloading area.The truck shall be able to unload the container with the inbuilt hydraulic unloading mechanism.

The container size shall be 6 cum. The minimum specification required for the truck is as follows.

5.1.1 The vehicular chassis supplied shall be as per following specifications for mounting Compactor

5.1.2 Equipment suitable for use with containers as per specifications.

5.1.3 Make of Chassis : Any suitable Chassis as per ARAI approvals in India

5.1.4 Type: Full forward only. Single axle at the rear

5.1.5 Engine: 6 Cylinder water cooled engine developing suitable BHP. The engine shall be operated withdiesel as a fuel and shall meet BS-III emission norms.

5.1.6 Gear Box : 5 forward and 1 reverse gear (Synchromesh)

5.1.7 Wheel Base: Suitable to accommodate drivers cum- attendant compartment and container body of 5 Ton without exceeding the permitted over hang, as per RTO Norms.

5.1.8 Drive: Right Hand Drive only

5.1.9 Brakes; Full Air Brakes with Air dryer kit and automatic slack adjuster or Air assisted hydraulicallyoperated brakes.

5.1.10 PTO: Power take off unit should be supplied

5.1.11 The truck shall be provided with tailgate and hydraulic bin lifter which shall be suitable to lift standard containers.

6. EXHAUST FANS FOR ROOM VENTILATION

6.1 Fan should comply with IS 2312.

6.2 For basement area of WHF handling system minimum 30 air change per hour has to be considered. There shall be fresh air circulation & exhaust fans .For packaged type substation & MCC room separate fans shall be considered. For ground floor fresh air louvers & ceiling fans shall be provided

6.3 Fan blades shall be of mild steel / cast aluminium of an airfoil design mounted on stream lined hub. It shall be properly balanced so as to avoid noise and vibration. The blade and blade carriers shall be securely fixed so that they do not loosen in operation. Mild steel casing shall be of heavy gauge construction properly reinforced for rigidity. The means provided for securing the fan mounting or fan casing to the wall, partition such as to provide a secure fixing without damage to the fan or wall.

6.4 The fan shall have protective insulation or be capable of being earthed. A fan with protective insulation may be of all insulated construction or have either double insulation or reinforced insulation. The fan should be driven by single phase motor. Each fan should be provided with a wall cowl and bird screen. Bird screen shall be of 10mm square mesh and wall cowl shall be 18 G.

Fans shall be with ISI marking.

Description	Particulars
Capacity (cum/hr)	As required based on higher of heat load and air change requirements which shall be worked out by Contractor and shall be submitted to Engineer for approval.
Speed (rpm)	<1000 rpm

7. EOT Cranes

7.1 The crane shall be electrically operated, bridge type complete with all accessories including down shop conductor, crane rails and fixtures, and shall conform to IS 3177. Class M6.

7.2 The crane shall consist of bridge girders on which a wheeled trolley is to run. The bridge trucks and trolley frames shall be fabricated from structural steel. Access walkway with safe hand railing as is required along the full span length of the bridge girder. Steel shall be tested quality conforming to ASTM A36 except that, plates more than 20 mm thick shall conform to BS: 4360 The bridge shall be designed to carry safely the loads specified in IS 807 & IS 800. All anti-friction bearings for bridge and trolley track wheels, gear boxes and bottom sheaves on hook shall be lubricated manually by hand operated grease pump through respective grease nipples.

7.3 Wheel and structural frame of the wheel mounting of the end carriages shall be designed so as to ensure that the crane remains square and prevent skewness. Bridge and trolley track wheels shall be of forged steel and shall be double flanged type. The wheel diameter and rail sizes shall be suitable for the wheel loads. The crane rails shall be manufactured from wear resistant austenitic manganese steel. Mountings of the wheels shall be designed to facilitate easy removal for maintenance. Walkways shall be at least 500 mm clear inside width with a 6mm thick non-skid steel plate surface. Steel rail stops to prevent rails from creeping and trolley from running off the bridge shall be abutted against ends of rails and welded to the girders. Bridge and trolley stops to match the wheel radius shall be provided before the buffer stops.

7.4 All exposed couplings, shafts, gear, wheels, pinions and chain drives etc. shall be safely encased and guarded completely to prevent any hazard to persons working around. All bearings and gears shall have a design life of 10,000 hours. Electro-magnetic and

hydraulic thrustor brake shall be provided for the main hoist. One electro-magnetic brake shall be provided for each of the cross travel and long travel motions.

7.5 Hook shall be solid forged, heat treated alloy or carbon steel suitable for the duty service. They shall have swivels and operate on ball thrust bearings with hardened races. The lifting hooks shall comply with the requirements of BS: 2903 / BS: 3017 and shall have a safety latch to prevent rope coming off the hook.

7.6 Hoist rope shall be extra flexible, improved plough galvanised steel rope with well lubricated hemp core and having six strands of 37 wires per stand with minimum ultimate tensile strength of 1.6 X 106 kN/m2 of Right Hand Ordinary (RHO) lay construction. The ropes shall have a 6:1 safety factor on the specified safe working load. Rope drums shall be grooved and shall be either cast iron or cast steel of or welded steel conforming to IS 3177.

7.7 Gears shall be cut from solid cast or forged steel blanks or shall be stress relieved welded steel construction. Pinions shall be of forged carbon or heat treated alloy steel. Strength, quality of steel, heat treatment, face, pitch of teeth and design shall conform to IS 807 and IS 800.

7.8 A capacity plate showing year of manufacture and rated capacity of hoist in figures not less than 150 mm height shall be placed on each side of the crane girder.maximum deflection under full load shall not exceed 1/900 of the span.

7.9 All accessory and auxiliary electrical equipment including drive motors, electrically operated brakes, controllers, resistors, conductors, insulators, current collectors, pendant push button station, protective devices, operating devices, cables, conduits, etc. necessary for the safe and satisfactory operation of the crane shall be provided. Switch gear & controller and motors shall conform to respectively IS 4237 and IS 325.

7.10 Power to the crane shall be provided by down shop conductors manufactured from high conductivity hard drawn copper. Conductors shall be completely shrouded such that they have no exposed current carrying surfaces. Pendant type push button station shall be sheet steel enclosed and shall comprise the following push buttons and indicating lamps:

‘Start’ and ‘Stop’
Long travel – ‘Right’ and ‘Left’
Cross travel – ‘To’ and ‘Fro’
Hook – ‘Hoist’ and ‘Lower’
Red indicating lamp for supply ‘ON’ indication

7.11 Pendant type push button shall be supported independently of the electrical cable and shall be earthed separately, independent of the suspension. Automatic reset type of limit switches shall be provided to prevent over travel for each of the following:

For 'UP' and 'Down' motions of the hook
Long travel motion
Cross travel motion

7.12 Crane structures, motor frames and metal cases of all electrical equipment including metal conduit and cable guards shall be earthed. All motors, brakes, limit switches, panels, drum controllers, resistor unit sets shall be provided with two studs for earthing.

TECHNICAL SPECIFICATIONS (ELECTRICAL)

SCOPE OF WORK:

THE SCOPE OF SERVICES COVERS THE DESIGN, DETAILED ENGINEERING, PREPARATION OF CONSTRUCTION DRAWING, MANUFACTURE, ACCEPTANCE TESTING AT MANUFACTURER'S WORKS OR AT ANY ACCREDITED AGENCY, SUPPLY, PACKING, FORWARDING AND DELIVERY FROM MANUFACTURER'S WORKS/ PLACE OF STORAGE TO ERECTION SITE INCLUDING TRANSIT INSURANCE, UNLOADING, STORAGE AT SITE, MOVING FROM PLACE OF STORAGE TO PLACE OF INSTALLATION, ASSEMBLY, CLEANING/ LUBRICATING, TOUCH UP PAINTING, ERECTION, TESTING, COMMISSIONING & PERFORMANCE DEMONSTRATION AND HANDING OVER OF THE FOLLOWING SYSTEMS/ EQUIPMENTS ALONG WITH ALL NECESSARY SPARES OF ORIGINAL RATINGS & SPECIFICATIONS IN DESIGN, BUILD AND OPERATE (DBO) BASIS INCLUDING THE DEFECT LIABILITY AND OPERATION & MAINTENANCE PERIOD AS PER THIS RFP.

a) Tariff metering equipment & electric supply connection shall be provided by BSCDCL/MPPKVVCL for which necessary liaison shall be done by the CONTRACTOR

b) Incoming Power supply arrangement as per BSCDCL/MPPKVVCL proposal from the nearest substation with two independent HV feeders either through transmission line or HV underground laid cables up to the tariff meters including all other accessories and works as per BSCDCL/MPPKVVCL norms. This will include Two/ four pole structure (along with necessary earthing, fence and gate) for receiving incoming supply with GOD (including operating handle and lock), Lightning Arrestors and Drop Out Fuses; all civil works; Incoming point of supply breaker panel/ Ring Main Units with outdoor type (RMU) etc as per BSCDCL/MPPKVVCL proposal.

c) Independent power for the Solid waste plant shall be provided by state Distribution company Madhya Pradesh Kshetra Vidyut Vitaran Company Ltd. (MPKVVCL) or a private Distribution Franchisee company as may be decided by BSCDCL, at 33kVor 11kV through underground laid HV cables till the plot Substation.

d) The temporary Source of this power shall be from the nearest existing Substation of MPMKVVCL or as may be decided by the service provider. Permanent power shall be provided from the EHV GIS substation as per the power distribution plan of the ABD area. The power supply to the plots shall be loop in and looped out of the either 33kV or 11kV Rings.

e) Compact Substations with Ring Main Unit, transformer and LV panel

f) Auto mains Failure Diesel Standby Generator along with LV Breaker Panel for 100% power back up

g) LV metal enclosed switchgears including Power Control Centre (PCC), Power Distribution Boards (PDB) including feeders, equipments as per technical specification requirements, Sub DBs, Lighting DBs, Receptacle DBs and receptacles for utilities etc.

h) LV capacitor banks with control panel consisting of Hybrid Power Factor Correction (HPFC) relay to improve the plant power factor up to 0.99.

i) Cabling system consisting of various HV and LV grade, XLPE/ PVC insulated, multi-stranded Al/ Cu, GI round wire/ flat strip armoured power & control cables, prefabricated GI ladder/ perforated type cable trays, GI raceways & associated accessories including support structures.

j) Earthing system for HV/ LV equipments and lightning protection system for the building.

k) Lighting and Receptacle system for all indoor & outdoor areas controlled by lighting panels and Raw power panels installed in respective areas

l) Continuous monitoring of electrical Power & Energy parameters like Voltage, Current, Power Factor, Frequency, Kilo Watts, Kilowatt-hours etc.

ALL EQUIPMENT WHICH WILL BE HANDED OVER TO MPPKVVCL SHALL BE AS PER THEIR SPECIFICATION.

INLAND AND OVERSEAS TRANSIT INSURANCE, TRANSPORT, TESTING AT SITE SHALL BE CONTRACTOR'S SCOPE. TENDER BOQ AND DRAWINGS, IF PROVIDED, ARE FOR REFERENCE PURPOSES ONLY WHICH ARE THE MINIMUM REQUIREMENTS; CONTRACTOR SHALL ENSURE THAT DESIGN & EQUIPMENT RATINGS SHALL BE AS PER SPECIFICATION REQUIREMENTS.

THE CONTRACTOR SHALL PREPARE DESIGN CALCULATIONS BASED ON PARAMETERS/ DESIGN CRITERIA INDICATED IN THE SPECIFICATIONS. THE CONTRACTOR SHALL PREPARE DETAILED ENGINEERING AND CONSTRUCTION PURPOSE DRAWINGS TO MAKE HIS/ HER OWN ESTIMATE OF RATINGS & QUANTITIES (MINIMUM REQUIREMENTS AS PER PRICE SCHEDULE, TECHNICAL DATA SHEETS, REFERENCE ELECTRICAL SINGLE LINE DIAGRAM (SLD) & OTHER RELEVANT DETAILS) FOR ENTIRE ELECTRICAL SYSTEMS INCLUDING ALL ITEMS, SYSTEMS SUCH AS EQUIPMENTS, POWER & CONTROL CABLES/ CABLING SYSTEM, LIGHTING SYSTEM, EARTHING, LIGHTNING PROTECTION, MAIN & AUXILIARY POWER DISTRIBUTION, CIVIL WORKS REQUIRED FOR COMPLETION OF WORKS.

CONTRACTOR SHALL TAKE DUE CARE OF THE SITE SEISMIC CONDITIONS WHILE DESIGNING ALL EQUIPMENTS/ COMPONENTS USED IN ENTIRE ELECTRICAL SYSTEMS COVERED IN THIS SPECIFICATION. CONTRACTOR SHALL FURNISH LIST OF ADDITIONAL DESIGN PARAMETERS CONSIDERED IN DESIGN TO FULFIL THE ABOVE REQUIREMENT.

DESIGN AND DETAILED ENGINEERING OF THE MATERIALS PROCURED BY CONTRACTOR IS INCLUDED IN SCOPE. CONTRACTOR SHALL SUBMIT EACH DOCUMENT/ CALCULATIONS OF SYSTEM WHICH IS INCLUDED IN SCOPE TO PURCHASER/ CONSULTANT FOR FINAL REVIEW/ APPROVAL. ALL DESIGN DOCUMENTS/ CALCULATIONS PREPARED BY CONTRACTOR SHALL BE DULY SIGNED BY QUALIFIED AUTHORITIES AND STAMPED. DESIGN DOCUMENTS/ CALCULATIONS PREPARED BY SUB-CONTRACTORS SHALL BE APPROVED BY CONTRACTOR AND STAMPED COPY OF APPROVAL ALONG WITH NO-DEVIATION SHEET FROM SUB-CONTRACTOR SHALL BE SUBMITTED BY THE CONTRACTOR TO PURCHASER/ PURCHASER'S REPRESENTATIVE FOR FINAL REVIEW/ APPROVAL.

EXPERT OR MANUFACTURER SUPERVISION FOR SUB-CONTRACTOR SUPPLIED MATERIAL SHALL BE PROVIDED BY CONTRACTOR AND SHALL BE INCLUDED IN OFFER.

CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR ANY SHORTAGES OR DAMAGES IN TRANSIT FOR HIS SUPPLY SCOPE, HANDLING AND/ OR IN

STORAGE OF ANY MATERIALS AND ERECTION OF THE EQUIPMENT, SUPPLY OF ERECTION TOOLS AT SITE. CONTRACTOR SHALL ENSURE THAT IT WILL NOT AFFECT ANY ACTIVITY OR PROJECT SCHEDULE. ANY DEMURRAGE, WHARFAGE AND OTHER SUCH CHARGES CLAIMED BY THE TRANSPORTERS, RAILWAYS ETC. SHALL BE TO THE ACCOUNT OF THE CONTRACTOR.

CONTRACTOR SHALL IDENTIFY ACTIVITIES AND MILE STONES OF THE WORK FORECASTED FOR NEXT MONTH WITH OPTIMISTIC AND PESSIMISTIC DATES OF WORK COMPLETION. CONTRACTOR SHALL PREPARE PROGRAM EVALUATION AND REVIEW TECHNIQUES TO IDENTIFY CRITICAL PATH OF PROJECT AND ACTIVITY SEQUENCES. THE PROJECT SCHEDULE SHALL BE PREPARED AND UPDATED FORTNIGHTLY IN MS PROJECT.

NOTHING IN THIS SPECIFICATION SHALL BE CONSTRUCTED TO RELIEVE THE CONTRACTOR OF HIS/ HER RESPONSIBILITIES TOWARDS FOLLOWING BEST ENGINEERING PRACTICES ESTABLISHED IN THE COUNTRY.

OBTAINING APPROVALS INCLUDING LOAD SANCTION/ RELEASE FROM POWER DISTRIBUTION COMPANY LTD (BSCDCL/MPPKVVCL); NO OBJECTION CERTIFICATES/ APPROVALS FROM ELECTRICAL INSPECTOR (CEIG), RELEVANT GOVERNMENT AGENCIES, STATUTORY AUTHORITIES, AS APPLICABLE IS INCLUDED IN CONTRACTOR'S SCOPE.

VOLTAGE LEVEL FOR SUPPLY SHALL NEED TO BE CONFIRMED WITH BSCDCL/MPPKVVCL BY CONTRACTOR BEFORE THE COMMENCEMENT OF DESIGN.

ALL NECESSARY LEGAL FEES REQUIRED FOR VARIOUS APPLICATIONS TO MPPKVVCL /ELECTRICAL INSPECTOR (CEIG), RELEVANT GOVERNMENT AGENCIES, STATUTORY AUTHORITIES SHALL BE PAID BY THE PURCHASER UPON PRODUCTION OF VALID RECEIPTS.

THE CONTRACTOR'S SCOPE SHALL ALSO INCLUDE MEASUREMENT OF SOIL RESISTIVITY AT SITE BY WENNER'S FOUR ELECTRODE METHOD AS PER IS: 3043 – 1987 (REAFFIRMED IN 2006 OR ITS LATEST VERSION) AT MINIMUM FOUR LOCATIONS AT SITE. THE EARTHING SYSTEM SHALL BE DESIGNED FOR THE ACTUAL MEAN SOIL RESISTIVITY VALUE OBTAINED.

EVEN IF ALL COMPONENTS OF A SYSTEM INCLUDED IN THIS SPECIFICATION ARE NOT EXPLICITLY IDENTIFIED AND/ OR LISTED HEREIN, THESE SHALL BE SUPPLIED UNDER THIS CONTRACT TO ENSURE COMPLETENESS OF THE SYSTEM AND FACILITATE PROPER OPERATION AND EASY MAINTENANCE OF THE PLANT. ANY AND ALL OTHER WORKS NOT INDICATED ABOVE BUT NECESSARY/ REQUIRED TO COMPLETE THE JOB IN ALL ASPECTS, ARE INCLUDED IN THE CONTRACTOR'S SCOPE.

THE CONTRACTOR SHALL INDICATE AND INCLUDE START UP SPARES, ESSENTIAL SPARES, RECOMMENDED SPARES AND A SET OF SPECIAL TOOLS NECESSARY FOR OPERATION, ROUTINE MAINTENANCE OF EQUIPMENT SUPPLIED FOR A PERIOD OF FIVE YEARS.

WHETHER SPECIFICALLY CALLED FOR OR NOT, ALL ACCESSORIES REQUIRED FOR NORMAL AND SATISFACTORY OPERATION (AS DEEMED BY THE PURCHASER) OF THE EQUIPMENT SHALL BE CONSIDERED TO BE A PART OF THE CONTRACTOR'S BASIC SCOPE OF SUPPLY AND/ OR WORK AND NO CLAIMS WHATSOEVER, FOR EXTRA PAYMENT ON THESE GROUNDS, WILL BE ACCEPTED.

CONTRACTOR SHOULD VISIT SITE AND GET HIMSELF/ HERSELF ASCERTAINED REGARDING THE SCOPE OF WORK FOR THE COMPLETE ELECTRICAL WORKS BEFORE SUBMISSION OF QUOTE/ OFFER.

CONTRACTOR'S SCOPE SHALL ALSO INCLUDE ALL CIVIL WORKS AND STRUCTURAL WORKS REQUIRED FOR INSTALLATION OF ALL ELECTRICAL EQUIPMENT/ SYSTEMS SUCH AS EQUIPMENT FOUNDATIONS, INDOOR & OUTDOOR TRENCHES, EQUIPMENT SUPPORT STRUCTURES AND ALL EXCAVATION WORKS INCLUDING THOSE FOR LIGHTING, EARTHING, CABLING SYSTEMS ETC.

IT IS NOT THE INTENT TO COMPLETELY SPECIFY HEREIN ALL DETAILS OF DESIGN AND CONSTRUCTION OF THE EQUIPMENT AND SYSTEMS. NEVERTHELESS, THE ELECTRICAL SYSTEM SHALL CONFORM TO HIGH STANDARD OF ENGINEERING, DESIGN AND WORKMANSHIP IN ALL RESPECTS AND SHALL BE CAPABLE OF PERFORMING SATISFACTORILY IN CONTINUOUS COMMERCIAL OPERATION UNDER THE SPECIFIED ENVIRONMENTAL CONDITIONS.

PURCHASER RESERVES THE RIGHT TO ISSUE ADDENDUM TO THE TECHNICAL SPECIFICATION TO INDICATE MODIFICATION/ CHANGES IN THE REQUIREMENTS, IF SO REQUIRED AT A LATER DATE.

2. DESIGN BASIS REPORT FOR ELECTRICAL WORK

SITE/ ENVIRONMENTAL CONDITIONS:

AMBIENT TEMPERATURE:45ºC (SITE SPECIFIC)

RELATIVE HUMIDITY: 5 - 95%

AREA CLASSIFICATION:NON-HAZARDOUS / HAZARDOUS

SEISMIC DATA: AS PER IS 1893 (LATEST ISSUE)

NOMINAL SYSTEM VOLTAGE:

INCOMING AC POWER SUPPLY VOLTAGE TO THE CONTROL CENTRE SHALL BE DERIVED BASED ON LOAD DEMAND AS PER ELECTRICITY REGULATORY AUTHORITY/ MPPKVVCL NORMS

VOLTAGE LEVEL FOR SUPPLY SHALL NEED TO BE CONFIRMED WITH BSCDCL/MPPKVVCL BY CONTRACTOR BEFORE THE COMMENCEMENT OF DESIGN.

POWER/ CONTROL SUPPLY DISTRIBUTION VOLTAGE:

HV -11 KV OR 33 KV, 3 PHASE, 3 WIRE, 50 HZ, AC DEPENDING UPON THE AVAILABLE SOURCE AT THE SITE OR AS PER THE RECOMMENDATION OF BSCDCL/MPPKVVCL

LV - 415V, 3 PHASE, 4 WIRE, 50 HZ, AC

GENERAL LIGHTING & SPACE HEATING - 240V, 1 PH, 2 WIRE, 50HZ, AC

CONTROL & PROTECTION - 24/ 30 V OR 110V, 2 WIRE DC (AS APPLICABLE)

CRITICAL LIGHTING: 240V, 1 PH, 2 WIRE, 50HZ, AC THRU UPS

VOLTAGE TRANSFORMER SECONDARY: 110 V, 3 PH, 50 HZ, AC

VOLTAGE VARIATION: ± 10%,

FREQUENCY VARIATION: ± 3% AND

COMBINED VOLTAGE & FREQUENCY VARIATION: ± 10%

SYSTEM EARTHING:

11 KV OR 33 KV, 3 PH AC SYSTEM: NEUTRAL SOLIDLY EARTHED

415 V, 3 PH, AC SYSTEM: NEUTRAL SOLIDLY EARTHED

240 V, 1 PH, AC SYSTEM: NEUTRAL SOLIDLY EARTHED

APPLICABLE CODES AND STANDARDS:

THE DESIGN, MANUFACTURE, INSTALLATION, TESTING, COMMISSIONING AND PERFORMANCE OF ALL THE EQUIPMENT AND SYSTEM SHALL COMPLY WITH ALL CURRENTLY APPLICABLE STATUTES, REGULATIONS AND SAFETY CODES IN THE LOCALITY WHERE THE EQUIPMENT WILL BE INSTALLED. NOTHING IN THIS SPECIFICATION SHALL BE CONSTRUED TO RELIEVE THE CONTRACTOR OF HIS RESPONSIBILITY.

POWER DISTRIBUTION ARRANGEMENT:

IT IS PRESUMED THAT THE POWER SUPPLY TO THE PROPOSED BUILDING SHALL BE PROVIDED FROM THE NEAREST BSCDCL/MPPKVVCL SUBSTATION AT HV LEVEL FROM THE NEAREST NETWORK THROUGH TWO INDEPENDENT FEEDERS.

TARIFF METERING ARRANGEMENT AS PER MPPKVVCL STANDARDS & SPECIFICATIONS SHALL BE PROVIDED BY CONTRACTOR. CONTRACTOR SHALL MAKE ALL THE ABOVE ARRANGEMENTS IN CASE THE SAME ARE NOT PROVIDED BY BSCDCL/MPPKVVCL. THE CONTRACTOR SHALL TAKE NECESSARY CONFIRMATION ON THE SAME BEFORE SUBMISSION OF THE OFFER/ BID AND INCLUDE THE SAME IN IT.

TWO NOS. COMPACT SUBSTATIONS (CSS) ARE PROPOSED TO STEP DOWN THE HV VOLTAGE TO LV VOLTAGE FOR FURTHER USAGE. CSS SHALL BE 100% REDUNDANT TO EACH OTHER.

HPFC CAPACITOR BANKS WITH CONTROL PANEL CONSISTING OF AUTOMATIC POWER FACTOR CORRECTION (HPFC) RELAY TO IMPROVE THE PLANT POWER FACTOR UP TO 0.99. HPFC PANELS SHALL BE PROVIDED ON EACH BUS SECTIONS OF THE PCC AND OPERATED THROUGH SUMMATION CT METHOD AS INDICATED IN THE SLD.

A SELF SUFFICIENT STANDBY DG SET WITH ALL THE REQUIRED ACCESSORIES AND AUXILIARY SYSTEMS LIKE ACOUSTIC ENCLOSURE, SILENCER, METAL STACK (AS PER POLLUTION CONTROL BOARD REGULATIONS), BREAKER AND PROTECTION PANEL WITH PROVISION FOR INCOMING AND OUTGOING CABLE CONNECTIONS, FUEL DAY TANK, FOUNDATION, EARTHING AND OTHER

UTILITY PIPING IS PROPOSED FOR SUPPLYING THE BACK UP POWER INCASE OF GRID POWER FAILURE.

THE DG SET SHALL ALSO BE A PACKAGED SYSTEM AND OPERATED IN AUTO MAINS FAILURE (AMF) MODE.

THE OUTGOINGS FROM EACH OF THE TRANSFORMERS AND DG SET SHALL BE CONNECTED TO INDEPENDENT BUS SECTION OF THE MAIN POWER CONTROL CENTRE (PCC) LOCATED IN THE SWITCHGEAR ROOM AND CONNECTED TO EACH OTHER THROUGH BUS-COUPLER.

FURTHER DISTRIBUTION OF POWER TO EACH AREA SHALL BE CARRIED OUT THROUGH DEDICATED DISTRIBUTION BOARDS FOR EACH FLOOR FOR LIGHTING & RECEPTACLES.

NORMAL LIGHTING FOR EACH FLOOR SHALL BE PROVIDED THROUGH SEPARATE PER PHASE ISOLATED THREE PHASE DISTRIBUTION BOARDS FOR EACH FLOOR FED FROM THE PCC AT ELECTRICAL ROOM.

CRITICAL LIGHTING FOR EACH FLOOR SHALL BE PROVIDED THROUGH SEPARATE PER PHASE ISOLATED THREE PHASE DISTRIBUTION BOARDS FOR EACH FLOOR FED FROM THE UPS DB LOCATED AT ELECTRICAL ROOM.

SINGLE PHASE POWER FOR GENERAL PURPOSE AS WELL AS DEDICATED POWER OUTLETS SHALL BE PROVIDED THROUGH SEPARATE RAW POWER DBS LOCATED IN EACH FLOOR FED FROM PCC AT ELECTRICAL ROOM.

ALL THE CABLING FROM THE PCC TO THE INDIVIDUAL FLOORS SHALL BE LAID ON CABLE TRAYS THROUGH A DEDICATED RCC DUCT WITH ACCESS WINDOW ON EACH FLOOR. THE DB SHALL BE SUITABLY LOCATED NEAR THE AREA WHERE THE DUCTS ARE LOCATED.

DESIGN CRITERIA FOR ELECTRICAL EQUIPMENT/ SYSTEMS:

GENERAL:

THE DESIGN CRITERIA, GIVEN BELOW HAS TO BE FOLLOWED BY THE CONTRACTOR FOR DESIGNING/ SIZING OF ELECTRICAL EQUIPMENTS COVERED UNDER CONTRACTOR'S BATTERY LIMITS; HOWEVER, IT IS TO BE NOTED BY THE CONTRACTOR THAT, FOLLOWING THIS DESIGN CRITERIA DOES NOT RELIEVE THE CONTRACTOR FROM ADHERENCE TO THE STANDARDS, REGULATORY REQUIREMENTS & BEST ENGINEERING PRACTICES.

THE ELECTRICAL SYSTEM SHALL BE DESIGNED TO PROVIDE

Safety to Personnel and equipment during both operation and maintenance

Reliability of Service

Minimal fire risk.

Ease of maintenance and convenience of operation.

Protection of all electrical equipment through selective relaying system.

Electrical supply to equipment and machinery within the design operating limits.

Adequate provision for future extension and modification.

Maximum inter-changeability of equipment.

Fail safe feature.

Energy efficient equipment/ system such that BEE Rating above 3 stars

Suitability for applicable environmental factors

ESTIMATION OF LOAD/ MAX DEMAND:

THE FOLLOWING CONSIDERATIONS ARE TO BE FOLLOWED TO ARRIVE AT THE MAXIMUM ELECTRICAL DEMAND.

LOAD FACTOR

ICT Load	:	1.0
Workstation Load	:	0.7
Motors (Fire Hydrant system)	:	0.9 (As per Mech/ Process Input)
Auxiliary load	:	0.9
Lighting load	:	1.0
Miscellaneous Power loads	:	0.6
Watering Pump	:	1.0 (As per Mech/ Process Input)
Ventilation System	:	1.0 (As per Mech/ Process Input)
Equipment	:	1.0 (As per Mech/ Process Input)

OVERALL DIVERSITY FACTOR : 1.2

DESIGN MARGIN : 10%

POWER FACTOR OF MOTORS : AS PER THE MANUFACTURE'S DATA SHEETS

EFFICIENCY OF MOTORS : AS PER THE MANUFACTURER'S DATA SHEETS (IE3 AS PER IS 12615)

TRANSFORMER SIZING/ SELECTION:

CRITERIA 1:

The capacity of the transformers will be calculated based on the total simultaneous maximum demand (calculated based on the load factors and diversity given above, PF, efficiency).

Additional 10% contingency shall be considered for deriving transformer sizing.

Similarly, after consideration of 10% contingency over maximum demand (MD), sizing of the selected transformer shall be such that maximum transformer loading shall not exceed 90%.

CRITERIA 2:

The adequacy of transformer sizing shall also be proved on the basis of % Voltage dip observed at the motor terminal. % voltage dip at motor terminal shall not exceed 15% i.e. with the use of appropriate starter & considering largest motor starting & base load (all other loads except the highest rating motor are running); the % voltage dip during starting at motor terminal shall not exceed 15%.

The Voltage dip and fault level calculations needs to be calculated based on following actual data collected from nearest Substation and Grid:

The fault level of HV bus from which power supply will be taken.

Impedance of HV Overhead Line Conductor/ HV Cable interconnecting the HV bus of Substation and HV switchboards

FOR THE PER UNIT CALCULATION PURPOSE, MINIMUM STARTING CURRENT FOR VARIOUS TYPES OF STARTER APPLICATIONS SHALL BE CONSIDERED AS FOLLOWING:

DOL STARTER – 6 TIMES THE RATED CURRENT.

STAR- DELTA STARTER – 2.5 TIMES THE RATED CURRENT.

AUTO TRANSFORMER STARTER (ATS) – 3 TIMES THE RATED CURRENT.

SOFT STARTER – 2 TIMES THE RATED CURRENT.

VFD– 2 TIMES THE RATED CURRENT.

WHEREVER HT SUPPLY IS ENVISAGED, 100% STAND-BY SHALL BE PROVIDED FOR TRANSFORMERS. ALL THE ASSOCIATED EQUIPMENTS/ ACCESSORIES SHALL BE PROVIDED FOR STAND-BY TRANSFORMER AS WELL. IN NORMAL CONDITION, BOTH THE TRANSFORMERS SHALL FEED THEIR RESPECTIVE BUS SECTIONS BY KEEPING BUS COUPLER OPEN & IN CASE OF FAILURE OF ONE

TRANSFORMER, THE OTHER TRANSFORMER SHALL BE ABLE TO TAKE 100% LOAD WITH BUS COUPLER IN CLOSE POSITION.

THE LOAD LOSSES AND NO-LOAD LOSSES OF TRANSFORMER SHALL BE AS PER ECBC 2017.

DG SIZING

CRITERIA 1:

THE CAPACITY OF THE DG WILL BE CALCULATED BASED ON THE TOTAL SIMULTANEOUS MAXIMUM DEMAND (CALCULATED BASED ON THE LOAD FACTORS AND DIVERSITY GIVEN ABOVE, PF, EFFICIENCY).

ADDITIONAL 10% CONTINGENCY SHALL BE CONSIDERED.

AFTER CONSIDERATION OF 10% CONTINGENCY OVER MAXIMUM DEMAND (MD), SIZING OF THE SELECTED DG SHALL BE SUCH THAT MAXIMUM LOADING SHALL NOT EXCEED 80%.

CRITERIA 2:

The adequacy of DG sizing shall also be proved on the basis of % Voltage dip observed at the motor terminal. % voltage dip at motor terminal shall not exceed 15% i.e. with the use of appropriate starter & considering largest motor starting & base load (all other loads except the highest rating motor are running); the % voltage dip during starting at motor terminal shall not exceed 15%.

SWITCHGEAR SIZING/ SELECTION:

Switchgear shall be sized/ selected considering the following:

Rating suitable for carrying full load current of the equipment.

Suitability for Short Circuit Rating for 1 sec duration.

Switchgear for motors shall be suitable for motor duty application.

Switchgear for all the motor feeders shall be Type-2 co-ordination.

Motor starter selection shall be done as follows:

Direct On Line (DOL) Starter – For motors rated up to 5.5 kW

Star- Delta Starter - For motors rated above 5.5 kW to 15 kW

Auto Transformer Starter (ATS) - For motors rated above 15 kW to 75 kW

Soft Starter – For all low/ medium voltage motors above 75 kW rating.

VFD – For all low/ medium voltage motors above 100 kW rating.

In-panel de-ration of minimum 20% or as provided in Manufacturer's catalogue, whichever is higher shall be considered.

BUS BAR SIZING:

The CONTRACTOR shall furnish calculations after award of contract, establishing the adequacy of the bus bar sizes to meet the continuous and short time current ratings as calculated.

The bus-bars shall be sized considering the following criteria:

Sleeves made of insulating material on all bus bars.

Design ambient temperature 45^{o}C.

Final temperature of the bus-bars complying with requirements of IEC 61439.

Bus bars being inside the panel; De- ration for enclosure and ventilation.

Bus bar suitability for carrying rated current continuously.

Configuration of bus bars and Proximity effect

Bus bars shall withstand the short time rating of the panel for 1 sec duration.

POWER FACTOR IMPROVEMENT:

HPFC Panel shall be sized considering following design criteria:

Minimum 6 steps in an APFC relay shall be considered with 2 steps as spare.

Capacitor shall be All Poly Propylene (APP), double layer type.

Fixed type capacitor bank, with manual & auto switching and components shall be provided at the incomer of Main PCC panel (LV) for transformer no load compensation.

For each bus section of the Main PCC panel, separate APFC panel- based on the design criteria to be provided. Other requirements of APFC panel & its components shall be as per requirement provided in this specification.

Total Capacity & Capacitor bank sizes shall be as given in Table below:

Capacity	5 kVAr	10 kVAr	15 kVAr	25 kVAr	50 kVAr	100 kVAr

* kVAr	# Nos.	# Nos.	# Nos.	# Nos.	# Nos.	# Nos.

* - CONTRACTOR has to calculate the capacitor rating based on the system power factor (0.85 or actual, whichever is lesser - to be corrected for 0.99. Rating of HPFC panel shall be based on 50% of total running load for each bus section & not on the total connected load basis. Number of stages / steps in a particular HPFC panel shall be decided by the CONTRACTOR such that minimum 8 steps & maximum 16 steps shall be provided in a particular panel.

Scheme with Summation CT shall be provided to operate both the APFC/HPFC while one of the transformers is in line.

Switchgear rating for individual capacitor bank shall be sized at 1.5 times the rated current rating.

CABLE SIZING:

The CONTRACTOR shall ensure that cable and wires associated with the power distribution and control systems in all the installations throughout the Works are adequately rated for their use

The following main aspects shall also be considered while deciding the final size of the cables-

Supply voltage and frequency

All cables shall be selected to carry the corresponding full load current under site conditions.

Route length and disposition of cables

Maximum allowable temperature rise under normal full load condition based on the material of cable insulation (XLPE/ PVC).

Maximum short circuit current duration (fault clearing time) and final temperature of cable during short circuit current flowing through the cable.

Cable from transformer secondary to PCC incomer, fault clearing time shall be 1sec

For Cables emerging from ACB outgoing, fault clearing time shall be considered as 0.16 second (for Tie feeders if any it shall be 0.5 second)

For Cables emerging from MCCB outgoing, fault clearing time shall be considered as 0.01 second

For the HT incomer cables (metering kiosk to GOD, GOD to HT switchgear/ transformer) minimum fault clearing time shall be considered as 1 sec.

For cable from HT panel outgoing to transformer, fault clearing time shall be considered as 0.16 second.

CONTRACTOR to note that, the above fault clearing times are minimum to be considered. Actual fault clearing time shall be considered as per actual relay co-ordination.

Appropriate de-rating factors as per cable manufacturer's catalogue and enlisted below shall be considered for sizing the cable:

Ambient Air Temperature (minimum 45^{o}C).

Ambient ground temperature (minimum 40^{o}C to be considered)

Laid in Air / ducts/ directly in ground etc.

Depth of cable burial (minimum 750 mm for LT and 900 mm/ 1050mm for 11kV/ 1200mm for 33KV HT)

Thermal Resistivity of Soil (minimum 150^{o}C Cm/ W to be considered)

No. of cables in a group-touching each other or separated by a distance

No. of cable trays in tier

Any other de-ration factors as applicable & as per Manufacturer's catalog.

Permissible voltage dips at the time of starting the corresponding motor/ load. CONTRACTOR to ensure adherence to the Criteria-2 mentioned above.

In running condition, cumulative voltage drop (Including HV and LV at 100% rated load) shall not exceed 5% (measured at load end) for the LV loads.

All the HV cables shall be Earthed grade (as per system requirement), multi-stranded Al conductor, XLPE insulated, inner/ outer extruded PVC sheath ST2, galvanized steel flat strip armoured cables.

The LV cables shall be 1.1 kV grade, multi-stranded Copper/ Al conductor, XLPE insulated, colour coded, inner and outer extruded PVC sheathed, galvanized steel round wire/ flat strip armoured cables.

Cables up to & including 6.0 sq.mm shall be Cu multi-stranded conductor with galvanized steel round wire armoured & balance cables shall be Al multi-stranded conductor with galvanized steel round wire/ flat strip armoured.

Single core cable shall have non magnetic material armouring.

Control cables shall be Cu multi-stranded conductor with galvanized steel round wire/ flat strip armoured. For cables above 7 cores, minimum two spare cores shall be considered.

ILLUMINATION SYSTEM:

Illumination for various indoor & outdoor areas shall be conforming to the requirements mentioned below:

All Indoor and outdoor lighting fixtures shall be LED type including the building periphery fixtures, street light fixtures, landscape fixtures and office and other interior fixtures, with suitable driver and heat sink as testified by the type tests mentioned further in the specifications under appropriate clause.

The illumination levels to be considered for the design of lighting system for various areas shall be as follows. These are the illumination levels achieved at Work plane. Work plane height shall be considered as 0.75 m from FGL.

S.No.	Area	Illumination Level (Lux) - Average values
	Electrical/ Switchgear rooms;	250 Lux
	UPS and Battery Room	300 Lux
	Control room	300 Lux
	Manager cabins; Conference rooms; Workstations, Office Area	300 lux
	Waiting Area	200 Lux
	Entrance Lobby	150 Lux
	Parking	50 Lux
	Passage	150 Lux
	Switchyard & Transformer Area General On Equipment	 15 Lux 30 Lux
	Roads	15 – 20 Lux
	Outdoor areas	20 Lux
	Pantry	200 Lux

	Toilet	100 Lux
	Critical and Emergency Lighting	10 Lux

Critical lighting shall be designed such that at all junctions, exit passages & strategic locations the Lux level shall be maintained above 10 Lux. The same shall be powered from lighting UPS and shall be Backed up with Battery.

Installite fixtures with built in battery backup shall be considered for the outdoor areas like CSS and DG set areas etc. for approaching the sets in emergencies.

Lighting design shall be performed using latest version of DiaLux Software/ Original Equipment Manufacturer (OEM) validated software. The Validation Report along with software and data files shall be acceptable to PURCHASER/ PURCHASER's representative.

Various design factors shall be considered as following:

a) Maintenance Factor:

i) Outdoor area : (0.8 for LED)

ii) Indoor areas : (0.8 for LED)

b) Reflectance Factors:

i) Wall : 50%

ii) Ceiling : 30%

iii) Floor : 10%

c) Uniformity (Min. / Avg.) : 50% Minimum for indoor and 30% for outdoor

d) Color Temperature of the lamp shall be:

i. Indoor Areas : 6500K Minimum

ii. Outdoor Areas 5400K Preferably, but minimum 4000K

PROVISION OF GENERAL RECEPTACLES AND OTHER SERVICE OUTLETS

General Purpose switched single phase three pin 6 A and 16A receptacles (decorative type) shall be provided throughout.

The number of such outlets shall be as follows, unless additional numbers are required for specific loads:

6 A type one outlet per 6 m or part thereof of perimeter in offices;

6 A type one outlet per 20 m or part thereof of perimeter in all other areas;

16 A type one outlet per 20 m or part thereof of perimeter in offices;

16 A type one outlet per 20 m or part thereof of perimeter in all other areas.

The location of outlets shall be approved by the Engineer-in-charge. The spacing of 6 A and 16 A outlets shall be arranged to suit the intended location of equipment, desks etc.

These shall be in addition to the 6A or 16A dedicated Switch sockets provided for the Power equipments at their location of installation.

For Split Airconditioners 32 A, 1 Ph decorative Switch Socket shall be provided per equipment as suitable.

32 A switched three phase and neutral receptacles shall be provided in Switchgear room, where appropriate.

Receptacles for outside areas shall have a degree of protection of IP 65. Outdoor receptacles shall be provided in the landscaped area for grass cutting and other maintenance functions. Outdoor receptacles shall be provided in the stage area of the open-air theatre as per relevant standards or requirement.

For Office workstation area –

Two (2) Nos. UPS points (2 nos. of 6/10/13A Sockets with switches) and One (1) No. Raw power socket point (1 No. 6/10/13A socket with switch) is considered per workstation. Four (4) nos. of such workstations are considered on one single phase circuit of UPS workstation DB. Whereas, 8 nos. of raw power receptacles are considered on one single phase circuit of Raw power receptacle distribution boards.

Two (2) nos. RJ-11Telephone outlets shall be provided from the proposed Krone Box per Workstation.

Two (2) nos. RJ45 outlets for LAN connectivity shall be provided per Workstation connected by high speed Systimax Giga SPEED XL CAT-6 UTP cable or better option.

One (1) set of Three (3) Nos of 6/10/13A Sockets with switches shall be provided for every One and half (1.5) m table length along with Two (2) nos. RJ45 outlets for LAN connectivity& Two (2) nos. RJ-11Telephone outlets.

One (1) set of Two (2) Nos of 6/10/13A Sockets with switches shall be provided for Electronic Equipment like LED Screen, Printer etc. along with Two (2) nos. RJ45 outlets for LAN connectivity.

POINT WIRING

Internal point wiring to light point/Fan point/ Exhaust fan point/Call bell point with 1.5 sq.mm FRLS PVC insulated single core multistrand copper conductor of ISI marked with 20 mm dia non-metallic PVC conduit with 6Amp, 250V Modular switch ISI marked and ceiling rose ISI marked mounted on metal box having front Modular cover of suitable size, metal box with 1.5 sq.mm FRLS PVC insulated single core multistrand copper conductor as earth wire including all accessories and connection.

Lighting in external areas shall be installed using 1.1kV multicore armoured cable of suitable sizes.

The 6A light plug shall be installed with 2 x 2.5 sq.mm FRLS PVC insulated single core multistrand copper conductor of ISI marked with 20mm dia non-metallic PVC flexible conduit along with 1 x 1.5 sq.mm FRLS PVC insulated single core multistrand copper conductor for loop earthing as required.

The 16A power plug shall be installed with 2 x 4 sq.mm FRLS PVC insulated single core multistrand copper conductor of ISI marked with 20mm dia non-metallic PVC flexible conduit along with 1 x 2.5 sq.mm FRLS PVC insulated single core multistrand copper conductor for loop earthing.

Steel metallic conduit shall be used in case of false ceiling areas.

UPS AND BATTERY SIZING

UPS shall be rated with reference to the running load with a contingency of 10% and loading upto 80% for normal operation.

Battery sizing shall be done considering following factors:

Design Margin – 1.1

Aging Factor – 1.25

Temperature derating factor for 25 Deg C -1

EARTHING & LIGHTNING PROTECTION SYSTEM:

The safety earthing and lightning protection system will be generally on the basis of latest versions of the following codes and standards (including their latest editions).

IS 3043 -1987 (Reaffirmed in 2006): Code of practice for Safety Earthing

IEEE 80 - 2000.

IS/IEC-62305, 2013: Code of Practice for the protection of buildings and allied structures against lightning.

CEA Regulations - 2010: Measures related to safety & electric supply.

The fault levels considered shall be as follows:

System	Fault level in kA
a) 33kV System	As per BSCDCL/MPPKVVCL/ Local Power supply company source fault level, Minimum 25kA for 1 sec
b) 11kV System	As per BSCDCL/MPPKVVCL/ Local Power supply company source fault level, Minimum 20kA for 1 sec
c) 415V System	As per Transformer rating; it's percentage impedance and impedance of other network component for 1 sec

(*) CONTRACTOR to design on the basis of actual impedance & adequacy calculations for sufficiency of earth conductor size shall be provided.

Following factors shall be considered for sizing the earthing conductor:

Design Ambient Temperature	45°C
Allowable temperature rise for steel welded joints	500°C
Fault clearing time	1 Second
Overall earthing resistance	< 1 Ohm

Measurement of soil resistivity shall be done using Wenner's 4 electrode method as described in IS 3043 -1987 (Reaffirmed in 2006) including its latest amendment.

The soil resistivity of the proposed plot area has not yet been measured; the same should be carried out during detailed engineering by successful CONTRACTOR. Test reports shall be certified by Govt. Authorised Laboratory/ Institutes/ Agencies.

After soil resistivity measurement; no. of earth electrodes and no. of test pits shall be finalized based on these design criteria & the requirements specified in earthing requirements.

DRAWINGS/ DOCUMENTS FOR REFERENCE:

The electrical Single Line Diagram(s) form part of this specification and should be used for reference purpose only.

After the award of contract, CONTRACTOR has to get approval for the equipment selection along with the approval for sufficiency calculations.

GENERAL TECHNICAL & PARTICULAR REQUIREMENTS FOR ELECTRICAL, EQUIPMENT/ SYSTEMS:

HV TWO/ FOUR POLE STRUCTURE:

The design, material, construction, manufacture and testing of HV two/ four pole structures shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed.

Two/ four pole structures shall be erected to receive HV power supply from Power Supply Company/ Authority. The specifications for all the equipment and systems shall be supplied and installed in accordance with the prevailing standards and guidelines of the Power Supply Company/ MPPKVVCL

Each two/ four pole structure shall be inclusive of items listed below.

Two/ four pole structure

Insulators:

ACSR Conductor:

Drop Out (DO) Fuse Unit:

Station Class Lightening Arrestors

Insulators:

Chain Link Fencing and Gravel Filling:

Earthing

Gang Operated Device (offload Disconnectors -GOD) with earth switch

Accessories:

Each lightning arrester shall be furnished complete with the accessories as listed below:

Anti – contamination and pressure relief diaphragm complete with vent pipe.

Two (2) grounding pads.

Base plate suitable for mounting on G.I. / steel structure or concrete structure.

Line side terminal suitable for specified conductor.

Other standard accessories which are not specifically mentioned but are usually provided with lightning arrester of similar type and rating for efficient and trouble free operation.

Name plates fixed on lightning arresters giving full technical details.

The clamps and connectors on arrestor terminals for connection to PURCHASER's line conductor and the connection between incoming transmission line and LA will be in the CONTRACTORs scope.

All drawings/ documents such as GA drawing (Layout and all the Sections) of two/ four pole structure showing all equipment mounted on the structure, all the dimensions, technical particulars & Bill of Material etc shall be prepared and submitted to BSCDCL/MPPKVVCL for approval.

Similar approval shall be obtained from Power supply company/ Authority/ BSCDCL/MPPKVVCL before start of installation works and getting power released after completion of works from supply authority are also included in the scope of work.

Drawings/ documents to be furnished for BSCDCL/MPPKVVCL's approval:

Technical Particulars

GA drawing of LA indicating weight and overall dimensions

GA drawing of insulating base, discharge counter, terminal assembly

Bill of Material

Mounting arrangement (base plate details) on the structure

QAP for Lightning Arrester

POINT OF SUPPLY BREAKER – RING MAIN UNIT (RMU)

This POS Breaker may/ shall be provided if the PURCHASER's Transformer installations are away from the point of supply to the PURCHASER premises in accordance with the requirements of Local Power Supply Company/ BSCDCL/MPPKVVCL.

The RMU shall be located in a separate compartment inside the enclosure and shall consist of two (2) nos. Load Break Isolators and two (2) nos. Vacuum Circuit Breaker for Distribution transformer protection.

The RMUs shall be supplied in compliance with the latest BSCDCL/MPPKVVCL specification.

The RMU shall be compact, maintenance free, reliable, easy to install, safe and easy to operate and complete with all necessary accessories and spares. The design, material and manufacturing of the RMU shall be of the highest order to ensure continuous and trouble free service over the years.

The RMU components viz., Load Break Isolator and VCB shall be housed in robotically welded 3mm thick sheet metal enclosure with SF6 as insulating media and conforming to IP67. Above inner tank along with all other indication, measuring and protection components shall be enclosed in a compact metal enclosure made of galvanised sheet steel of 1.6mm thickness conforming to IP54.

Self sufficient Power pack with One (1) Hr backup shall be provided in each RMU to take care of the DC load requirements within the CSS.

System Particulars

Frequency:	50Hz ±3%
No. Of Phases:	3 Phase
Neutral Grounding:	Solidly Grounded
Fault level	As per the CONTRACTOR calculation for 1 sec
Internal Arc Tested	As per IEC 61641 for 1s

Max Ambient Temperature for design and temperature rise shall be 45ºC.

Equipment Particulars:

RMU type:	Non extendible type
Bus rating:	As per the CONTRACTOR calculation

Bus bar material: EC grade Copper

Load Break Isolator rating: As per the CONTRACTOR calculation

Load Break Isolator type: Motorised/ electrically operated Triple Pole with spring operated non automatic mechanism, quick break contacts with integral earthing arrangement. Interlock shall be provided between Earth and Main switch.

Breaker type: VCB

Breaker rating: As per the CONTRACTOR calculation

Breaker operation: O-3Min-CO-3Min-CO

CT ratio/ Class: 5P10

Protection relay: µP based IDMT relay with 2OC (10%-200%) and 1 EF (10%-40%).

The VCB shall be interlocked with the door Limit switches of the CSS compartments such that the VCB shall trip if the doors are opened.

The above requirements are project specific requirements. However, the same shall stand superseded as per Local Power supply Authority/ BSCDCL/MPPKVVCLGuidelines & requirements if required.

Voltage indications (VPI) and Fault Passage Indicators (FPI) shall be provided for all the RMU enclosure.

Testing and warranty terms for equipment and components shall be as per Local Power supply Authority/ MPPKVVCLGuidelines &requirements if required.

COMPACT SUBSTATIONS:

Each CSS shall typically consist of the following parts:

Metallic Enclosure with ventilation and rain/ dust protection as appropriate.

Ring Main Unit (RMU).

Dry type Transformer of respective rating with required accessories.

LT switchgear.

Power pack with One (1) Hr backup to take care of the DC load requirements within the CSS.

FRTU for remote access and monitoring.

All the above components of each CSS shall conform to latest relevant standards and specifications and requirements of Local Power Company if required.

Civil works for the preparation of equipment foundation, cable trench, earth pits electrodes, earth grid around CSS and chain link fencing with gate for each CSS shall conform to latest relevant standards and State electricity board specifications and requirements.

Electrical Works like HT/LT cable termination in the respective boards inside the CSS shall conform to latest relevant standards and specifications and requirements of Local Power Company if required.

All SAFETY considerations in design and manufacturing for safe operation & maintenance by PURCHASER personnel and safe practices during installation at site shall be in the scope of the CONTRACTOR. Cost towards accomplishing the same shall be included in the BID price and no extra claim shall be entertained later.

Equipments furnished shall be complete in every respect with all mountings, fittings, fixtures, and standard accessories normally provided with such equipment and / or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the Technical Specification unless included in the list of exclusions. Materials and component not specifically stated in the specification but which are necessary for commissioning and satisfactory operation unless specifically excluded shall be deemed to be included in the scope of specification and shall be supplied without any extra cost. All similar standard components/ parts of similar standard equipment provided shall be inter-changeable with one another.

The CONTRACTOR shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinated performance of the entire system. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

SYSTEM DESCRIPTION:

Compact Substations (CSS) to step down the power from HT to LT. Two CSS each capable of supplying complete load shall be installed.

The CSSs shall be looped in ring main in the open space within the plot area and shall be fenced around for safety and to avoid unauthorized access.

The LV Switchgear inside the CSS typically feeds the following types of loads:

Server, Workstation and other Electronic loads.

Ventilation loads

Building Common services loads including lifts; area/ street/ landscape/ lighting and fire& domestic water pumps.

CODES AND STANDARDS:

The design, manufacture and performance of equipment shall comply with latest applicable Codes of Standards.

All components as well as the CSS as a whole shall be Type tested in accordance with the above standards.

CONTRACTOR shall submit the type test certificates for Heat run test, Short circuit test and Ingress protection test for the CSS components of similar equipment.

SPECIFIC REQUIREMENTS OF COMPACT SUBSTATION:

ENCLOSURE FOR CSS:

The CSS shall be skid mounted, metal clad housing, single enclosure with modular construction housing with all necessary requirements as specified in this specification.

The enclosure shall have three distinct compartments with two distinct access isolated from each other for HT RMU, Transformer and LV Switchboard along with their respective accessories.

The CSS metal clad housing shall be fabricated of powder coated hot dipped galvanised CRCA sheet of minimum 4mm thickness for outer enclosure and base while minimum 2 mm thickness for the rest balance enclosure parts. The base frame shall be fabricated of Mild steel channel of minimum size ISMC 100 mm or suitable enough to bear the load of the entire components on ground as well as when lifted as one entity. The structure of the substation enclosure shall be capable of supporting the gross weight of all equipment.

Intermediate water proof ceiling roof shall be provided. A minimum clearance shall be left between the top of any component installed in the substation and the roof of the substation.

The enclosure shall conform to IEC 61330 standards, for Prefabricated Secondary Substation and must provide high level of personal safety by protecting all live parts against any accidental contacts either during commissioning, operation or maintenance. All electrical clearances shall be as per relevant Standards for HV as well as for LV. All doors and ventilation grills shall be earthed to provide a fully earthed enclosure for better personal safety.

All non galvanised parts of the enclosure shall undergo rigorous seven tank process before applying epoxy powder coating of designated shade of RAL 1001 (Cream). Base frame shall be painted Tar Black.

The CSS enclosure shall be dust and vermin proof suitable for outdoor application, compact and easily portable. Long lasting and durable Neoprene gasket shall be provided on all doors, cut outs, louvers etc. to achieve internal protection.

Access Doors of suitable/ convenient size for entry movement of respective components and humans in and out of the enclosure, shall be provided in each compartment with hinged construction with stoppers. All doors shall be provided with Pad locking and/or lock protected arrangement as well as an Internal Emergency handle so that door can be opened quickly in case of emergency.

The doors shall be provided with proper interlocking arrangement with the VCB for safety of operator.

Aluminium grilled Louvers with dust and vermin filter suitable for carrying out natural ventilation and adequate for limiting the temperature rise shall be provided in each compartment of the enclosure.

The enclosure shall conform to IP55 for RMU and LV compartment while the transformer compartment shall conform to IP23. The entire enclosure shall confirm to temperature class K10.

All cable entry shall be from Bottom. All the trenches below shall be at least 800mm wide.

Climate proof connection equipment shall be used to avoid leakage current and flashovers due to moisture/ condensation/ dust.

CONTRACTOR shall submit the following type test reports carried out on the CSS.

Temperature rise inside the enclosure

Internal Protection Class

Anodized Aluminium Sheet labels shall be provided in all the compartments identifying the systems/ sub-systems inside/ outside the enclosure as per state electricity board requirements or else with black engraving on white background of appropriate size. Danger boards on Anodized aluminium plate shall be provided on all Doors as well as on all four sides of the enclosure.

Two (2) nos. 18W CFL Lighting fixtures along with lamp, and protection MCB shall be provided in each compartment. The power for the same shall be tapped from the LT side of the CSS.

One (1) no. Self contained, Non Maintained, Emergency lighting luminarie suitable for 1x20W FTL with 3 hr backup & sealed rechargeable Ni-Cd batteries (high temperature type) shall be provided in each compartment for Emergency lighting. Suitable charging point with 5A switch socket shall be provided for each such luminaire.

The supply for all accessories like lighting within the CSS shall be tapped through DP MCBs in order to restrict the fault level within that of available MCBs.

All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation, by way of flexible jumpers/strips & Lug arrangement. The continuity of the earth system shall be ensured taking into

account the thermal & mechanical stresses caused by the current it may have to carry. The components to be connected to the earth system shall include:

The enclosure of Package substation, doors, ventilators etc.

The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose.

The transformer tank or metal frame of transformer & transformer neutral.

The frame &/or enclosure of low voltage switchgear.

RING MAIN UNIT (RMU) FOR CSS

The specifications of the RMU shall be similar to the specifications mentioned above in Item 6.2.

The RMU shall consist of Two Load Break Switch (LBS) and Two Vaccum Circuit Breaker (VCB) housed in an enclosure as specified above.

The Breaker and the components like energy meter and relay shall be SCADA compatible for remote control and operation.

Field Remote Terminal Unit (FRTU) shall be provided for the remote monitoring and control if required.

FIELD REMOTE TERMINAL UNIT (FRTU)

The Compact Substation remote control interface shall include all the functions required to monitor and control HV/ transformer/ LV cubicles.

The FRTU Architecture shall support convenient installation, maintenance and expansion features. The Architecture shall include a central processing module; and Digital and Analogue I/O modules.

The Central Processing Module (CPM) shall be suitable to handle all types of communication protocols, perform data acquisition, perform address recognition, receive command messages, assemble response messages and execute control requests. The CPM shall have an internal Real Time Clock for data collection coordination and time tagging and provide time synchronization accomplished by IEC 104 protocol.

The CPM shall effectively communicate with main SCADA as well as its peer FRTUs for fault detection and control operations over the same structure as the main SCADA.

The required no. Of I/O modules shall be decided by the Bidder.

Each Digital and Analogue I/O module shall be capable of interfacing with the respective inputs and outputs. These I/O modules shall be replaceable without reprogramming, reconfiguration and rewiring.

A control disable switch shall be provided with each module with its status indication so that when the switch is put off the control outputs shall be disabled.

IEC 870-5-101 / 104 or an open protocol shall be provided to transfer information to control center SCADA.

Modbus protocol shall be used to communicate with MFM (Multi Functional Meters) on RS485 provided in the LV incomer of the LV switchgear if the CSS.

The control unit shall have following communication ports:

Two Ethernet port for interfacing with the IP compatible communication equipment.

One RS232 Console port and for connecting external modem.

Required no. of RS485 port to connect field IED's / Energy Meters on RS485.

It shall be possible to increase the number of communication ports in the FRTU if required in Future.

Following Functions shall be provided by the FRTU;

Monitoring and control of medium voltage cubicles

Detection of faults and shall be adjustable for carrying out the setting as per requirement

Load current measurement on the line fitted with a fault detector

Data transmission to the remote control centre

Chronological time-stamped event recording

It shall be possible to view LBS/breaker status from the front mimic of FRTU

It shall be possible to issue control command from the front panel of the FRTU with security button

It shall be possible to retrieve and display on a PC the time-stamped events recorded at the enclosure

The minimum storage capacity shall be 50000 events

The FRTU shall have remote or local control mode switch on its front panel
In remote control mode, the enclosure shall ensure:

Transmission of remote measurements and time-stamped events

Possibility of electrical remote control

Inhibition of local electrical control pushbuttons

In local mode, the enclosure shall ensure:

Transmission of remote measurements and time-stamped events

Possibility of local electrical control of opening and closing operations by simultaneously pressing a pushbutton to select the unit to be operated and a validation pushbutton

Inhibition of opening/closing remote control

CAST RESIN DRY TYPE TRANSFORMER (CSS)

The CONTRACTOR shall design, manufacture, install, test and demonstrate the performance of the equipment as specified in the IS Standards/ statutory requirement / State Electricity Board or Power Supply Company specification, guidelines and requirements.

3 Nos. resistance winding temperature detectors/ thermistors shall be provided. These shall give alarm at 110 deg.C and give trip signal to trip the transformer incoming breaker at 120 deg.C through RTDs/ Thermistor or suitable for temperature rise limited for Class B.

All routine tests shall be carried out as per IS: -11171 and IEC 726 at manufacturer's works with complete assembly in presence of PURCHASER or his representatives.

System conditions are similar to those specified for RMU above.

Equipment Particulars:

Voltage Ratio:	11 or 33 /0.433kV
Frequency:	50Hz ±3%
No. Of Phases:	3 Phase
Neutral Grounding:	Solidly Grounded
Cooling:	Natural Air cooled - AN
Vector Group:	DYn11
Tap Changer:	-5% to +5% in steps of 2.5%
Type of tap Changer:	OCTC
Winding	Electrolytic Cu conductor

Class of Insulation	Class F
Temperature rise	Class B
No load current:	1.5% of full load current
Max flux density:	1.55T
Current density:	Max 1.4 A/sq mm
Losses:	As per Standard requirements (ECBC 2011)
Impedance @75ºC	As per Standard requirements
Constructional requirements:	As per Standard requirements.
Clearances:	As per relevant standards.

Bidders are encouraged to quote for energy efficient design.

Windings shall be of copper only. The thermal expansion coefficients of the insulation used shall be close to copper conductor, so as to achieve maximum thermal reliability, i.e. the thermal stresses due to load changes shall be minimum.

Fuse less design shall be implemented for control cabinets. MCB/ MCCB of suitable rating shall be used in place of HRC fuses.

The magnetic circuit shall be constructed from high grade cold-rolled non-ageing grain oriented silicon steel laminations with non-hygroscopic insulation material on both sides. The magnetic circuit shall be of “core type” construction. The core shall be built up with ‘step-lap' configuration to have lower no-load losses, no-load current and noise level. The grade of laminations shall be as per DIN/applicable standards.

Lifting eyes or lugs shall be provided on all parts of the transformer, which require independent handling during loading/ unloading, assembly or dismantling.

HV Winding shall be of Copper wire, foil-disc type construction for withstanding high voltages & impulse, linear voltage distribution, double layer winding, and cast under vacuum with a mixture of pure silica (quartz) and specially blended epoxy resins.

LV Winding shall be of Copper foil, coated with class F insulation, epoxy resin reinforced with fibre glass layers pre-impregnated and casted under vacuum, to be thermally bound to the winding.

Transformer shall be certified for following:

Class F1 : - “Fire Behaviour”

Class C1 : - “Climatic”

Class E1 : - “ Condensation and humidity”

K factor : K 9

Transformer shall have very low partial discharge level (< 10pC).

Two Nos. separate earthing pad / terminals shall be provided on the HV cable termination box for armour earthing from inside and for PURCHASER’s grid connection from outside. Earthing strip from earthing bushings up to earthing terminal shall be provided.

For all dry type transformers following safety interlocks shall be provided:

A safety interlock shall be provided to ensure that the enclosure door can be opened only when transformer is de energised.

Safety limit switches operated by door handle shall be provided for tripping primary & secondary side breaker. Door handle operated safety limit switch should have with 1 NO. + 1 NC contact.

Max Ambient Temperature for design and temperature rise shall be 45ºC.

The loss figures shall be as specified in the latest standards or as specified by the State Electricity Board or Power Supply Company whichever is more stringent.

Average winding temperature rise over ambient temperature of 45º C shall not exceed 65 º C measured by resistance method.

Core, Metallic parts and adjacent material shall in no case reach a value that may damage these materials or reduce their life expectancies.

Current density of the HV & LV windings shall not be more than 1.4A / sq mm.

Noise level of transformers shall be as per NEMA standard.

LV SWITCHBOARD FOR CSS

The LV Switchboards housed inside the CSS enclosure shall be as per the requirements of this specification.

All panels shall be Type tested in accordance with IS 8623/ IEC 61439-1 and Arc resistant tested in accordance with IEC 61641-part 500, supplement 2 for 0.3sec minimum.

The metal enclosed switchgear shall be designed to operate continuously with reference of ambient temperature of 45ºC without any de-ration.

The equipment shall be designed and manufactured in accordance with the best engineering practice and shall be such that has been proved to be suitable for the intended purpose.

Provision for interlocking of LV Incomer breaker with HV side breaker shall be provided such that if the HV breaker trips then the LV breaker will trip and it shall not be possible to close the LV breaker unless the HV side breaker is closed.

Constructional Requirements:

Constructional requirements of the LV panel inside the CSS shall be similar to that specified for the other LV panels below.

One no. Circuit Breaker shall be provided with Microprocessor based Overload/ Short Circuit and Earth Fault (Inbuilt) releases.

Adequate space shall be provided for terminating the outgoing cables.

INSTALLATION OF CSS

All installation works shall be carried out by Manufacturer's trained/ skilled personnel and supervised by Manufacturer Certified/ Approved Engineer as per good and safe engineering practices and relevant standards for installation of particular components.

All routine and pre-commissioning tests shall be carried out by certified engineer of CONTRACTOR at site and test reports shall be submitted duly signed and stamped. This is included in the scope and quoted price offered by CONTRACTOR. Proper tools for unloading/ lifting and erection shall be arranged by CONTRACTOR.

All testing equipments and set ups shall be arranged by CONTRACTOR. This is included in the scope and quoted price offered by CONTRACTOR.

Proper unloading, handling, storage and security arrangement of all the materials/ equipment supplied are included in the scope and the CONTRACTOR shall ensure the same without any additional extra cost to the PURCHASER.

Assembly of the various sections of the equipment, either free issue by PURCHASER or supplied/ procured by CONTRACTOR, dispatched separately from the factory shall be in the scope of CONTRACTOR.

Installation shall be considered as being the erection of equipment at its permanent location. Thus, unless otherwise specified, shall include shifting from place of storage to the place of erection,

unpacking, cleaning, assembly and lifting into position, grouting, leveling, aligning, coupling of or bolting down to previously installed equipment bases/ foundations, performing the alignment check and final adjustment prior to initial operation, testing & commissioning in accordance with MANUFACTURER's tolerances, instructions and the specifications.

It is expected that equipment/ systems shall be installed as per the best engineering practice and in strict accordance with the MANUFACTURER's recommendation(s). PURCHASER shall have full authority to reject all/ any portion of the work that is considered bad in quality or workmanship. The rejected work shall be made good by the CONTRACTOR free of cost. In this regard the decision of PURCHASER would be final and binding

Pre-commissioning checks and final commissioning of the equipment's being supplied by the PURCHASER or the equipment/ system supplied by the CONTRACTOR shall be carried out as per the provisions of this specification, relevant standards, MPPKVVCLGuidelines and MANUFACTURER's erection / commissioning manual.

CONTRACTOR shall submit site test reports & its test procedures; details of test equipment used etc. in printed format with sufficient no. of copies along with originals duly signed & stamped by appropriate authority as may be decided by relevant Statutory Bodies.

CONTRACTOR shall maintain necessary co-ordination with the PURCHASER and various other agencies working at the same site as the CONTRACTOR.

MAINTENANCE REQUIREMENTS:

Easy access shall be provided for all components in the CSS for maintenance.

The CONTRACTOR shall furnish operating and maintenance instructions manual to enable the PURCHASER to carry out maintenance of the equipment effectively and safely after the defect liability period.

As far as possible the components & switchgears shall be so designed that no special tools are necessary for installation and maintenance. However, if special tools are required, the CONTRACTOR shall include price of one complete set in his BID and indicate the same for PURCHASER's approval.

CONTRACTOR shall furnish detailed inter panel wiring diagrams, internal wiring diagrams, detailed component layout drawings to enable the PURCHASER to carry out maintenance work the defect liability period.

Consumable required for installation like greases, jointing compounds or pastes, etc. shall be supplied along with the equipment including 10% extra and their prices shall be included in the offer. Detailed technical descriptions for future purchase shall be also submitted.

PERFORMANCE TESTS:

Prices quoted shall include the cost of all Type & Routine tests as per relevant IS standards.

CONTRACTOR shall carry out all Type, Routine and Functional tests as specified in the relevant IS standard requirements on the completely assembled components of the CSS (RMU, Transformer and LV Panels) in the presence of the PURCHASER's representative or/ and BSCDCL/MPPKVVCLrepresentative as may be decided later, at its/ sub vendor's works before despatch and furnish copies of test reports for approval.

CONTRACTOR shall furnish copies of Routine and Type test report for all bought out items, as may be demanded by PURCHASER, for approval during the inspection or prior as instructed by them.

The CONTRACTOR shall also make available at works as well as at site various instruments, meters etc. necessary for testing and commissioning of the equipment under scope of work duly calibrated within not more than one (1) year from accredited laboratory.

LV PANEL BOARDS (TTA Panels)

GENERAL:

The scope of this specification includes design, engineering, manufacture/ assembly, installation, testing and performance demonstration of the LV Panel boards for various sizes and ratings to be provided for the distribution of the power supply in the Command Center.

The panels include

Power Control Center with two transformer and one DG incomer and bus couplers (PCC)

Auto Power Factor Control panel (APFC)

UPS Distribution Board

Wall mounted Distribution Board for

Lighting Panels (LP) for lighting fixtures

Raw Power DB for receptacles (RDB) for general and dedicated raw power points

UPS sub DB (UPS SDB) for workstation

Emergency Lighting Panels (ELP) for critical lighting

Outdoor Lighting Panel (OLP) for outdoor lighting

Any other Panels and Distribution Boards if deemed required for the proposed scheme of power distribution for the center may be added appropriately.

Each switchgear shall be complete with all fittings and accessories, drawing details, quantity shall be brought to PURCHASER's notice at the time of bid submission only.

Protection circuits, control wiring and interlock circuits not specified, but deemed necessary for the safe operation of the system shall be provided without any additional cost to complete the system.

APPLICABLE STANDARDS:

The design, manufacture and performance of equipment shall conform to the latest standards specified below. In case of conflict between standards and this specification, this specification shall govern.

Metal enclosed switchgear- General requirements	IS: 3427
Factory Built Assemblies of SWGR and control gear for Voltages up to and including 1000V AC & 1200VAC	IS: 8623 / BS: 5486 / IEC: 439
Air Break Switches	IS: 13947-P3 / BSEN6049 / IEC: 947-3
Miniature Circuit Breakers	IS: 8828 / BSEN: 60898
Low Voltage Fuses	IS: 13703 / BS: 1362 / IEC: 269-1
Contactors	IS: 13947/ BSEN: 60947 4 / IEC: 947-1
Starters	IS: 13947/ BSEN60947-4/ IEC: 292-1 to 4
Control Switches & Push buttons	IS: 6857 / BSEN: 60947
Current Transformer	IS: 2705 / BS: 7626
Voltage Transformer	IS: 3156 / BS: 7625 / IEC: 44, 186
Indicating instruments	IS: 1248 / BS: 89 / IEC: 51
Marking and Identification of Conductors and Apparatus Terminals	IS: 11353 / BS: 159

A.C. Electricity Meters	IS: 722, 8530 / BS: 5685 / IEC 145,211
Degree of Protection	IS: 13947 / IEC: 947-P1
Selection installation and maintenance of switchgear and control gear	IS: 10118
Code of practice for phosphating iron and steel	IS: 6005 / BS: 3189
Specification for copper rods and bars for electrical purposes	IS: 613
Control transformers for switchgear and control gear voltage not exceeding 1000V AC	IS: 12021

CONSTRUCTIONAL REQUIREMENTS:

Sheet Metal Works Requirement:

Main PCC panel board shall be free standing, metal enclosed, single front, compartmentalised fabricated with 2mm CRCA sheet steel for all doors, partitions and covers and 2.5mm CRCA sheet steel for load bearing sections.

All indoor panels shall be minimum IP42 certified.

The gasket shall be suitable to withstand all weathers for long tenure of service.

All hardware shall be HD Galvanized or stainless steel.

All panels shall conform to FORM 4B as per IS 8623: 1993, Part I.

Each door & cover shall have adequate reinforcement of suitable ribs & stiffeners.

All feeders and cable alleys shall have hinged type door with panel locks. All such doors shall open min 105 deg. All bus-bar covers and other panel covers shall be screw fixed. Cable alleys and bus-bar chamber shall have minimum width of 300mm.

All doors shall be with concealed type hinges and captive screws. Rear doors of panels requiring rear access shall be provided with removable hinged doors. Side covers of panels shall be with removable panels.

All doors shall be provided with durable and easy fitting locks with special keys to ensure opening by authorised personnel. Rubber grommets shall be provided at the cable entry.

All mounting accessories like base channels, cross angles if required, nuts, bolts etc. shall be supplied by the vendor.

All free standing panels shall have uniform height. The operating height of all the panels shall not be less than 300mm and more than 1900mm.

All the panel boards shall have cable entry from bottom. Gland plate (can be Split) of 2mm thick shall be supplied for termination of power, control and instrumentation cables sized as per the required no. of cable and 20% spare space for future addition.

The exposed bus live parts in the cable alley shall be totally covered against accidental contact by a shroud (and not by sleeve) to protect the workmen working on the switchgear. The protection shall be minimum IP20 inside the entire panel. A protective wire mesh with mesh size conforming to IP20 shall be provided in the busbar chambers to avoid direct contact with the bus while accessing them during maintenance and to make it vermin proof.

Separate metering compartment for incomer shall be provided for all analogue / digital meters and its accessories like load manager, voltmeter, ammeter, indication lamp, Voltmeter and ammeter selector switch etc. All wiring & MCBs shall be mounted in metering compartment such that meter maintenance is independent of the power compartments.

All fabrication work like cutting, drilling, punching, shearing & welding etc. Related to switch board shall be complete before proceeding to 7 tank process. All interiors and exteriors of switchgear enclosure shall be finished and painted to prevent rusting and corrosion.

Sheet metal components shall be pre-treated using the seven tank phosphating process consisting of de-greasing, acid pickling, de-rusting, phosphating and passivation including repeated rinsing in between each process. On completion of passivation of the components they shall be preheated and then epoxy powder coated with Siemens grey RAL 7035 shade for exterior as well as interior and Glossy White shade for the gland plates (Inside the panel) and component mounting plate. Thickness of all painting shall be minimum 80 - 100 microns DFT.

Bus-Bars:

All bus-bars shall be electrolytic grade Aluminium. CONTRACTOR shall specify the purity and conductivity of the bus bar along with the BID.

All the bus bars shall be sleeved with heat shrinkable Black colour PVC sleeve or better insulation with coloured polyester tapes for phase identification at regular intervals/ locations.

CONTRACTOR shall submit all calculations & documental proof of the adequacy of the bus bar sizes to meet the continuous and short time current ratings specified for approval during procurement/ manufacturing.

Main Horizontal bus-bars of PCC above 2000A with Aluminium bars shall be interleaved type if required. Vertical bus-bars shall have S.C. rating same as main bus bar and shall be suitable for all connected load of vertical section.

CONTRACTOR shall ensure that incoming feeder shall be suitably designed for terminating the required no. of runs of 1.1kV grade XLPE insulated armoured cables with 20% spare capacity. CONTRACTOR shall consider the necessary arrangement (dummy panel, adapter panel, rear extension etc.) if required, for terminating the cables within the limits specified above.

Bus bar supports shall only be SMC irrespective of bus bar size. The span between the two insulators shall be as per the approved TYPE TEST REPORT for short time rating. Joint positions and insulators shall be properly adjusted so that they don’t interfere. Bus bar bending shall be carried out on appropriate machines designated for the same rather than doing manually.

Neutral bus-bars of different panel boards shall be as per the required standard.

All bus-bar shall be treated with anti-oxide paste wherever bi-metallic contact is required.

Earthing:

Earth bus bars of Aluminium material shall be run all along the panel, extended out at both ends of value equal to the rated symmetrical short circuit rating of the associated switchboard/ panel. The same shall be properly supported to withstand stresses induced by the rated symmetrical short circuit current.

Earthing bus-bar shall be terminated at both ends of the switchgear to suit the connections to PURCHASER’s earthing conductor. The locations where the bus are protruding out of the panel boards, CONTRACTOR shall ensure that proper ingress protections are provided at all such locations.

All doors and detachable components inside the feeder are required to be earthed individually with green (with yellow band) colour PVC insulated multi stranded copper conductor wire of size 4 sq.mm duly crimped with ring type lugs and are to be looped & connected to horizontal earth bus.

Earthing bus shall be run continuously in panel drawn out suitably considering respective cable entry inside the panel.

Separate Al earth bus shall be provided at each cable alley for all the panels.

Power Wiring (Inside The Feeder):

All power wiring for rating upto and including 63A shall be carried out with 1.1kV grade coloured HFFR/ FR PVC insulated, coloured for phase identification, multi stranded copper wires duly crimped with ring type lugs.

Power connections for rating above 63A shall be done with AL bus bars (machine bend for proper profile) insulated with black heat shrinkable sleeves with phase identification coloured tapes duly supported on SMC insulators and placed with required minimum clearance of 25mm between phases and between phase to ground/ neutral. Such bus when brought out of the feeder for cable connections shall be sufficient enough and profiled suitable for termination of the prescribed number of cables.

Control Wiring (For Panel And Feeders):

All panel Control wiring shall be done by 1.1kV grade HFFR/FR PVC insulated multi-stranded copper wire. CT circuit wiring shall be done with minimum 2.5 Sq.mm size wire of above specification. Control and Potential circuits shall be wired with minimum 1.5 sq. mm size wires of above specifications. Wires shall be gray coloured with suitable crimpable copper lugs. CT's & PT's wiring shall be colour coded for multi-phase identifications (R-Y-B-N).

Panel wiring & cabling shall be cross-ferruled. Ferrules shall be printed type.

Terminals:

All the Terminals shall be Polyamide type. Sliding link type CT shorting terminals shall be provided for CT connections & screw / stud type terminals shall be provided for PT connections & other control circuit wiring.

All unused auxiliary contacts of circuit breakers, protection, auxiliary, control relays shall be wired up to terminal block. The terminal blocks shall be located suitably spaced from each other and atleast 200mm from the side/ bottom wall or any adjacent feeder component to provide better convenience for running the wire troughs and termination of the control cables.

All panels shall have Terminal block suitable for connecting minimum 6sq.mm. conductor unless otherwise stated.

20% extra terminals shall be provided for power as well as control for PURCHASER's use in each terminal strip/feeder.

GENERAL REQUIREMENTS:

The panel shall be Internal Arc tested in accordance with IEC 61641 for minimum 0.3s.

The panel shall conform to fuse less design except for the semiconductor fuses used for protection of devices and cards and HRC fuses for protection of Control transformers. ACB/ MCCB shall be provided for all outgoing and incoming feeders as per the rating.

DP MCB shall be provided for all control circuits where the fault level is less than 10kA. Else the control supply shall be tapped through a control transformer of adequate capacity supplied with MCCB/ MPCB/ SFU of adequate short time rating. Independent DP MCBs shall be provided for each circuit such that tripping due to fault in one circuit should not affect other functions adversely.

Where control transformer has been provided, a separate control bus shall be run maintaining adequate clearance of atleast 300mm from the power bus with provision of tapping at each vertical column section. The control bus should be preferably a bus bar with Heat shrinkable sleeve.

Self explanatory Wiring diagrams with terminal and wire numbers, component numbers shall be provided on the inner face of the door of each feeder. Drawing set in the panel shall be laminated.

All labels for identification of feeders as well as internal and external components as per legends provided in the approved drawings shall be on white acrylic sheet with black engraving. These labels shall be fixed by screws/rivets and shall not be pasted.

Aluminium etched 415V Caution boards written in three languages (English, Hindi & Gujrati) shall be riveted on the panel on all four sides at locations where live bus bars are present and need isolation before any access to it. In case secondary covers have been provided inside the panel, then caution boards shall be also marked on these boards in addition to the external covers.

Selector/control switches shall have an 'Off' position. The 'Off' position shall not be wired in any circuit and shall be utilised to disconnect (or bypass) power supply to control circuit for any maintenance work.

All hardware e.g. Nuts, bolts & gasket, anchor fasteners etc, are included in the VENDOR's scope. No separate claim shall be entertained, in this respect. Atleast 10% extra hardware shall be provided for any installation/fixing work. This is to ensure ready availability of hardware in case of loss of some hardware during installation.

Start push button shall be recess type, spring return. Stop push button shall be stay-put lockable type. The pushbuttons shall be dust and vermin tight.

All electrical panels (internal components & arrangement) shall have finger touch protection, for human safety viz. working on one component shall not cause shock to the personnel due to any other live component in the panel. Also, the terminal live parts shall not be accessible by fingers (finger cannot come in contact with live parts of the terminals).

No openings/ holes meant for fixing hardware shall be left open. All the hardware (esp. screws, nuts, bolts, and washers) shall be in all appropriate positions & properly tightened.

Phase separators, shrouds, falling tool barriers shall be suitably provided. Any additional requirements as observed at any stage upto handing-over shall be provided (for safety and ease of maintenance) without any cost implication to the PURCHASER.

All PVC/engineering plastic based items (including but not limited to conduits, casing-capping, trough, trunk, enclosures, covers, plugs, etc) shall be with FR properties.

Lifting hooks/eyes shall be provided in each shipping section of the equipment and shall be removable type.

The equipment shall be given tropical and fungicidal treatment.

Insulation mat of suitable standard width shall be provided in front of the HV and LV panels.

Atleast one 230V, 1Ph, Space heater shall be provided for each vertical section of the switchboard. Each Space heater shall be provided with an isolating switch, a thermostat and dedicated MCB protection of appropriate rating. Heater shall be mounted at bottom of the panel with cover to avoid accidental contact of heater with skin.

230V 1Ph, Panel illumination (11W CFL fixture with lamp, limit switch and isolation switch) along with 1 no. 5/15A 5 pin socket with switch shall be provided for each vertical section. Bare holder with open lamp is not acceptable. Interlock with the Door limit switch shall be provided

EQUIPMENT REQUIREMENT:

Continuous Rating at design ambient temperature as specified elsewhere in the tender; configuration of poles, operation mechanism and short time rating of each Circuit breaker (ACB and MCCB) for the panel along with all the specified releases, switches, push buttons and indication lamps etc shall be as per SLD.

Earth fault release for 4 pole breakers microprocessor based release shall be inbuilt in the release. However, for three pole breakers, suitable earth fault module with CT on neutral shall be considered along with shunt trip. These provisions shall not affect the provision of indication lamps or remote communication module.

For Distinct Fault Indication, required voltage supply shall be derived from the existing control supply by VENDOR.

415V switchgear panels shall have MCCBs upto 400Amp and ACB shall be considered above that.

All ACBs shall be in draw-out modules. ACBs shall be rated for 415 V, 50 Hz, with minimum 6 NO and 6 NC auxiliary contacts rated 10A at 230V. The breaking capacity shall be rated for 1sec for symmetrical short circuit current (Ics = Icu =Icw = 100%).

Air Circuit breakers (ACB) shall be operated by a motor spring charging type of mechanism. The tripping spring shall be charged by the closing action, to enable quick tripping. Closing of the circuit breaker shall automatically initiate recharging of the springs to enable the mechanism to be ready for the next closing stroke. Charging time for the springs shall not exceed 30 seconds. It shall be possible to manually charge the springs in an emergency. Transfer from motor to manual charging shall automatically disconnect the charging motor. The charging mechanism shall be provided with mechanical indicators to show "charged" and "discharged" conditions of the spring. Failure of any spring, vibration or mechanical shock shall not cause tripping or closing of the circuit breaker. All operating mechanisms shall be provided with "ON" - "OFF" mechanical indication.

The trip coil and closing coils of ACBs (230 V AC) shall operate satisfactorily under the following conditions of supply voltage.

Closing coils 85 % to 110 % of rated voltage

Trip coils- 70 % to 110 % of rated voltage.

All MCCBs shall be rated for 415V, 3 Ph, 50Hz. MCCBs shall be of the air break, quick make, quick break and trip free type and shall be totally enclosed in a heat resistant, moulded, insulating material housing. The service breaking capacity of all the MCCBs shall be for 1sec for symmetrical short circuit current (ICU =ICW = 100%).

The ACBs & MCCBs shall be suitable for remote communication (SCADA control).

For ACBs, 6NO + 6NC and for MCCBs 2NO + 2NC potential free contacts for PURCHASER’s use in addition to those required for control and indication shall be provided. If any contact multiplication is done, it should be done by an auxiliary relay and not by contactor.

All the MCCBs shall be of current limiting type and shall provide a cut off in, < 10 ms for prospective currents during faults. Necessary auxiliary contact block for provision of auxiliary contacts is included in scope. The CONTRACTOR shall ensure co-ordination between upstream & down- stream ACB/MCCBs.

All MCCBs shall be provided with rotary handle with door interlock and extension links/ spreaders with proper shrouds.

All protective components esp. ACBs and MCCBs installed in PCC and at Incomer of downstream Panels shall be with Utilisation Category "B" (i.e. offering time discrimination with downstream devices).

Protective releases shall be EMC compliant. The release shall be protected against non-linear loads and shall not cause nuisance tripping due to harmonics.

All instrument transformers shall be cast resin type and shall have insulation of class B or better.

Current transformers shall have polarity markings indelibly marked on each transformer and at the lead terminations at the associated terminal block.

Current transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary duties of the switchgear, as indicated in the Technical Specification. CT core laminations shall be of high grade silicon steel. Identification labels shall be fitted giving type, ratio, rating, output and serial numbers.

It shall be entirely the responsibility of the CONTRACTOR to ensure that characteristics of CTs, VTs and all other devices offered by him are such as to be suitable for the purpose for which they are intended.

Transient Voltage Surge Suppressor (TVSS) shall be provided at the incomer of LV panel before the incoming breaker. TVSS shall be provided suitable for the fault level of the LV panel.

Electrical analogue indicating instruments shall be 96mm square with 240º scale. Taut band type of instruments is preferred. Instrument dials shall be white with black numbers and lettering. Instruments shall have an accuracy of Class 1.0.

Indicating lamps shall be of the Multi chip LED type with low watt consumption. Indicating lamp shall be of the double contact, bayonet cap type rated for operation at 240 V AC. Lamps shall be provided with translucent lamp covers.

"Start" and "Stop" push buttons shall be colored green and red respectively. Stop Push Button shall be lockable stay-put type with Mushroom head.

Multi Function Meter shall display all electrical parameters like (but not limited to) current, voltage, kW, kVA, KVAr, kWH, MD, PF, F, ITHD, VTHD etc. and shall have provision for remote communication with SCADA.

The switchgear shall be complete with all equipment such as CT, VT, switches etc. duly wired up to terminal blocks. Terminal blocks shall be located at suitable place for easy access. CT shorting, isolating terminals shall be provided for CTs and isolating terminals shall be provided for VT connections. Twenty (20) percent spare terminals shall be provided in each cubicle. Ring type lugs suitable for termination of 2.5 sq mm copper wires shall be used.

SPECIFIC REQUIREMENTS OF PCC PANEL:

In the PCC panel, the Transformer incomer breakers, the Bus coupler breaker, and the DG incomer breaker shall be electro-mechanically interlocked in a scheme such that no two supply source clash with each other.

CONTROL CIRCUIT:

Following control voltages shall be provided in all the panels;

All ACB/MCCB tripping- Direct acting releases/ Shunt trip coil 230V AC

All ACB/MCCB closing- 230V AC

All ACB closing motor - 230V AC

Indications - 230V AC

Space heater, Panel lamp, Aux Plug-Socket etc. - 230V AC

Control supply for tripping and closing circuit of incomer breaker and outgoing breakers shall be tapped from incoming and outgoing bus respectively.

Control supply for metering of the outgoing feeders shall be tapped from either one point on outgoing bus or from the respective feeders.

Power supply for space heater, panel lamps and spring charging motors shall be tapped from the incomer of the panel.

Necessary mechanical interlocks shall be provided for transformer breaker, DG breaker, the Bus-coupler.

In location of PCC panel and thus the Electrical Room shall be in concurrence with the Fire Officer's requirement of Local Isolation in case of Fire.

SPECIFIC REQUIREMENT OF WALL MOUNTED PANELS

The Normal Indoor Lighting Panels (LP) shall be of industrial type, totally sheet steel enclosed of 2mm thick, double door construction, fully dust and vermin proof, wall/column mounting type with a degree of protection of IP – 52. Outdoor panels shall be weather proof type with IP – 54 degree of protection. The boards shall have welded back and sides and hinged door with gasket at the front with door handle and suitable locking device. Detachable cover plates shall be provided at the top and bottom for cable/conduit entry and suitable knock out shall be provided for this purpose. The Lighting panel after fabrication shall be subject to rust removal treatment and provided with epoxy powder coating followed by baking. The board shall have 2 No. earthing terminals suitable for 25mm X 6mm GI flat and mounting arrangement for wall/column mounting.

Critical Lighting panel (ELP) shall be wall/ structure mounted, 1 phase 230V 50Hz, powder coated double door construction of 2.0 mm thick sheet steel enclosure, conforming to IP52 protection for indoor installation, with DP ELMCB (30mA sensitivity) Incomer, and required Nos. of SP MCBs as outgoings duly wired with copper PVC insulated wires and terminals. All emergency lighting shall be controlled directly from the respective LP.

Raw Power Distribution Board (RDB) shall be similar in construction to the LPs. The board shall be 3 phase and neutral, 4wire type. The board shall have current limiting type 3 pole (TP) MCCB with

OL/SC/EF release as incoming feeder; adequate nos. of three pole (TP) and single phase (SP) MCB outgoing circuits.

Protective cover plates shall be provided inside the board to shroud all the live parts with only the operating knobs of MCBs protruding outside the cover plate. Adequate space shall be provided within the board to facilitate termination of incoming and outgoing multi core cables. The board shall be factory assembled and wired with HFFR/ FR/ FRLS insulated stranded copper wires. The MCB phase feeders shall be suitable for mounting on the DIN rail provided in the board. Tinned copper bus bar shall be used in the board.

20% spare outgoing circuits shall be considered per phase in each LP as spare.

HPFC CAPACITOR PANEL:

Scope comprises of Design, fabrication, assembling, wiring, supply, installation, testing and commissioning of HPFC (hybrid power factor correction) panel having IGBTs, microprocessors, capacitors, reactors and other associated accessories, as explained below.

The system shall be designed as per IS 16636. The degree of protection of enclosures system shall be IP42 in accordance with IEC 60529.

The HPFC panel shall be controlled through a single integrated controller for both Active and Passive part.

Operation Philosophy:

Active Harmonic Filters (AHF) shall employ digital logic and IGBT semiconductors to synthesize a current waveform that is injected into the electrical network to cancel harmonic currents caused by nonlinear loads. The AHF shall employ a current transformer to measure the load current to determine the content of harmonic current present. By injecting the synthesized current, network harmonic currents shall be greatly mitigated, thus reducing the heating effects of harmonic current and reducing voltage distortion.

The harmonic filtering equipment shall also be able to correct either leading (capacitive) or lagging (reactive) power factors as well. The AHF shall also have the ability to correct displacement power factor (DPF) and mains current balancing. DPF correction can be provided for either leading (capacitive) or lagging (inductive) loads that cause poor DPF. Mains current balancing shall be achieved by measuring the negative sequence current present and injecting the inverse negative sequence current to balance the current for the upstream network.

The Passive Correction device (capacitor bank) shall work on the principle of measurement network power factor and shall switch on required number of capacitor bank stages (through a PF Controller) to improve the power factor of the electrical network.

The contractor has to submit software simulations indicating that the Total Demand Distortion (TDD) is less than 5%. The Total Harmonic Distortion Voltage (THD V) shall be within the limits as specified in IEEE Std 519-2014 (Standards on IEEE recommended practices and requirements for Harmonic Control in Electric Power System). The point of common coupling (PCC) for such calculations shall be at the transformer incomer secondary (415 V Supply). The simulation software should take into consideration the performance of the de-tuned capacitor bank. The Passive Correction device shall not amplify the existing system harmonics.

To ensure safety, reliability and accountability of component coordination, all the major components such as Active Filters, Capacitor units, De tuning reactors, PF controllers, Circuit breakers, Contactors and the Enclosure system called for in this specification should preferably be from a single manufacturer.

The HPFC panel shall, in its default configuration, shall implement the following:

Step-less Power Factor Correction (for both leading and lagging current)

Harmonics Compensation up to 51st order (2nd priority)

Load Current Balancing in the three phases (3rd priority)

Neutral compensation

The HPFC panel shall comprise:

Incomer

A suitable sized four pole ACB/MCCB having microprocessor based over-current and short-circuit protection and at least 36kA breaking capacity (Ics) as the incomer of the panel. The breaker shall be selected considering 1.5 times the full load current carrying capacity. Refer the breaker section in the LT Panel specifications for details.

Metering and Indication

HMI display meter showing voltage, current, frequency, PF, THD, kW, kVA, and other related parameters shall be provisioned

Required number of CTs of suitable rating shall be provisioned

Required number of three phase digital ammeter showing current of HPFC panel shall be provided

An active filter part and a passive filter part; the ratio of the rating of active filter to that of the passive filter shall be at least 1:1. The exact distribution of total capacity between the active and passive part shall depend on the rating of the HPFC panel.

Specific number of fixed detuned capacitor banks

Each fixed detuned capacitor bank unit shall comprise:

Incomer

A suitable sized three pole, microprocessor based MCCB having over-current and short-circuit protection and at least 25kA breaking capacity as the incomer. 100% Icu breakers shall be used.

Contactor switching module of required rating.

Power Circuit

One unit of three phase delta connected capacitors of suitable rating

The capacitor unit shall be heavy-duty APP type and have an AC voltage rating of 525V

A series detuned reactor of suitable rating connected to the capacitor bank

The series detuned reactor shall be a 14% copper reactor having linearity of at least 180%

Heavy duty exhaust fans and suitably placed ventilation louvers for proper heat dissipation from the reactors and capacitors shall be provided

Control Circuit

On and Off indication lights for each detuned capacitor bank

Start and Stop push buttons for each detuned capacitor bank

Auto/Manual selector switch for auto mode (through the HPFC Panel's DSP microprocessor) or manual mode of operation of the capacitor banks

On delay timer for the detuned capacitor bank so that all the detuned banks don't get switched on at the same time

Specific number Active filter unit of suitable rating

Active filter unit shall provide the required reactive power in a step-less mode to meet the requirement for power factor correction, harmonic compensation and load balancing

Each Active filter unit shall comprise:

Incomer

A suitable sized three pole MCCB having microprocessor based over-current and short-circuit protection and at least 25kA breaking capacity (Ics) as the incomer of the 3Ph HPFC Panel

100% Icu breakers shall be used

Metering and Indication

On/Off selector switch for the Active filter

Power Circuit

A suitably sized three phase inverter stack. Alternatively, the 3Ph inverter stack may be replaced with equivalent number of single-phase inverter stacks depending on the rating of the active filter

The inverter stack shall be rated for the full rating of active filter and shall have sufficient margins for overloading the filter

Three single phase inductor chokes of suitable rating

Inductor chokes shall have overload margin of at least 150% for 1 minute

A suitable sized three pole AC3 duty power contactor

The contactor shall be connected to the input of the IGBT power stack

The inverter stack shall comprise suitable number and rating (with sufficient margin for overload) of IGBTs, DC Capacitors and IGBT driver circuits to meet the full power output of the inverter stack

Resistors, capacitors and other passive components of suitable rating (with sufficient margin) and quantity to continuously carry the full load of the filter

Cables, bus-bars and other associated hardware of suitable rating (with sufficient margin) to continuously carry the full load of the filter

Heavy duty exhaust fans and suitably placed ventilation louvers for proper heat dissipation from the inverter stacks and inductor choke shall be provided

Heavy duty PWM filter comprising capacitors, resistances and/or inductors to filter out the switching ripple from the filter output

Control Circuit

Control MCB of rating 6A-FP-10kA-C Curve to provide power supply to the control circuit of the Active filter

Advanced DSP microprocessor controller which shall monitor the voltage and current in the three phases (Red, Yellow and Blue) to compute the exact power requirement in the three phases, and thus, implement the following features - step-less compensation of leading and lagging power factor, harmonics compensation and load balancing

Suitable number and rating of voltage and current sensing circuits

Necessary control and firing cards with proper wiring and lugs of required rating shall be provided

Suitable number and rating of any other items, e.g. relays, SMPS, etc.

The HMI (human machine interface) installed in the HPFC Panel shall have the following features:

A 7-inch, colored touchscreen LCD interface

It must at-least have Ethernet port, USB port and SD card port

It must support MODBUS TCP communication protocol

Start, stop and trip status (with trip code) on the home screen

Internal CAN communication with the DSP controller

The HMI must display the following (minimum) numerical parameters

Arms - All 3 phase currents + Neutral

A1rms (Fundamental Current) - All 3 phase fundamental currents

iTHD (%) - All 3 phase current harmonic distortion

Aunb (%) - All 3 phase current unbalance

Vrms - All 3 phase voltages

Urms - All 3 line voltages

V1rms (Fundamental Voltage) - All 3 phase fundamental voltages

vTHD (%) - All 3 phases voltage harmonic distortion

Vunb (%) - All 3 phase voltage unbalance

Grid Frequency

Active Power (kW) - All 3 phases + Total

Reactive Power (kVAr) - All 3 phases + Total

Apparent Power (kVA) - All 3 phases + Total

Power Factor (PF) - All 3 phases + Total

Displacement Power Factor (dPF) - All 3 phases + Total

Apk - Peak Current of 3 phases of power stack

Utilization (%) - Utilization percentage of 3 phases of power stack

Vdc - DC bus voltage of power stack

Stack Temperature - Temperature of 3 phase IGBTs of power stack

Control Card Temperature

System Running hours

Fan Running hours

Advanced logging capabilities

The HMI must save a minimum of 50,000 time stamped event logs

The logs view must be password protected

The logs should capture system events like System On/Off

System trip event should be logged with associated trip code and time stamp

User entry into settings should get logged

Any failed user login attempt (wrong password) should be logged

Changes in user settings must be logged

Logs must be accessible day-wise for ease of navigation

Logs must be arranged in First In - Last Out fashion to display the latest events on top

User must be able to export the logs to an external USB storage device

HMI must have provision for Ethernet communication

The HMI must provide graphical information for the following (minimum) data

Individual harmonic bar chart of 3 phase currents - upto 51st order

Individual harmonic bar chart of 3 phase voltages - upto 51st order

Simultaneous graphical display of 3 phase currents and 3 phase voltages on single window with user select-able options

The HPFC Panel shall have the following features, in addition to those already mentioned above:

Panel shall be suitable for operation within an ambient temperature between $0^{o}C$ and $45^{o}C$

Panel shall have an audible noise level lesser than 70db as per NEMA standard.

Panel shall have a filtering efficiency of at least 98%

Panel shall have a reaction time of less than 200 micro-seconds

Priority selection between the three features - PF compensation, harmonics compensation and load balancing - of the filter shall be programmable using the HMI

In the default mode, harmonics compensation is set at 1st priority, PF compensation is set at 2nd priority and load balancing is set at 3rd priority

Panel shall also have provision for selection of individual harmonic orders for compensation in the harmonic compensation mode through the HMI

Panel shall only compensate the load balancing requirements arising from distributed loading in the three phases or due to two phase loads

Any compensation requirements arising due to the unbalanced current in the neutral shall not be compensated (a 4P/4W HPFC Panel will be required for such cases)

Auto fold-back of the HPFC Panel if total current requirement exceeds the rated capacity of the filter

Bus-bars or cables shall be suitably colour coded and mounted using appropriate insulator supports

Suitable clearances shall be provided for the bus-bars and other live parts of the system as per international standards

All live parts of the system shall be properly shrouded

Inspection terminal strip, number ferruling, and other labelling shall be suitably provided

Stickers marked with “DANGER” shall be provided wherever required

Detailed drawings and manuals shall be provided wherever required

Following protections shall be provided:

Over voltage (AC) protection

Over voltage (DC) protection

Phase sequence protection

Over current protection

One phase disconnection (double phasing) detection/protection

Over temperature protection

Temperature sensor abnormality detection

Protection circuits for the IGBT stack and its components

Temperature based de-rating to protect the system and longer operational life

The system will de rate its capacity by sensing the control card temperature

System will sense abnormally high stack temperature and trip itself to protect the converter with suitable error indication

The system will sense abnormality with stack temperature sensing circuit and generate a suitable error indication

All components and wiring used in the system shall adhere to the relevant ISI and IEC standard

The HPFC Panel shall have the following settings options for the user

Define priority between Harmonic, Reactive and Unbalance compensation e.g: User can easily choose to do only one of the three or a combination of the three. Filter will utilize its full capacity as per defined priority.

Individual harmonic selection

INSPECTION & TESTS:

The complete assembly shall be subject to routine tests including functional test of the control, protection and interlocking schemes. The routine tests shall be carried out at its place of manufacture.

Routine test results should be a part of the O&M Manual and shall be produced at the time of delivery of the equipment.

The manufacturer shall prepare a programme for routine tests and submit these to the client / consultant at least on month before commencement of the programme.

ROUTINE TESTS:

All tests shall be carried out in the presence of and to the satisfaction of the Employer or his representative and at such times as he may reasonably require.

All samples used for testing shall be to the contractor's expense and shall not affect the quantities to be supplied under this contract.

All instrument used for testing purposes, shall if required by the engineer be calibrated by an approved authority.

The cost of all tests shall be included in the contract price and shall not be quoted for separately.

ROUTINE TESTSON CAPACITOR BANK :

All routine tests shall be carried out in accordance with IEC 61921 as per the relevant clauses mentioned against each test. Routine tests shall be carried out by the manufacturer on every Low voltage power factor correction banks before delivery.

Inspection of the assembly including inspection of wiring and, if necessary, an electrical operation test

Dielectric test

Checking of protective measures and of the electrical continuity of the protective circuit

Verification of insulation resistance

ROUTINE TESTS ON CAPACITOR UNITS :

All routine tests shall be carried out in accordance with IEC 60831 as per the relevant clauses mentioned against each test. Routine tests shall be carried out by the manufacturer on every capacitor unit before delivery.

Capacitance measurement and output calculation

Measurement of the tangent of the loss angle (tan δ) of the capacitor

Voltage test between terminals

Voltage test between terminals and container

Test of the internal discharge device

Sealing test

TYPE TESTS:

Type tests may be omitted if acceptable test records can be submitted, unless specified otherwise. The design of the low voltage power factor correction banks tests shall conform to IEC 61921 / IEC 61439-1/2 and must include the following:

TYPE TESTS ON CAPACITOR BANK:

All type tests shall be carried out in accordance with the International Electro-technical Commission (IEC) Publication No. IEC 61921 as per the relevant clauses mentioned against each test.

Temperature Rise Test

Di-electric Test

Short-circuit withstand strength

Effectiveness of the protective circuit

Clearances and creepage distances

Mechanical operation

Verification of Degree of Protection

TYPE TEST ON CAPACITOR UNIT:

All type tests shall be carried out in accordance with the International Electro-technical Commission (IEC) Publication No. IEC 60831 as per the relevant clauses mentioned against each test. Every capacitor sample to which it is intended to apply the type test shall first have withstood satisfactorily the application of all the routine tests.

Thermal stability test

Measurement of the tangent of the loss angle (tan δ) of the capacitor at elevated temperature

Voltage test between terminals

Voltage test between terminals and container

Lightning impulse voltage test between terminals and container

Discharge test

Ageing test

Self-healing test

Destruction test

DIESEL STAND BY GENERATOR SET:

Applicable Standards:The Diesel Standby Generator and its components shall conform to the latest applicable standards specified below:

Diesel Engines for General Purposes	:	BS 5514 / ISO 3046
The Electrical Performance of Rotating Electrical Machinery	:	BS 5000
Rotating Electrical Machines	:	IS 4722
Circuit breakers	:	IS-13118, BS-5311, IEC-56 & 694, BSEN-60942 (P-2)
Air break switches air break disconnectors, air break switch disconnectors and fuse combination units for voltage not exceeding 1000 V AC or 1200 V DC	:	IS-13947 (P-3), BS-EN60947, IEC-60947-3
Current transformer	:	IS-2705/BS-7626, IEC-60185
Voltage transformer	:	IS-3156/BS-7625/IEC 60186
Electrical Relays	:	IS-3231, 3842/BS-142/IEC-60255
Contactors for voltage not exceeding 1000 V ac or 1200 VDC	:	IS-13947 Part-IV/ BSEN-60947-4-1/ IEC-60947-4-1
Control Switches	:	IS-6875/BSEN-60947 /

		IEC-60947-4-1
High Voltage Fuse		IS-9385/BS-2692/ IEC-60282
Low Voltage Fuse	:	IS-13703/BS-1362 IEC-269-1
Electrical direct acting indicating instruments	:	IS-1248/BS-89/IEC-6005
A.C. electricity metres of induction type voltage greater than1000 volts	:	IS722, 8530/BS-5685 / IEC-60145, 60211
Resistance wire, tapes and stripes for heating elements	:	IS-3725
Wrought aluminium and aluminium alloy bars, rods, tubes and sections for electrical purposes	:	IS-5082
Specification for copper rods and bars for electrical purposes	:	IS-613
Toggle switches	:	IS-3452/BS-3676
Control switches/push buttons	:	IS-6875/BSEN 60947
Noise and Emission Limit	:	As per latest notification of ministry of Environment and Forests

General Requirements:

The diesel engine and generator shall be located outdoors near the building. The DG set shall be provided in a weatherproof and acoustically treated enclosure. The exhaust system shall be insulated to minimize the amount of heat entering the room and to prevent injury to personnel. The silencer shall be of the 'residential' type and be located externally.

The generation voltage shall be 415V for DG. At no point DG sets will be operating parallel with grid.

Bulk fuel storage is not envisaged in this project and only Day tank with maximum allowable capacity as per Fire safety standards shall be provided along with the DG set along with all the accessories.

A system shall be provided within the generator enclosure to detect fire, to raise a local audible alarm (manually silenced locally) and if the level of the day tank is above the permissible level beyond which it may overflow.

The system shall be constructed such that leakage of water, fuel or oil within the generator room shall be routed to a local sump where a detector shall be provided to raise an alarm.

The system shall be constructed such that the leakage of fuel or the accumulation of water within the fuel storage bund shall be detected and shall raise an alarm.

All alarms shall be conveyed to the central HMI through the PLC.

Diesel Generating Set Automatic Control

Auto Mains Failure (AMF) Diesel Generator Set capable of automatic starting and picking the load within 30 seconds shall be provided to cater for emergency loads and lighting during mains power failure. Diesel generating set for use in AMF mode shall have a three-position automatic / off / manual selection and shall operate as follows:

Automatic mode:

On occurrence of mains failure the following sequence shall be followed.

Mains to Generator changeover

mains failure detected

delay of 5 seconds

generator is started and run up to speed

time delay of 30 seconds

mains supply is switched off

generator supply is switched on

Generator to Mains changeover

mains healthy detected

manual changeover signal received,

generator supply is switched off

mains supply is switched on

generator runs for 2 minutes and stops

All timer settings shall be adjustable.

If mains power is restored during the initial one-minute delay then the power shall be monitored for a further one minute and if it is still healthy, mains power shall be restored. The generator shall be stopped after a further 2 minutes of running on no load. If the generator fails to start after an initial period of cranking, two further attempts shall be made with an appropriate interval between each attempt. If the engine fails to start after three attempts the system shall shut down and a local and remote alarm shall be annunciated.

Manual mode:

The generator shall run to the dictates of manual controls on the generator. No automatic changeover of mains to generator supply or vice versa shall take place. The generator shall be loaded by manual switching if required.

Alternator for Diesel Generating Set:

The generation voltage shall be 415V. The operating duty for the Alternator shall be Prime or stand by duty.

Alternator shall be 4 pole, 3 phase ,50 Hz, 0.8 P. F, salient pole, revolving field, brushless type, self-regulating continuously rated and manufactured in accordance with IS 4722, BS 5000 : Part 99 or IEC 60034-1. They shall be totally enclosed, screen protected, fan ventilated and vertical drip-proof conforming to IP 23. The Alternator shall be complete with excitation system, AVR and all necessary auxiliaries. The alternator shall be driven by diesel engine detailed below and shall match the same in all respects. The terminal box shall be dustproof with IP 54 degree of protection. The terminal box shall be suitably sized to terminate the size and number of cables involved. Alternators shall be capable of withstanding a 10% overload for 1 hour in any 12-hour Period under the specified conditions of temperature, humidity and atmospheric pressure.

Alternator windings shall be of Class H insulation with Class F temperature rise andtropicalised. The alternator shall have pre-packed grease lubricated ball or roller bearingsand provided with facilities for regreasing whilst in service.

The alternator shall be foot mounted on a common bed frame with the prime mover close coupled to the engine flywheel housing. The direction of alternator rotation when viewed from the driven end shall

be clockwise and phase voltage sequence UVW. The alternator vibration level shall not exceed the values defined in IS 12075.

The alternator shall be capable of maintaining a short circuit current of three times full load current for a period of 10 seconds. The alternator shall be fitted with an anti-condensation heater. No individual harmonic shall exceed 1% and the total harmonic shall not exceed 3%. The alternator, its neutral and control panel shall be earthed as per relevant standards.

The alternator rotor assembly shall comprise exciter rotor, full wave silicon bridge rectifier surge protection device and salient pole rotating field system. The rotor shall be fitted with interconnected pole face damping windings. Voltage regulation shall be maintained to within ±2.5% for a power factor of 0.8 to unity, including hot to cold variations. The steady state frequency droop between no load and full load shall not exceed 5%. Transient voltage deviation following a step load of 60% of rated at a power factor of between 0.4 and zero shall not exceed 15% with a voltage recovery time to 97% rated voltage not exceeding 0.5 second. The set shall be capable of continuous operation with a phase current imbalance of 33% of rated current whilst maintaining the output voltage within ±5% of rated.

Diesel Engine for Generating Set:

Engine shall be four stroke, direct injection, turbocharged industrial machines. They shall be fitted with renewable wet cylinder liners if water cooled and shall be direct coupled to the alternator and mounted on a common rigid steel bedplate.

Engines shall be rated for continuous duty at site ambient conditions with an inherent O/ L Capacity of 10% for 1 hour in any 12 hours. The engine shall be capable of running at full load for not less than 180 hours without maintenance adjustments and 10000 hours between major overhauls. The maximum operating speed shall be 1 500 rpm. The range of manual adjustment shall not be less than ±5% of rated speed. The performance of engine governors under load conditions shall be to Class A2 in accordance with BS 5514: Part 4.

Engine governors shall be suitable for remote control load sharing between identical engine units. In addition to any electrical over speed trips, there shall be a mechanical device which shall operate at 120% of the rated speed. Re-setting of the over speed trip shall be possible by hand only. The steady state output speed drop between no load and full load shall not exceed 5%. The transient output speed deviation shall not exceed 10% for a step of 60%. Engines shall be designed to run on fuel oil complying with IS 1460 or BS 2869, Class A2. Engines shall be cooled by means of a water jacket, heavy duty air blast radiator with integral radiator header tank, circulating pump and engine driven pusher type fan. The fan shall draw air in from the vicinity of the engine block and discharge it through the radiator core. The radiator shall be mounted on the same bedplate as the engine and alternator on suitable vibration isolators and be arranged so that it is located directly behind automatic louvers set into the external wall of the engine room. A thermostatically operated by-pass valve shall be fitted in the cooling system to

maintain an optimum operating temperature during starting and running conditions. Drain cocks shall be provided so that all the water can be drained from the system. A separate oil cooler shall be used for cooling the engine oil. A thermostatic by- pass valve shall be incorporated. Engine lubrication shall be by a closed-circuit wet sump, forced feed system supplied by an engine driven pump fitted with pressure regulating and relief valves, sump suction filter and changeover renewable micro-felt full flow line filters. A hand operated semi-rotary oil pump shall be installed to carry out initial priming or to fill or empty the sump as required. The sump shall be fitted with an easily accessible drain point. The oil shall be of the grade recommended by the engine manufacturer. The starting system shall comprise 12 or 24 V heavy duty lead acid batteries (positioned on a floor mounted stand adjacent to the engine) connected by heavy duty flexible butyl rubber cables. Batteries shall be sized to give six consecutive starts of the engine at 0°C. An engine driven alternator and charging system shall be provided. An automatic mains energized battery charger shall be provided, with sufficient capacity to maintain the battery in a condition to fulfil the starting requirements. Barring (hand turning) equipment shall be provided so that the engine can be manually rotated for maintenance purposes. It shall be arranged so that normal starting of the engine is inhibited whilst the hand turning equipment is connected. Twin heavy-duty air intake filters in accordance with IS 3169 or BS 7226 suitable for operating in dust laden atmospheres shall be fitted. The filters shall be of the paper element with pre-cleaner type. Turbocharger filters shall be fitted. Breathers shall be fitted with washable filters which are easily accessible for maintenance.

Instrumentation shall be provided to monitor speed, oil pressure, oil temperature (sets larger than 250 kVA), water temperature and battery charge current. The bedplate shall be of heavy gauge steel construction, stress relieved and free from distortion.

Machined surfaces shall be incorporated for mountings and for levelling. Anti-vibration mountings shall be fitted between the bedplate and the floor to prevent vibrations being transmitted to the building. The mountings shall be adjustable for leveling purposes and shall be designed to resist horizontal movement of the diesel set.

The fuel System shall comprise an engine driven feed pump with duplex filters, 990 litres day tank with supporting structure or generator skid mounted day fuel tank, with all interconnecting pipe work, flexible engine connection pipe etc.

Diesel Generator Control Panel:

The control panel shall be separately mounted on anti-vibration mountings and shall Comprise the following:

Breaker incorporating short circuit, overload trip and

Earth fault protection for the Alternator

Alternator Over & Under Voltage Protection

Voltage Controlled Over Current Relay

Voltmeter and seven position selector switch

Ammeter and 4 Position selector switch

Frequency meter

Power Factor Meter

KWh Meter

Engine temperature and oil pressure gauge

Service hours run indicator

Key switch start and stop control

Operational status indicator

Anti-condensation heater and thermostat

Alternator anti-condensation heater controls

Mains fed battery charger

Auto start on mains power supply failure facility

Fails to Start (Alarm)

Over / Under Voltage Alarm

Battery Charger Fault (Alarm)

Low fuel Oil Level (Alarm)

Over Load (Alarm)

Low Lube Oil Pressure (Trip)

High Water Temperature (Trip)

High Lube Oil Temperature (Trip)

A reset button shall be provided to cancel the alarm /shut-down condition prior to re-starting.

Simple operating instructions shall be detailed on the fascia of the control panel.

Local Circuit Breaker incorporating short circuit, overload trip and Earth fault protection for the Alternator shall be provided within the Acoustic Enclosure.

Acoustic Enclosure

The DG Set shall be provided with acoustic enclosure, fully integrated, weather proof with superior finish for long and durable life.

The acoustic enclosure shall be CRCA sheet steel enclosed with necessary panels and doors, inside lining of fire-retardant foam /glass wool as acoustic material.

The sound level shall be restricted to 75 dB at a distance of 1 meter, under full load, free field conditions as per relevant standards.

The acoustic enclosure shall be certified to meet the emission norms.

Drawings / Documents Required:

All Drawings, data, technical particulars, calculations, detailed literature, catalogues Test certificates etc shall be submitted along with the bid/ after award of contract.

TECHNICAL DATA SHEET

S. No.	ITEM	RATING	ATTRIBUTE
1.0	DESIGNATION		DG Set
2.0	NUMBER REQUIRED		As per SLD
3.0	TAG NUMBERS		*
4.	TYPE: MANUALLY STARTED / AUTO		Auto Mains Failure (AMF)

S. No.	ITEM	RATING	ATTRIBUTE
0	MAINS FAILURE (AMF)		
5.0	FUELAS PER IS 1460		High Speed Diesel (HSD)
6.0	SITE CONDITIONS:		
6.1	ALTITUDE - ABOVE MEAN SEA LEVEL	M	*
6.2	MAXIMUM AMBIENT TEMPERATURE	°C	45
6.3	RELATIVE HUMIDITY	%	90 (Max)
7.0	RECIPROCATING INTERNAL COMBUSTION ENGINES - BS 5514/ISO 3046 PARTS 1,3,4,5,6 &7		Yes
8.0	MACHINES FOR MISCELLANEOUS APPLICATIONS - BS 5000 PART 99		Yes
9.0	ROTATING ELECTRICALMACHINES - IS 4722		Yes
10	CONTINUOUS OUTPUT AT SITE CONDITIONS	KW	*

S.No.	ITEM	RATING	ATTRIBUTE
.0			
11.0	OVERLOAD CAPABILITY FOR ONE (1)HOUR IN TWELVE (12) CONSECUTIVEHOURS OF OPERATION		10%
12.0	RATED VOLTAGE		433 V
13.0	RATED FREQUENCY		50Hz
14.0	NUMBER OF PHASES		3
15.0	POWER FACTOR (PF)		0.80
16.0	WINDING CONNECTION		Star with neutral earthed through resistor and isolator
17.	TYPE OF INSULATION:		

S. No.	ITEM	RATING	ATTRIBUTE
0			
17.1	ARMATURE WINDINGS		Class F
17.2	FIELD WINDINGS		Class F
17.3	COMMUTATOR		Class B
17.4	CORE CONNECTION		Class B
18.0	TYPE OF ENCLOSURE		IP 54
19.0	PERMISSIBLE VOLTAGE VARIATIONAT RATED KVA, SPEED AND PF	%	+/- 10%
20.	TRANSIENT REACTANCES:	%	

S. No.	ITEM	RATING	ATTRIBUTE
0			
20.1	X' d:		*
20.2	X'' d:		*
21.0	PERMISSIBLE FREQUENCY VARIATIONAT RATED KVA, SPEED AND PF	± %	+/- 5%
22.0	METHOD OF NEUTRAL GROUNDING: SOLIDLY EARTHED / THROUGH NGR		Solidly Earthed
23.0	LARGEST MOTOR TO BE STARTED WITH DROP IN THE GENERATOR TERMINAL VOLTAGE LESS THAN 15% WITH FULL BASE LOAD		
23.1	DOL /STAR DELTA	KW	*
23.	REDUCED VOLTAGE	V	*

S. No.	ITEM	RATING	ATTRIBUTE
2			
24.0	PARALLEL OPERATION		
24.1	IF MORE THAN ONE DG IS IN OPERATION, WHETHER IN ISOLATION/ IN PARALLEL		NA
24.2	DG IN PARALLEL WITH THE GRID CONTINUOUSLY	YES/NO	No
24.3	DG IN PARALLEL WITH THE GRID MOMENTARILY	YES/NO	No
24.4	ARE UNDERFREQUENCY LOAD SHEDDING SCHEMES REQUIRED IF YES:	YES/NO	No
24.4.1	TYPE OF UNDER FREQUENCY RELAY		
24	LOAD SHEDDING REQUIREMENTS		

S. No.	ITEM	RATING	ATTRIBUTE
.4.2			
24.4.3	PROTECTION REQUIREMENTS		
25.0	HARMONIC LOADING (IF ANY): CURRENT-	%THD	*
26.0	SIZE OF CONDUCTOR CABLES	C x mm2	*
27.0	PERIOD FOR TAKING LOAD FROM 'START' IMPULSE	sec	*
28.0	COOLING WATER /MAKE-UP WATER QUALITY:		*
28.	COOLING WATER INLET TEMPERATURE	°C	*

S. No.	ITEM	RATING	ATTRIBUTE
1			
28.2	MAXIMUM ALLOWABLE COOLING WATER TEMPERATURE RISE	°C	*
28.3	COOLING WATER INLET PRESSURE	kg/cm2 (g)	*
28.4	MAXIMUM ALLOWABLE COOLING WATER PRESSURE DROP	kg/cm2	*
29.0	ENGINE STARTING SYSTEM: COMPRESSED AIR / ELECTRIC		Electric
30.0	BATTERY AND BATTERY CHARGER	YES/NO	Yes
31.0	EXCITATION SYSTEM: STATIC / BRUSHLESS		Brushless
32.	MANUAL START/STOP OF ENGINE THROUGH LOCAL / REMOTE PUSH BUTTON REQUIRED	YES / NO	Yes

S. No.	ITEM	RATING	ATTRIBUTE
0			
33.0	TRIP DEVICE ON MAIN SUPPLY RESTORATION REQUIRED	YES/NO	Yes
34.0	STOPPING OF DG SET: MANUAL/AUTO		MANUAL/AUTO
35.0	GOVERNOR CLASS: A1 / A2		A1
36.0	RESPONSE TO STEP CHANGE OF LOAD: SWITCH-IN AND/OR THROW-OFF		*
37.0	SPEEDERGEAR OPERATION ON DC VOLTAGE FOR REMOTE VARIATION OF SPEED REQUIRED	YES / NO	No
38.0	MAXIMUM TIME OF OPERATION WITHOUT COOLING WATER AVAILABILITY DURING START UP	Min	*
39.	GENERATOR SWITCHGEAR BY CONTRACTOR / EMPLOYER		*

S. No.	ITEM	RATING	ATTRIBUTE
0			
40.0	MOTORS: BY CONTRACTOR / EMPLOYER		*
41.0	ENGINE COOLING SYSTEM: WATER COOLED HEAT EXCHANGER / RADIATOR WITH ENGINE DRIVEN FAN		Radiator type
42.0	COOLING TOWER: BY CONTRACTOR/ EMPLOYER		*
43.0	COOLING WATER PUMPS: BY CONTRACTOR/ EMPLOYER		*
44.0	COUPLING AND COUPLING GUARD	YES/NO	Yes
45.0	EXHAUST PIPE/ STEEL STACK	YES/NO	*
46.	TACHO GENERATORS	YES/NO	*

S. No.	ITEM	RATING	ATTRIBUTE
0			
47.0	AC MOTOR DRIVEN PRIMING OIL PUMP WITH CLOCK TIMER	YES/NO	*
48.0	BATTERY VOLTMETER	YES/NO	Yes
49.0	WINDING AND BEARING RTDs FOR GENERATOR	YES/NO	*
50.0	ENGINE COUPLED WITH GENERATOR		
50.1	ONE (1) HOUR AT 50% LOAD		*
50.2	ONE (1) HOUR AT 75% LOAD		*
50.	FOUR (4) HOURS AT FULL LOAD		*

S. No.	ITEM	RATING	ATTRIBUTE
3			
	FOLLOWED BY ONE (1) HOUR CONTINUOUS LOAD OF 110%		
51.0	GENERATOR		
51.1	TYPE AND ROUTINE TESTS AS PER STANDARD IS 4722 / BS 5000 PART 99		Yes
52.0	EXCITER		
52.1	TYPE AND ROUTINE TESTS AS PER STANDARD IS 4722 / BS 5000 PART 99		Yes

CABLES

SCOPE

The scope includes Design, engineering, manufacture, Acceptance testing at manufacturer's works, packing, forwarding, delivery including transit insurance, unloading at site, handling, assembly, installation, testing, commissioning & performance demonstration of HV, LV, Control AC & DC Cables of various sizes as required, to be laid buried in ground or RCC trenches/ laid on cable trays in RCC trenches or on wall or structural supports or in specified ducts. Civil work such as excavation, providing sand bedding above and below the cable; laying of Class A Red clay brick/ RCC tile/ semi-circle hume pipe

protection; or for mounting structural support for cable trays / supports shall be included in installation CONTRACTOR scope.

Miscellaneous items such as cable dressing accessories like nylon tie, GI clamps, GI cleats, GI Saddle Spacers, cable tags, cable route marker etc. are included in the scope. Removal of empty drums, cartons and making the site normal as instructed by PURCHASER is included in scope.

The construction, performance and testing of cables shall comply with IS 7098 Part II for HT cables, 7098 Part I for LT XLPE cables and IS1554-Part-I for PVC cables.

In general cable installation works shall be carried out in accordance with IS 1255 – 1983, latest version.

Installation of cables at height more than 3 meters if required by Use of metal modular scaffolding / scissor lift & other necessary safety gears arrangements for working at this height are included in the scope of installation CONTRACTOR.

Use of all the personal Safety gears per person required as per standard safety practices prevailing in included in the scope of the CONTRACTOR.

The HV power cables shall conform to Earthed grade (E), three core, multi-stranded, Aluminium conductor, screened by extruded semi-conducting compound, cross-linked poly ethylene (XLPE) insulated, cores screened with non-magnetic metallic tape laid up with inner and outer extruded PVC sheath compound Type-ST2 and galvanised steel strip armouring. The cables shall generally conform to IS 7098-1985(latest version) with relevant parts thereof. The insulation over the individual conductor core will be colour coded.

All Armouring shall confirm to latest version of IS: 3975.

The LV Power cables shall be 1100V grade, multi-stranded, Al / Copper conductor, XLPE insulated, extruded inner & outer PVC sheath compound type ST2 and galvanised steel strip armoured cables.

All the control cables shall be 1100V grade, multi-stranded, Copper conductor, XLPE insulated, extruded inner PVC & outer PVC FRLS sheath compound type ST2 and galvanised steel round wire armoured.

The cable sizes & type shall in general follow the criteria as tabulated below.

SR. NO.	PARAMETER	LT CABLE	HT CABLE
1	Application	Control & Power	Power
2	Applicable Standard	IS 7098 –I	IS 7098-II

SR. NO.	PARAMETER	LT CABLE	HT CABLE
3	Voltage Grade	1.1 kV	11 kV or 33 kV as per the Local Power supply company norms
4	Conductor	Multi stranded Cu up to 4 sq. mm Multi stranded Al for ≥10 sq. mm	Multi stranded Al
5	Insulation	XLPE	XLPE
6	Inner Sheath	ST2 extruded PVC	ST2 extruded PVC
7	Armouring	GI armour for multi-core Al armour for single core	GI armour for multi-core Al armour for single core
		Up to 10 sq. mm round wire and 16 sq. mm & above - flat strip armouring.	Flat strip armouring.
8	Outer Sheath	ST2 extruded PVC	ST2 extruded PVC
		FRLS PVC Outer sheath for- a) All control Cables b) All cables inside the building area c) All cables in Hazardous area.	
9	Cable Laying (Mainly complying with Installation practice as mentioned in IS 1255)		

Inside the electrical switchgear room, cables will be laid in prefabricated HD galvanised Steel cable trays mounted on support structures anchored to the RCC ceiling. All vertical cable trays shall be covered with prefabricated GI covers after proper dressing.

HT cable from the meter to the Point of supply and if required, from POS to the Transformer units shall be laid as per local Power company or CEIG requirement and guidelines or laid buried as per IS 1255.

The DC power supply cable shall be two core, multi-stranded Copper conductor, GI armoured cables with inner extruded PVC & outer PVC FRLS sheath.

Fire protection sealing (Brick or Mortar) for 4 Hrs fire rating rating shall be provided for cables/ cut outs/ outlets wherever passing through wall/ slabs/ cable trench/ conduits etc.

The Installation CONTRACTOR shall prepare the cable and interconnection schedule for entire electrical system from HV Switchgear/ RMU to tail end of equipment based on equipment drawings and submit the same to Consultant /PURCHASER for review & approval.

Printed ferrule (tubular types) white with black lettering shall be provided. The printing shall be done with the indelible ink.

All wiring shall be with 0.75 kV grade, multi-stranded Cu conductor, PVC FRLS insulated wires.

All cables & wires shall be with multi-stranded conductor irrespective of size.

If required, looping of all RS 485 ports shall be done using 3 core twisted & shielded 1.5 sq. Mm copper cable & shall be terminated at incomer panel.

For control wiring straight + cross ferruling shall be provided, so that identification of wire emergence & destination can be done.

Outdoor cables will be galvanised steel wire / strip armoured. These cables shall generally conform to latest version of Indian Standards.

All control cables shall be with following specific requirements:

Copper conductor stranded class 2.

PVC Insulated

Provided with inner extruded PVC and outer PVC FRLS sheath of extruded black PVC compound.

Galvanised steel armouring in the form of GI round wire.

Core identification shall be by printed numerals.

The insulation over the individual conductor core will be colour coded.

All the power & control cables used in the Hazardous area shall be with FRLS PVC outer sheath.

Any buried cable crossing a road shall be laid in a Hume / HDPE pipes/Culverts atleast 750mm below the Finished Road Level.

Earthing Cable shall be Single core multi-stranded Cu 1100V grade, XLPE insulated, un-armoured green coloured outer sheath with yellow strips/band cable to be laid in trays, underground, trenches etc. where ever required - for transformer neutral earthing.

All cables shall be terminated at both ends.

For HT cables Raychem make Heat Shrinkable termination kits shall be used for outdoor & indoor terminations/ straight through joints. M-seal push on type terminations may be used for indoor terminations.

For all HT, LT power and control cables, double compression glands with aluminium lugs for Aluminium cables and tinned Copper lugs for Copper cables shall be used in indoor and outdoor application.

The termination shall be inclusive of miscellaneous items such as clamps, cleats, cable tags, cable markers etc.

For Underground cables, cable marker shall project 150mm above ground and shall be spaced at an interval of 30 metres, and at every change in direction. They shall be located on both side of road and drain crossings. Top of cable marker/joint marker shall be sloped, to avoid accumulation of water/dust on marker.

Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossings, on each duct/ conduit entry, and at every ten (10) metres in cable tray runs. Cable tags shall also be provided inside the switchgear, motor control centres, control and relay panels, etc., cable identification is also required where number of cables enter together a gland plate.

Separate cable trays will be used for control, signalling, Data and supervisory cables. In case separate cable tray provision is not possible, then separation distance of minimum 300mm shall be maintained between power/ control & signal cables. The cables can be segregated using metallic conduits also. Where ever cables with two different voltage classes cross each other, they shall cross each other at 90 degree.

Telephone and LAN networking will be embedded in flooring-(through GI raceways) / wall (through Flexible GI conduits) and junction boxes/ cable pull boxes will be located in flooring/wall as per furniture layout.

For telephone networking, 0.5mm 2 pair PVC insulated un armoured telephone cable shall be used for individual distribution.

Cable Lugs

Cable lugs shall be of tinned Copper, solder less crimping type for Cu cables & Al lugs for the Al cables.

The current rating of the lugs shall be same as that of the respective cable conductors.

Ring type cable terminations shall be used.

Insulated lugs are not acceptable for any cable terminations.

Bi-metal strip/ Bi-metallic lug shall be used whenever two different metals are to be connected together.

Double hole extended neck (long barrel neck) type lugs shall be used in case of cables above 185 sq. mm.

Fork terminals shall be used for luminaires & decorative switch/ socket. Pin terminals may be acceptable during execution only in case other terminals/ lugs cannot be accommodated.

Reducer / wire pin terminals shall be avoided for MCB terminations. MCB terminations shall be with 'long palm terminals.

All terminations in DBs / enclosure for earthing & neutral busbars / terminals shall be with ring type terminals.

All earthing terminations shall be with ring type lugs only.

All control & interlock cable terminations shall be with ring type lugs.

Anticorrosion/ anti-oxidation compounds shall be used for crimping lugs [This shall especially be ensured for Al cable terminations & any bimetallic terminations (Cu cable termination using tinned Copper lugs)].

If termination is done with crimping tool employing crimping die then forming dies shall be used to make the sector shaped conductor into a round conductor before crimping the lugs on the conductor. The lug must not be crimped directly on the sector conductor. Before crimping the lug, the conductor shall be thoroughly cleaned and special jelly applied over it to prevent further oxidation.

Cable Glands

Double compression type cable glands shall be used for the termination of all the power and control cables. Cable glands shall be brass casting, machine finished and Nickel-plated to avoid corrosion and oxidation. Rubber components used in cable gland shall be of neoprene.

For single core cables, gland shall be with brass ring.

Cable glands shall be with metric threads.

Cable glands shall be conical (& not flange type).

Where ever applicable, supply & installation provision of bimetallic strip for connection between Al to Cu strip & GI to CU strip shall be the scope of CONTRACTOR.

Following colour coding shall be used for the Panel wiring (1.1kV grade Copper conductor):

Control circuit wiring minimum 1.5 Sq.mm Grey colour FRLS wire.

CT circuit wiring minimum 2.5 Sq.mm Red, Yellow & Blue colour FRLS wire.

PT circuit wiring minimum 1.5 Sq.mm Red, Yellow & Blue colour FRLS wire.

Power circuit wiring minimum 2.5 Sq. mm Red, Yellow & Blue colour FRLS.

Earthing wire – Green/ Green with Yellow colour Band.

CONTRACTOR has to ensure reference of an arrow and suitable accompanying wording which shall be stencilled on the sides of the drums indicating which way it should be rolled. The number on each drum shall be either branded at the end of the drum or stamped on the metal attached to an end of the drum. The cable shall be placed on the drum in such a manner that it will be protected from injury during transit. Each end of the cable shall be firmly and properly secured to the drum. The drum shall be securely blocked in position so that the cable will not be displaced during transit.

It shall be the CONTRACTOR's responsibility to prepare the drum cutting schedule so that cable wastage is minimum while cutting.

CABLE TRAYS

The cable trays shall be pre-fabricated galvanised steel, perforated or ladder cable trays, suitably supported by primer coated (2 Coats) and epoxy painted (2 Coats) mild steel cable tray supports. Separate cable trays will be used for power, control, signalling and supervisory cables.

All cable trays will be earthed at minimum two places by suitable sized GI flats to main earthing system earth conductor. The cable trays shall also be earthed at a regular interval not more than 10m.

Cable trays of prefabricated perforated and ladder types and associated accessories such as coupler plates, tees, elbow etc. fabricated from 14SWG MS sheet and then hot dip galvanised (2.0 mm thick) sheet steel. 50mm side flanges for perforated tray and 75 side flange (100 mm only for 750mm tray) for ladder tray shall be provided on both sides of the tray. All the cable trays shall be hot dip galvanised (Min. 80-micron thickness) after fabrication.

All the Vertical cable trays shall be provided with covers. All cable trays & covers (only for vertical drops) shall be MS sheet fabricated and then hot dip galvanised with thickness of minimum 70 Micron as per IS 4759:1996. Thickness for Cable tray shall be minimum 2 mm & for covers shall be min. 1.6 mm.

Cable trays shall be in standard length of 2500 mm and clear inside width of trays shall be

Perforated type trays : 50, 75, 100, 150

Ladder type trays : 300, 450, 600, 750

Only Pre-Fabricated bends, joints and reducers shall be used.

Two lengths of Cable trays shall be fixed with twin coupler plates (inner & outer) at each joint. Erection with just one coupler plate shall result in rejection of the entire installation.

Hardware (esp. bolts) for Joining of two lengths of cable trays shall be installed such that, not to damage the cables under any condition.

2 nos. of earth strips shall run through each cable tray. In case of multi-tier cable trays, 2 nos. of earthing strips shall run only through one of the cable tray. The balance cable trays of the multi-tier cable trays shall be connected with these earth strips at a distance not more than 10 meter. The cable tray earthing shall be interconnected to Main earth grid at least at two places.

The CONTRACTOR shall ensure that, for all vertical drops no cable shall be seen uncovered i.e. all the vertical cable trays shall be covered with cable tray covers.

TESTS

The CONTRACTOR shall conduct the routine tests on each drum length, acceptance and type test on the cables as per applicable standards. Also special tests for critical oxygen index, temperature index values, and acid gas generation, smoke generation, and flammability test, effects of light and water test as specified shall be conducted on specimen, from different batches.

Following site test shall be done on MV cable

Very low frequency AC HV test (instead of DC test)

Insulation resistance including P.I. at rated voltage

Capacitance and tan delta

AC leakage current

Partial discharge measurement

Testing and Commissioning of Cables

Cables shall be checked for insulation resistance before and after jointing. The voltage rating of the Megger for cables of different voltage grades shall be as indicated below.

Voltage Grade	Megger rating
1.1kV	500V
11kV or 33kV	2500V

All cables of 1.1 kV grade cables & all HV cables shall be subjected to DC or AC (preferably DC) high voltage test after terminating but before commissioning as per Table 6 in IS: 1255 (Code of practise for Installation & Maintenance of Power Cables up to and including 33kV).

UNINTERRUPTED POWER SYSTEM (UPS)

SCOPE

Scope of this specification covers design, preparation of detailed drawings, manufacture, testing, inspection at manufacturer's/ vendors' works, supply, packing, forwarding and delivery from place of storage/ manufacturer's works to erection site including transit insurance, unloading, storage at site, assembly, erection, installation, testing, commissioning and performance demonstration of the UPS Systems mentioned below along with associated accessories and one set of spares recommended for specified no of years of trouble free operation.

CODES AND STANDARDS

The equipment shall fully comply with the requirements of enclosed specifications and the latest editions of codes and standards not limited to the following;:

Safety Standard:	IEC/EN 62040-1-1 IEC/EN 60950-1
Electromagnetic Compatibility Standard (EMC)	IEC/EN 61000-6-4 ; IEC/EN 62040-2 IEC/EN 61000-6-2 IEC/EN 61000-4-2 IEC/EN 61000-4-3 IEC/EN 61000-4-4 IEC/EN 61000-4-5

	IEC/EN 61000-4-6
Performance Standard:	EN 62040-3

In the event of any conflict between the codes and standards referred to elsewhere in the specification and the requirement of this specification, latter shall govern.

This specification describes the operation and functionality of a continuous duty, three-phase, solid-state, true on-line double conversion static Uninterruptible Power System (UPS). The UPS shall be rack-mounted scalable array architecture. Within the designed rating, UPS shall facilitate the replacement of power modules while the system remains in normal operation, without the requirement to transfer to bypass (hot swappable).

The malfunction of one of the UPS module's power or control modules shall cause that particular UPS module to be automatically isolated from the system and the remaining UPS modules shall continue to support the load. Replacement or repair of a UPS module shall be achieved without disturbance to the connected load (to be save swappable).

The minimum size of power module shall preferably be:

For rating up to 200 kVA UPS - 25kW

For rating above to 200 kVA UPS- 50kW

Each power module (kVA= 100% kW) contains a fully rated, power factor corrected input rectifier / boost converter (PFC) input stage, a fully rated output inverter and battery charging circuit. The system shall also be comprised of a hot swappable continuous duty bypass static switch module, redundant control modules, redundant logic system and touch screen user interface/ display. All the above system shall be housed in standard cabinet/ rack.

The UPS shall be forced air cooled by internally mounted fans with redundant arrangement.

Rectifiers:

The rectifier shall be capable of supplying the inverter full load, in addition to charging the fully discharged batteries in 8 to 10 hours or as recommended by battery manufacturer and then maintain the battery on trickle charge mode. The rectifiers shall automatically share the load during parallel operation.

The Power Factor Corrected (PFC) Input stage converters of the system are housed within the removable power modules, and shall constantly control the power imported from the mains input of the system, to provide the necessary UPS power for precise regulation of the DC bus voltage, battery charging, and Main Inverter regulated output power. These power modules are connected in parallel within the UPS frame.

Input Current Total Harmonic Distortion: The input current THDI shall be within limit while providing conditioned power to the critical load bus, and charging the batteries under steady-state operating conditions. This shall be true while supporting both a linear or non-linear loads. This shall be accomplished without the requirement for additional or optional filters, magnetic devices, or other components.

Soft Start: The rectifier shall be provided with soft start feature. Same shall be linear from 0-100% input current and shall not exhibit inrush. This shall take place over a user selectable 1-60 second time period with a factory default of 10 seconds.

Inverters:

The UPS output inverter shall constantly develop the UPS output voltage waveform by converting the DC bus voltage to AC voltage through a set of IGBT driven bi-directional power converters. In both normal operation and battery operation, the output inverters shall create an output voltage independent of the mains input voltage. Input voltage variation such as spikes, surges, sags and outages shall not affect the amplitude or sinusoidal nature of the output voltage sine wave of the inverters.

Output Contactor: The output inverter shall be provided with an output mechanical contactor to provide physical isolation of the inverter from the critical bus. With this feature a failed inverter shall be isolated from the critical bus.

Redundancy: The UPS shall be capable of being configured with redundant output inverters, each with semiconductor fusing, and logic controlled contactors to remove a failed component from the input, DC and output critical bus.

All UPS shall have IGBT technology for rectifier and inverter.

Other requirements

Overload Capacity	125% for 10 Min. 150% for 1Min 300% for 4 milli seconds
Synchronising	
- Between inverters	Required
- Between inverters and standby supply	Required
Parallel Operation	Required
Synchronising Range	50 $\pm$ 2 Hz(adjustable)

Static Bypass:

The static switch shall comprise thyristors connected in anti-parallel configuration, enabling loads on each branch circuit to be connected to the inverter of the other branch circuit or to the stand-by regulated AC supply.

The current rating of the static switch shall be not less than the continuous full load rating of the branch circuit and short time rating of 1000% for 20 milliseconds.

System static bypass shall provide no break transfer of the critical load from the Inverter output to the static bypass input source during times where maintenance is required, or the inverter cannot support the critical bus.

Automatic initiation of the transfer from a faulty branch circuit to either a healthy branch circuit or the stand-by regulated source shall be accomplished during following conditions:

Inverter failure.

Loss of inverter AC output.

Load over current (in case of non-redundant UPS with static by pass to regulated supply).

Automatic Transfers: An automatic transfer of load to static bypass shall take place whenever the load on the critical bus exceeds the overload rating of the UPS. Automatic transfers of the critical load from static bypass back to normal operation shall take place when the overload condition is removed from the critical bus output of the system. Automatic transfers of load to static bypass shall also take place if for any reason the UPS cannot support the critical bus.

Manual Transfers: Manually initiated transfers to and from static bypass shall be initiated through the UPS graphical user interface.

Modular: The static bypass switch shall be of a modular design & Hot Swappable Design. Distributed or multiple path static switch is not allowed.

Static Switch

Maximum transfer time 5ms (1/4 cycle)

Short time current rating 750% for 1.0 secs

Display and Controls:

Control Logic: The UPS shall be controlled by two fully redundant, user-replaceable / hot-swappable Intelligence modules (IM). These modules shall have separate, optically isolated, communication paths to the power and static switch modules.

Discrete LED indicators integrated in mimic diagram or multi line alpha numeric text display unit shall be provided for continuous monitoring of the UPS operation. The UPS control system shall be fully compatible for remote operation via communication link. Contractor to indicate the type of communication protocol supported by the system along with the details of links provided in the system. The control system shall operate on Windows or eqvt. Platform. The following operating conditions shall be annunciated.

Alarm:

System fault

Rectifier charger failure

Inverter failure

Battery undervoltage

Thyrister over temperature

Fuse failure

Over load

Static transfer to stand-by

Transfer inhibted

Over load shutdown

Emergency shutdown

Battery circuit breaker / switch open

AC Main failure

AC stand-by source mains failure

Manual bypass ON

Fan failure

Asynchronous condition

Control power failure

DC ground fault.

Input Frequency outside configured range

AC adequate for UPS but not for Bypass

Intelligence Module inserted

Intelligence Module removed

Redundant Intelligence Module inserted

Redundant Intelligence Module removed

Number of Batteries changed since last ON

Number of Power Modules changed since last ON

Number of Power Modules increased

Number of Power Modules decreased

Redundancy Restored

The Redundant Intelligence Module is in control

Shutdown or unable to transfer to battery due to overload

Load Shutdown from Bypass. Input Frequency Volts outside limits

Fault, Internal Temp exceeded system normal limits

Input Circuit Breaker Open

Bad Power Module

Intelligence Module is installed and failed

Redundant Intelligence Module is installed and failed

Redundancy has been lost

Redundancy is below alarm threshold

Runtime is below alarm threshold

Load is above alarm threshold

Load is no longer above alarm Threshold

Minimum Runtime restored

Bypass is not in range (either frequency or voltage)

Back feed contactor stuck in OFF position

Back feed contactor stuck in ON position

UPS in Bypass due to Internal Fault

UPS in Bypass due to overload

System in Forced Bypass

Fault, Bypass Relay Malfunction

High DC Warning

High DC Shutdown

Low Battery Shutdown

Low Battery Warning

Controls: The following controls or programming functions shall be accomplished by the use of the user interface/ display unit. The touch screen display shall facilitate these operations:

Silence audible Alarm

Display or set the date and time

Enable or disable the automatic restart feature

Transfer critical load to and from static bypass

Test battery condition on demand

Set intervals for automatic battery tests

Adjust set points for different alarms

Potential Free (Dry) Contacts

Status Indication on Mimic

Mains on

rectifier on

Battery on load

Inverter on

AC Stand-by source on

Inverter on –load

Manual by-pass on

Load on static by pass.

Invertor faulty

Remote UPS monitoring shall be possible via MODBUS.

Web Monitoring: Remote monitoring shall be available via a web browser such as Internet Explorer.

Meters

Meters shall be suitable for semi flush mounting with flanges projecting in vertical panels.

Meters shall have circular 240 Deg scale, 110 mm square, moving coil (taut band) type, conforming to IS: 1248 with accuracy class 1.0 or better.

The following meters shall be provided:

Voltmeter with selector switch to measure input voltage / stand-by AC supply.

Ammeter with selector switch to measure input current.

DC Volt meter for rectifier

DC Ammeter for rectifier

Volt meter for inverter output.

Ammeter for AC output and regulated stand-by AC.

Frequency meter for AC output of digital type.

Alternatively, an alphanumeric multi line display to indicate all the parameters listed above is acceptable.

Circuit Protection

The following devices shall be provided to protect the UPS system:

AC input circuit breaker to Rectifier unit.

AC input circuit breaker to supply stand-by transformer / voltage stabiliser.

DC circuit breaker for battery output.

Fast acting semiconductor fuses.

DI/ DO Requirement

These are the minimum requirement to be complied, however if the system need more parameters to be monitored and hence more DI/Dos the same shall be provided as part of the scope of works,

UPS status (ON- OFF) monitoring.

UPS % loading

RS485 port connection for IBMS

UPS Status Information

The software shall be able to retrieve status information present in the UPS. Retrieval of data shall be through either serial communication or through a network connection.

Battery system:

12V, Lead Acid Sealed Maintenance Free (SMF) type battery, battery isolator & mounting stand shall be provided.

Aging factor of 1.25% shall be considered for battery sizing calculations.

First charging of the battery shall be carried out by the CONTRACTOR.

Batteries shall be provided with FR casing.

Battery bank should be with 2 strings (100% x 2) per UPS with individual isolator/ protection for modular type UPS.

In the event of a battery malfunction the affected string shall be automatically isolated from the system thereby ensuring battery autonomy is retained, albeit of a shorter duration.

The expected life of the battery shall be minimum 5 years.

K-13 Rated Dry Type Isolation transformer:

The primary, or input, shall be three phases applied to the transformer windings (connected in the “delta” configuration.)

The secondary, or output, shall be connected in the “wye” (Y-shaped) configuration and consists of three phases and a neutral.

The isolation transformer shall be with 200% rated neutral.

The neutral on the output of the transformer shall be connected to ground and shall be used for further distribution, use by IT loads.

There will be no electrical connection between the input and output

Server & Desktop+NTC UPS shall be with isolation transformer at output side.

The output rating of the transformer shall be same as the continuous duty maximum full load rating of the UPS.

It shall comply with NEMA TP-1 - Energy Efficient Distribution Transformers:

Windings: Copper

Harmonic Distortion: less than 1%

Efficiency: 98% at 35 % load

Insulation: Class H

Temp Rise: 70°C winding temperature rise

Impedance: 4-5% at rated load

Ventilation: Forced Air Cooling

Earthing:

Dedicated Cu earthing shall be provided for UPS & isolation transformer neutral earthing.

Body earthing shall be provided for UPS, Isolation transformer & battery rack.

Other

UPS shall preferably have Decentralized architecture for each module i.e. each module shall have its own separate System Logic, Control Card, Static Bypass, Power Unit, Display & Fan.

Field replacement of any electrical component or assembly (other than the transformer) shall be achieved without lifting of more than 40 pounds (18 kilograms) of weight and without the use of hoists or jacks.

The system shall be complete with all mounting stands, insulators, interconnecting accessories etc. all as per enclosed specifications and data sheets.

It shall be the responsibility of the CONTRACTOR to perform all checks on wiring for trouble-free operation of the equipment.

All the works in connection with completion of the system shall be in the scope of this tender.

The CONTRACTOR shall take all statutory approvals for the complete UPS System

One (1) set of spares separately for battery and UPS recommended for specified no of years trouble free operation.

The scheme shall be fuse less type.

For All UPS systems, the efficiency shall be 94% or more for a load variation between 50% to 100%. PF shall be 0.99.

MCCB's with microprocessor based OL, SC and EF releases of suitable rating shall be provided on the incoming and outgoing side of UPS system for local isolation.

To permit access through a standard single doorway opening, either the width or the depth of the UPS and battery cabinets shall not exceed 750mm.

SYSTEM DESCRIPTION

Input		
Supply voltage		415 V, 3 PH, 3 W, 50 Hz effectively earthed.
Allowable Variation		
(a)	Voltage	+ 10%
(b)	Frequency	+ 3%
(c)	Combined voltage + frequency	10%

Output	
Output voltage	Modular UPS: 415 V, AC, 3 PH, 4 W Lighting UPS: 240 V, AC, 1 PH, 4W
AC voltage accuracy (steady state) over entire load, load PF & DC voltage range.	+ 2% for balanced load + 3% for 20% unbalanced load (RYB 100%, 80%, 0% or 100%, 100%, 80%
Transient voltage regulation	+ 3% at 100% load step + 10%
Transient recovery	Return to steady state condition within 50 ms after disturbance.
Voltage wave from	Sinusoidal
Range of adjustment of AC output voltage	+ 1% at rated load
Input terminal Harmonic: Current THD at complete nonlinear load	3% typical at 100% load 6% maximum at 50% load Both can be complete non-linear
Phase displacement for three phase output	1200+ 10 for balance load, 1200+ 30 for 20% unbalanced load.
Nominal frequency	50 Hz
Frequency regulation (Without static by-pass source)	+ 0.1 Hz
Frequency regulation (With static by-pass source)	± 2 Hz

ENCLOSURE

Sheet steel thickness	2mm, CRCA for doors and 1.6mm CRCA for side covers

Degree of protection as per IS-13947	IP-20
Painting	
- Exterior	Powder Coating-Siemens Grey (RAL7032)
- Interior	Glossy white
Cable Entry	Front Bottom / Top – (As per site condition)
Acoustic Noise level	60 – 65 dBA upto 40 kVA 60 – 70 dBA above 40 kVA Measured at a distance of 1m
Space heater, 240V, 1 Ph	Required

CABLING

Cables between UPS, battery and isolation transformer as well as between 3 phase input supply and UPS thru MCCB are included in the scope of work.

All LT power cables shall be FRLS type with following specific requirements.

Cu conductor, stranded, grade H4, class 2 as per IS 8130.

Insulated with extruded XLPE compound.

Provided with inner and outer sheath of extruded black PVC compound (Type ST-2).

The control and annunciation cables will be 1100V grade, multicore, 2.5 sq.mm cross-section, annealed high conductivity stranded copper conductor, FRLS PVC insulated with inner and outer PVC sheath. The cables shall generally conform to IS: 1554-1988 with relevant parts thereof. All control cables shall be with following specific requirements:

Copper conductor stranded class 2.

Insulated with extruded PVC compound.

Provided with inner and outer sheath of extruded black PVC compound.

The construction, performance and testing of cables shall comply with IS: 7098 and IS: 1554-1988.

Uninyvin cables shall be used for connection between battery & UPS system.

All cables shall be terminated at both ends. Double compression glands with tinned copper lugs shall be used in indoor and outdoor application.

PERFORMANCE TESTS ON UPS

Type and routine tests certificates for all components made use in the UPS system shall be furnished. Tests for components shall be as per relevant standard indicated.

CONTRACTOR shall furnish his quality assurance plan for the equipment offered. The quality assurance plan shall include bought out components and assemblies used in the UPS system.

Routine tests on the complete UPS system shall be carried out as per relevant standards for each major sub-system in the UPS, viz., Rectifier, Inverters, batteries, stand-by supply etc.

System tests shall be performed on the completely assembled UPS system. System tests shall include frequency regulations. Voltage regulation, current limiting feature and harmonic content tests in addition to the tests to prove the functional requirements such synchronisation with range of adjustments, transfer of static switches for conditions of loss of square wave, overload and under voltage conditions.

Type, routine and optional tests covered under clause 7.3 of IEC-60146-4 shall be conducted on the UPS system in addition to the system tests.

Endurance test on static switches shall be performed for not less than 10 transfer / retransfer cycles at full load.

Heat run test shall be carried out on each branch of UPS including bypass (if provided) and on overall UPS system at rated load under relevant ambient conditions for a period of 8 hours. This test shall be conducted as a routine test on all UPS being supplied.

TRAINING OF PERSONNEL

Training of PURCHASER’s personnel shall be free of cost to enable them to operate, troubleshoot and maintain the offered equipment/ components. The general guidelines for the training requirement, description of type of training required and the duration of training shall be indicated by the Bidder to fulfil the above objective.

FACTORY ACCEPTANCE TESTS.

CONTRACTOR shall also include cost towards factory testing in presence of Consultant/ PURCHASER - 3 persons.

The CONTRACTOR shall inform the Consultant/ Engineer well in advance before delivering the equipment at site. It shall be discretion of PURCHASER to waive off the inspection of equipment.

STORAGE AT SITE

CONTRACTOR shall indicate the specific requirements, if any for proper storage of the equipment supplied at site.

In general, while shipping the equipment to site, Vendor shall ensure that each assembly or component shall be crated, boxed or otherwise suitably protected against damage or loss during shipment and to facilitate site storage. All openings shall be effectively sealed with temporary closures to prevent entry of dust, dirt, moisture and other foreign matter.

DOCUMENTATION:

Both hard and soft copies (Auto- Cad) of all CONTRACTOR drawings shall be furnished right from approval stage.

The CONTRACTOR shall plan his manufacturing schedule so as to allow at least two weeks time for approval of the drawings after their receipt by the PURCHASER.

Upon completion of the installation, the CONTRACTOR shall furnish a complete set of soft copies drawings (Auto- Cad version) in CDs and hard copies.

Drawings prepared by the CONTRACTOR and approved by the PURCHASER shall be considered as a part of the Contract Specification. However, examination and approval of the drawings by the PURCHASER shall not relieve the CONTRACTOR of his responsibility for engineering, design, workmanship, materials and construction under the Contract.

If, at any time before the completion of the work, changes are made necessitating revision of approved drawings, the CONTRACTOR shall make such revisions and proceed in the same routine as for the original approval.

The PURCHASER shall reserve the right to comment on drawings and documents under information category and inform the CONTRACTOR to treat these drawings and documents as approval category.

DOCUMENT TO BE SUBMITTED

Along with the BID.

Data sheets as asked for in the Specifications.

Type test certificates as asked for UPS & transformer.

After the Placement of PO/ LOI

UPS Room Space Planning

Tentative GA of UPS & isolation transformer.

Battery sizing calculations.

Product catalogue

General arrangement of UPS & isolation transformer

Battery catalogue & Battery sizing calculations.

Single line diagram

Bill of material.

BATTERY

SCOPE

This specification covers requirementsof sealed VRLA lead acid battery complete with battery racks, inter-cell and inter-tier connectors and all other accessories.

CODES & STANDARDS

The design, manufacture and performanceof equipment shall confirm to the latest applicable electrical rules, all currently applicable standards codes of practice, regulations and safety codes of the locality where the equipment are to be installed. In case of conflict between these standards and specification, requirements of this specification shall govern. Nothing in this specification shall be construed to relieve the CONTRACTOR of his responsibility.

All codes and standards referred to in the specification shall be understood to be the latest version on the date of offer made by the bidder unless otherwise indicated.

The CONTRACTOR shall ensure that instruments and gauges to be used for testing and inspection of critical parameters as identified in the specification have valid calibration and the accuracy can be traced to National standards.

FEATURES OF CONSTRUCTION

GENERAL

The equipment offered shallbe complete with all parts that are necessary or usual for the efficient operation of the equipment, whether specifically mentioned or not.

SEALED LEAD ACID BATTERY

The sealed batteries shall be starved electrolyte type (with electrolyte immobilised in a micro porous material) to allow recombining of generated oxygen internally. The battery shall be completely explosion resistant, shall tolerate freezing and shall not allow gases to escape during normal charging conditions. The battery shall not require any topping and be maintenance free. The batteries shall conform to IEC: 60896-2 or equivalent standard.

Connectors and Terminal Posts

Inter-cell and inter-tier connectors and terminal posts shall be of low resistance corrosion resistant alloy/copper. Terminal posts shall be designed to accommodate external bolted connection conveniently and positively. Each terminal post shall have two bolt holes of the same diameter, preferably at right angles to each other. The bottom hole shall be used to terminate the inter-cell connection. The top hole shall be left for PURCHASER'S terminal connection. All the metal parts of the terminals shall be lead coated if necessary. The VENDOR shall indicate this in the bid. The junction between terminal posts and cover and between cover, and container shall be so sealed as to prevent any seepage of electrolyte. All terminals shall be provided with FRLS insulated covers/shrouds.

At the take off points for the PURCHASER's cable connection a suitable arrangement shall be made to suit termination of PURCHASER's cables. The termination points shall be shrouded with transparent covers in order to avoid any accidental contact.

All inter row, inter cell and inter row connectors shall be covered with heat shrunk FRLS sleeves.

The shrouds for Battery terminal shall be of FRLS (anti static type)

Containers

Containers, cell lids, safety vents, acid level indicators, separators, connectors, electrolyte, shall conform to the relevant IS/IEC standards. The cell containers and vent plugs, in addition, shall conform to the safety requirements of UL 924 or equivalent safety standard. The safety vent shall be self Resealing pressure regulating with flame arrestor. In case the batteries are proposed to be housed in a sheet metal or polymeric enclosure, the same is deemed to be included in the scope of the bidder. The enclosure for battery shall conform to the safety provisions of UL 1778 or equivalent standard.

Container should have adequate Mechanical strength to prevent bulging, cracking etc. during the life span of battery when operating under expected temperature range and due to action of static and dynamic loads and the action of electrolyte.

Containers shall be transparent and of Flame retardant material.

THERMAL RUNAWAY

In order to prevent thermal runaway an air flow distance of 10 mm shall be provided between the cells.

ACCESSORIES

The battery shall be complete with accessories and devices, including but not limited to the following:

Battery racks

Cell and stand insulators.

Set of intercell, inter-tier and interbank connectors as required for the complete installation.

Accessories for testing and maintenance.

a)	One	-	±3 volts DC voltmeter with built in discharge resistor and suitable leads for measuring cell

			voltage.
b)	Three	-	Pocket thermometers
c)	Two	-	PVC aprons
d)	Four	-	PVC gloves
			Any other protective wearing apparatus if required, to be specified by VENDOR
e)	Two	-	Cell lifting straps
f)	One set	-	Terminals and cable boxes with glands for connecting cable as required.
			Spare connectors
			Spare vent plugs
			Spare nuts and bolts
			Suitable set of spanners
			PVC spill trays under the battery cells.
g)	Insulated wrencher		

BATTERY LAYOUT

The bidder shall review the battery room dimensions/ Layout drawings included with the tender specifications and suggest suitable battery layout, providing dimensioned drawings.

An air flow distance of 10 mm shall be provided between the cells to allow better heat dissipation and minimise chances of thermal runaway.

No of battery banks shall be as specified under UPS section above.

BATTERY RACKS

Battery racks shall be constructed from good quality teak wood and painted with two coats of polyurethane which acts as a strong resistant to sulphuric acid and fitted with cell number plates . Metallic stands designed to withstand the seismic forces shall be provided suitable for the seismic zone. Metallic stands shall be painted with acid resistant paint after 2 coats of primer. The construction of the racks, shall be suitable for fixing to a flat concrete floor. The racks shall be rigid,

mechanically strong, free standing type and free from wrap and twist. The completed racks shall be suitable for being bolted end to end to form a continuous row. Insulators shall be provided below the legs of the stands.

The racks shall be of single tier/ two tier construction depending on the final layout based on space availability. The number of tiers shall be subject to PURCHASER's approval.

VENTILATION

The BIDDERS shall indicate in the tender, requirements of ventilation in the battery room.

BATTERY SIZING

The no. of cells in the battery shall be offered by BIDDER. The BIDDER shall guarantee the performance of the battery for the duty requirements indicated over the entire range of temperature and also at the minimum ambient temperature specified with the derating factors and ageing factor and temperature correction factors. The procedure for sizing the battery shall be as detailed in IEEE 485. Design margin to be considered has been specified in Design Criteria above.

DC system voltage at DC bus shall be specified by the BIDDER.

The Normal cell voltage shall be 2.0 V per cell

The Max Float charge voltage shall be 2.25V per cell

The Max Boost charge voltage shall be 2.75V per cell

The End cell voltage shall be 1.85 V per cell

The Total Momentary Load/Duration/Voltage at the end of this duration – To be defined by BIDDER

The Total Emergency Load/Duration/ Voltage at the end of this duration - To be defined by BIDDER

The Continuous Load/Duration/ Voltage at the end of this duration - To be defined by BIDDER

For selecting the number of cells, bidder shall consider a voltage drop of 3 % between the battery and the UPS.

BIDDER shall demonstrate theperformance ofthe battery at the specified duty cycle, at the specified min. ambient temperature during pre-dispatch inspection, by conducting test on a randomly selected cell.

Ambient conditions	Min. Temp.	5 Deg. C
	Max. Temp.	45 Deg. C
	Ave. Temp.	32 Deg. C

CHARGING

The proposed method of charging the battery shall be Float cum Boost.

BIDDER shall state whether an equalising charge is recommended for the battery. If so, the equalising charging voltage, current, duration and the interval between the equalising charging shall be specified in the BID. BIDDER shall also indicate the requirements for boost charging.

The charger shall be constant voltage, current limiting type unless otherwise stated.

LIFE

BIDDER shall quote in his offer the guaranteed life of the battery when operating under the conditions specified.

TESTS

All tests shall be conducted as per the relevant standards .Tests shall include following Type & Acceptance tests.

i)	Type Tests	:	Performed at MANUFACTURER'S works
ii)	Acceptance Tests	:	Performed at site after installation and commissioning of the battery.

All tests shall be witnessed by the PURCHASER'S representative.

Details of tests to be performed are given below.

TYPE TESTS

Type tests shall comprise of the following:

i) Visual inspection

ii) Dimensional check

iii) Capacity

iv) Retention of charge test

v) Ampere-hour and watt-hour efficiency test.

vi) Endurance test

vii) Start circuit current and Internal resistance measurement test.

iviii) Test for suitability of floating battery operation.

In application where the first momentary discharge is high and, lasts for several minutes a high discharge test shall be conducted, in addition to the above tests.

Type test report on an identical type and capacity of the battery shall be submitted for PURCHASER's review. If type tests reports are not available then these Type tests shall be conducted on a minimum of one sample cell typical and identical with the cells forming the complete battery offered. However, the test cell shall not be one of the cells offered in the battery offered.

ACCEPTANCE TESTS

Acceptance tests shall be conducted at site on completion of installation and commissioning and immediately prior to putting the battery in service. These tests shall comprise of:

Visual inspection

Dimensional check

Capacity test

Test for voltage during discharge

Storage test

Insulation resistance

Vendor shall carry out the capacity test for the following conditions:-

For the load cycle

For 10 Hr discharge as per IS-1651

The battery voltage at the end of the cycle time shall not be less than the values specified.

The vendor shall ensure that instruments and gauges to be used for testing and inspection of critical parameters as identified in the specification have valid calibration and the accuracy can be traced to National/International standards.

TEST REPORTS

A copy of routine and type test results shall be submitted for approval before the dispatch of batteries. Specified number of bound copies of complete test results shall be furnished with the batteries.

SPARE PARTS

BIDDER shall include the following items in his recommended list of spare:

Inter-cell/ Inter-row/Inter-bank/connectors

Battery stand insulators and cell insulators

Nuts, bolts, washers, etc.

Vent plugs/Vent plugs cum level indicators

Complete set of spare cell (without electrolyte for Ni-Cd cell)

IDENTIFICATION

Each cell shall be marked in a permanent manner in accordance with relevant standard. In addition, each cell shall be legibly numbered serially to identify the cell during manufacture, testing, installation and operation of battery to identify after having assembled into battery bank in battery racks. A set of loose stickers shall be provided to mark the cells position in the assembled battery bank.

Each cell shall be marked as per IS-1651 and IEC-486-1. Additionally the polarity of the cells shall also be marked.

TRANSPORT

The sealed lead acid battery shall be transported with the electrolyte immobilised, sealed & fully charged.

EARTHING & LIGHTNING PROTECTION SYSTEM:

Scope:

The scope includes collection of data, design of the system as per relevant National/International Standards preparation of layout drawing supply of earthing conductors, earth electrode, earthing strips installation and approval to the satisfaction of electrical inspector under this tender specification.

Earthing system shall be provided to ensure equipment safety, personnel safety and facilitate designed operation of protective switching during earth fault conditions in the associated system.

Codes and Standards:

The general design shall be on the basis of following codes and standards (their latest amendments) in line with design criteria & specification requirements.

IS 3043-1987 – Re-affirmed in 2006: Code of practice for Safety Earthing

IS / IEC 62305: Protection against lightning.

IEEE 80 – 2000: IEEE Guide for Safety in Sub-station Earthing.

Central Electricity Authority (CEA) Regulations – 2010

IEEE 1100- Electronic earthing.

IEEE – 142: IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems.

The maximum values of earth fault current for the design of the earthing system will be considered based on system requirement as follows:

11 kV or 33 kV systems : 25 kA for 1 sec

415 V systems : As calculated based on the system design for 1 sec

EARTHING CONDUCTOR LAYOUT

The design basis for designing earthing conductor is indicated under design criteria for electrical system. Earthing system shall be provided for complete plant i.e. Soild waste plant, switchyard and all electrical equipments as per the latest edition including all official amendments and revisions of IS-3043 and CEA guidelines.

All materials and fittings used in the earthing installation shall conform to the relevant Indian Standards or shall be approved by the Engineer's representative & CEIG.

CONTRACTOR has to carry out soil resistivity test at, at least 4 locations for which locations shall be provided by PURCHASER’s representative. Testing to be done at each site.

Soil resistivity shall be carried out by Wenner four electrode method as described in IS 3043. CONTRACTOR has to carry out the test in presence of PURCHASER's representative & test shall be carried out keeping electrode spacing as 1, 2, 4, 6, 8, 10, 15, 25 M (each, along all 8 directions) as per normal practice and report has to be submitted. Polar curves shall be used for measurement of mean soil resistivity, which shall be used in finding earthing resistance at a particular location. Mean soil resistivity values/ the results/ report shall be certified by Govt. Authorised Labs or agencies.

The CONTRACTOR shall base his earthing calculations on actual measurement carried out as explained above.

Galvanized Iron flat / wire shall be used as earthing conductor. Copper flat / wire shall be used if specifically mentioned.

The underground joints in the system shall be properly welded or brazed and the bolted type connection shall be made with structures/ equipments. Welded and Bolted joints shall be covered with bituminous compound/ tapes as suitable. Welding shall be done as per IS 816.

Earthing conductor shall be protected against mechanical damages considering the installation conditions.

The earthing system shall comprise of earth electrodes, earthing grid or a combination of these in order to obtain the required earth electrode resistance of less than 1 Ohm.

For equipment earthing, two earthing leads will be used if rated voltage of the equipment is 250 Volts & above and one earthing lead will be provided for equipment rated below 250 Volts.

The earthing conductors in outdoor areas shall be installed at a minimum depth of 600 mm below FGL.

For each 11 kV DP Structure, minimum 2 nos. of GI plate type earthing electrodes shall be provided. The earth plate shall be buried in specifically prepared earth pit- 3 mtr. below ground with alternate layers of charcoal and salt, 40 NB GI pipe with funnel with a wire mesh for watering and bricks masonry block and CI Cover complete as per IS 3043 with necessary length of double GI earth flat bolted with lug to the plate complete connected to the required point of DP with end socket as per direction and duly tested by earth tester conforming to IS.

For each transformer neutral, minimum 2 nos. of Cu plate type earthing electrodes shall be provided. The earth plate shall be buried in specifically prepared earth pit 3 mtr. below ground with alternate layers of charcoal and salt, 40 NB GI pipe with funnel with a wire mesh for watering and bricks masonry block CI Cover complete as per IS 3043 with necessary length of double Copper earth flat bolted with lug to the plate complete connected to the transformer neutral with end socket as per direction and duly tested by earth tester conforming to IS as per drawing and specifications complete with 600 x 600 x 3.15 mm Copper earth plate.

For other equipment & area, Earth electrodes shall be of heavy duty galvanized mild steel of not less than 40 mm NB and minimum 3000 mm long. Where multiple rods are used they shall be separated by a distance of not less than 2000mm.

Each earth electrode pipe shall be welded at the top to a mild steel plate to which the earthing strips shall be connected. These connections shall each be housed in individual inspection chamber set which shall project 100 mm above the finished ground level and shall allow disconnection for testing of individual electrodes. The chamber shall be permanently marked `Electrical Earth'.

All materials used for the earth electrode installation shall be purpose made for the application and site conditions and shall be approved by CEIG.

All civil works, such as excavation, boring, provision of charcoal & salt in adequate quantity, backfilling for the installation of the earth electrodes and the earth pit/ inspection pit shall be in the scope of CONTRACTOR.

After the earth installation has been completed the CONTRACTOR shall demonstrate to the PURCHASER/ PURCHASER’s Representative that the resistance of the electrodes to earth and the continuity of the earth network are within the limits specified. Any additional earth electrodes and test instruments required for the tests shall be provided by the CONTRACTOR.

Main equi-potential bonding conductors shall be provided to connect the earth electrode system to conductive parts forming the Works.

An independent circuit protective conductor shall be provided for each circuit and may comprise one or any of the following as appropriate:

A separate core within a multicore cable

A separate conductor installed within a conduit or trunking. Steel conduit or trunking shall not be used as a circuit protective conductor.

The metal sheath of an armoured cable. The sheath shall be bonded to the metal work of the apparatus and to the apparatus earth bar, if any.

the copper sheath of a mineral insulated copper sheathed cable

An independent earthing conductor MS or GS run adjacent to the circuit it protects.

The size of the circuit protective conductor shall be calculated in such a manner as not to take into consideration the contribution of any other parallel or fortuitous earth paths.

The armour of the supply cable shall not form the sole means of earthing a switchboard or distribution panel.

Instrumentation Earth:

An instrumentation earth bus shall be provided in each control panel. This shall comprise a GI flat of cross section not less than 25 x 6 mm and length to suit the number of connections. It shall be mounted on at least two insulated supports and be provided with a single earth connection to the control panel electrical power earth.

If due to the physical size of a control panel more than one instrument earth bar is required the additional bar shall be connected again with a single earth connection to the same point as before on the control panel electrical earth bar. In this fashion all instrument earths shall be connected radialy from the same earth point.

All signal cable screens (analogue and digital) shall be terminated on to the instrument earth bar. Signal cable screens shall be earthed at the control panel end only. Screens at the field end shall be tied back and insulated.

Surge Protector Devices (SPDs) associated with the control and instrumentation system shall be earthed to the instrument earth in accordance with the SPD manufacturer's recommendations.

Server Earthing:

The earth connection and the no. and type of earth pits required for the Server shall be as specified by the Server OEM and System integrator.

Important Instructions for Earthing:

Each pole of lightning arrestors shall be earthed with separate earth pit.

Two-earth conductor shall connect outdoor CT secondary winding to earth grid.

The switchyard fencing shall be earthed at every alternate block and the switchyard gate shall be earthed with flexible GI wire.

All the earthing material with laying etc. shall be included in the scope.

The entire Building will have an earth grid laid in trenches/ trays/ buried in the ground outside. The main earthing grid shall be embedded at a minimum depth of 600 mm below FGL which shall be connected to earth electrodes.

All interconnections of the earthing grid conductors will have welded type joints except at electrodes with disconnecting facility and at equipment with bolted connections. All indoor earthing grids will be suitably interconnected to the external earthing grid.

Each steel/ RCC column of the building will be interconnected to the floor-earthing grid. Steel columns, steel strips / conduits, cable trays etc. will not be used as earth continuity conductors.

Disconnecting type facility shall be provided between Earthing grid & each earth electrode.

All connection between the conductors shall be welded/ brazed type. Metallic pipe, conduit, structures shall be bonded to lightning protection conductors to prevent the side flashover. But no metallic pipe, conduit, structure shall be used as air termination conductor or down conductor.

The down conductors shall be fixed with embedded brass posts (on concrete columns) with nuts & bolts used for fixing the saddle/ clamp (direct drilling of down comer and fixing with screw shall not be acceptable).

Cleats for 'earthing and lightning protection systems' shall be of GI.

The lightning protective conductor shall not be connected with the earthing above ground however both the systems shall be interconnected below ground.

The earth pits may require boring & drilling in the soil & the same shall be considered in CONTRACTOR's scope.

Earth electrode with disconnecting facility shall be provided so that the resistance of the independent earth electrode may be measured.

Internal earth Bus of each panel shall be connected to both ends to the earthing system by means of earthing conductor.

Metallic frames of all current carrying equipment, structures supporting and adjacent to current carrying conductors, lightning protection system conductors, metallic structures, metallic stairs, hand rails, fences shall be connected to a single earthing system. Neutral points of various systems shall be connected to the dedicated treated earth pits and these earth pits shall be interconnected to each other below ground.

All connections in the equipment earth conductors buried in ground (or otherwise) shall be cad welded/ brazed, whereas connection at equipment end shall be of bolted type. All connections shall be of low resistance. All bimetallic connection shall be treated with suitable compound to prevent moisture ingression. For Bimetallic bolted connection, bimetallic washers shall be used. All bolted joints shall have minimum two bolts to ensure proper surface contact. Termination of stranded conductors at earth inserts shall be with ring type/ lugs.

Galvanized conductors shall be touched up with zinc-rich paint where holes are drilled at site for bolting to equipment/structure.

Suitable earth risers approved by the Engineer shall be provided above finished floor/ ground level, if the equipment is not available at the time of laying of the main earth conductor. The minimum length of such risers inside the building shall be 200 mm and outdoor shall be 500 mm above ground level.

Metallic conduits and pipes shall be connected to the earthing system unless specified otherwise.

All cable trays will be earthed at minimum two places by suitable sized GI flats to main earthing system earth conductor. The cable trays shall also be earthed at a regular interval of not more than 10 meters by the same size GI flat as run along the tray.

Wherever earthing conductor cross underground service ducts, pipes, trenches, tunnels, etc. or Road, it shall be laid in Hume pipes at minimum 600 mm below them. The earthing conductor shall be re-routed in case it fouls with equipment foundations.

Wherever earthing conductor passes through walls, floors, etc. galvanized conduit / HDPE pipe sleeves shall be provided for the passage of the conductor. Both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves. The seals, in addition, shall be fire proof if the specifications/project drawings call for the same.

Water stops shall be provided wherever earthing conductor enters the building from outside, below grade level.

Earthing conductor around the building shall be buried in earth at a minimum distance of 1500mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500mm away from such location.

Earthing conductors embedded in the concrete floor of the building shall have at least 50mm concrete cover.

Earthing conductors along their run on columns, walls, etc. shall be fixed by suitable welding or cleating at intervals of 1000mm and 750mm respectively. Earthing cables crossing other metallic structures such as conduits pipelines etc shall be minimum 300 mm away from such structures. Earthing conductors shall be protected against mechanical damage. All earth lead connections shall be as short and direct as possible and shall be without kink.

The main earth loop in the plot area shall be generally routed along cables. When equipments are located away from main earth loops, suitable sub-loops shall be run up to them for deriving connections for individual equipment. The entire earthing system shall fully comply with the CEA guidelines and requirements.

The CONTRACTOR shall have to carry out any changes as desired by the Electrical inspector or the Engineer in charge, in order to make installation conforming to the CEA guidelines 2010 and IS 3043.

Earthing Pits

Adequate number of earthing pits shall be provided in conjunction with earthing grid for the earthing system. The minimum spacing between two adjacent earthing pits shall not be less than 2000mm and shall be kept 1500 mm away from footings of the structure.

Earthing pits shall be located in ground, which has a reasonable chance of remaining moist. Arrangement comprising of GI pipe with top funnel with wire mesh shall be made to facilitate pouring of water to keep earthing pit wet.

A galvanized iron strip of adequate size (as per calculations) shall be provided from plate electrode to about ground level to facilitate jointing with earth conductors. Each earth electrode ending at the pit shall be connected to suitable linking strips to connect and disconnect the earthing suitably.

Earthing chamber shall be of RCC/ brick chamber of 600 mm x 600 mm, with Hinged cast Iron chequered cover plates. The covers shall have holes for handling. Earthing pits (chambers) shall be painted Green and the earth-pit number shall be marked on it.

Cable Earthing

Metallic sheaths, screens and armour of all multi-core power/control cables shall be earthed at both equipment and source/switchgear end. Sheath and armour of single core power cables shall be earthed at source/switchgear end only, unless other-wise stated elsewhere.

Lightning Protection:

The lightning protection system need will be established by calculating the risk factor value of each building, structure etc. as per procedure given in IS/IEC 62305-2010 and if found necessary the same shall be provided by the CONTRACTOR.

For Lightning protection of Civil Structures including RCC Buildings, fixing of 25x6 mm GI earth strip to roof as per IS/ IEC std, saddle clamp, down comer connector etc. as required with all hardware shall be in CONTRACTOR’s scope.

Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.

Down conductors shall be cleated on outer side of the building wall at 750 mm interval or welded to outside building columns at 1000 mm interval.

Connection between each down conductor and rod/pipe electrode shall be made via test link.

Lightning conductors shall not pass through or run inside G.I. conduits.

All metallic structures within a vicinity of 2000 mm in air shall be bonded to the conductors of lightning protection system.

Galvanizing:

Wherever galvanizing has been specified, the hot dip process shall be used. The galvanized coating shall be of uniform thickness. Weight of Zinc coatings for various applications shall not be less than those indicated in the standard.

Burrs shall be removed before galvanizing. Any site modification of galvanized parts should be covered well by zinc rich primer and aluminium paint.

CONTRACTOR shall ensure to use calibrated test equipment having valid calibration test certificates from standard laboratories traceable to National Standards.

Drawings/ Documents Required:

The CONTRACTOR shall submit the Earth resistivity measurement Report duly attested.

Earthing calculations based on the above earth resistivity and the calculated or estimated fault level.

The CONTRACTOR should prepare Layout drawings, after award of contract and before commencement of work for PURCHASER's approval, showing the location of earthing grid, electrodes, interconnection grids and earthing leads to various equipment, down comers, isolating links etc. should be accompanied by design calculations.

LIGHTING & RECEPTACLE SYSTEM

The scope of the CONTRACTOR shall include Design, Engineering, manufacture, testing at manufacturer's works, supply to site, unloading & handling, cleaning and assembly, installation, commissioning and performance demonstration of the of Illumination system and Receptacle system for Control & Command Centre Building and its adjoining area within the battery limits.

The lighting system includes luminaires & lamps, lighting panels (LP), Raw power distribution boards (RDB), modular switchboards, Modular and non-metallic industrial Receptacles, JBs, cables/wires for lighting/receptacles, conduits, support accessories etc.

The illumination levels to be considered for the design of lighting system for various areas shall be as per the National Lighting Code and BIS standards.

Lighting design shall be performed using latest version of DiaLux Software/ Original Equipment Manufacturer (OEM) validated software. The Validation Report along with software and data files shall be acceptable to PURCHASER/ PURCHASER's representative.

The CONTRACTOR shall carry out Lux Level test in each area and submit a report for the same to the PURCHASER as part of the performance demonstration. The same shall be compared with the Guaranteed performance parameters for any deviation and due rectifications.

After completing the erection work, the CONTRACTOR shall carry out various pre commissioning checks and commissioning tests on the distribution boards, light fittings, sockets and cables and all other items, to ensure that these are fit for energizing and operation on load.

The lighting system will comprise the following:

NORMAL AC LIGHTING - Normal lighting in all indoor and outdoor areas will be operated on normal 230V, 1Phase, 50 HZ A.C supply with DG back up fed from PCC. Minimum one no. individual Normal Lighting panel shall be provided for each floor lighting located at suitable place with proper access at all the times.

CRITICAL AC LIGHTING - Emergency Lighting shall be provided at all junctions, exit passages and near critical Work Places in each of the building from UPS DB with UPS power supply. Critical Lighting shall be designed for around 10 Lux. CONTRACTOR shall estimate the rating of such UPS and consider the supply and installation of the UPS along with associated DB and entire cabling/ wiring in the scope. Minimum 10% of the total lighting luminiares in a particular area shall be considered as Critical Lights.

Non-Maintained luminaries having inbuilt battery source for specified duration, shall also be provided in the outdoor working and critical areas like CSS enclosure/ DG enclosure on either side to approach the sets in emergency.

OUTDOOR LIGHTING – The Lighting of the outdoor areas like Parking, Transformer/ DG yards, approach roads and landscape within the battery area shall be operated with a time switch guided contactor.

The unit rate quoted for installation shall include all material to mount the fixtures in proposed manner. The various types of luminaires to be supplied & installed are listed below.

Recessed type luminaire fixing shall not rely on false ceiling strength alone. The luminaires shall be additionally supported / hung from ceiling/ cable tray supports with a hot-dip galvanised chain/ clutch wires.

The tension of clamps for fixing to ceiling shall be moderate (The ceiling should not be damaged while removing the Luminaire. Nor it should be too loose so as to cause the offset luminaire). The clamps shall also not cause dents on reflector during regular installation & maintenance handling.

Luminaire housing shall be strong enough as not to buckle/ twist while handling (including holding at two ends).

Luminaires shall be suitable for loop-in & loop-out with suitable terminals & twin cable entry size.

The accessories shall be more rigidly mounted to avoid transit damages/ displacement of accessories. If required, separate protection should be provided.

The scope of the CONTRACTOR shall include Supply and installation of luminaires including lamps, lighting panels (LP), switchboards, receptacles & JBs, cables/ wires for lighting/ receptacles, conduits, termination and performance testing etc.

Offers shall include comprehensive technical details of the luminaires which will be supplied by installation CONTRACTOR and the lamps being offered. The details must be sufficient to take into consideration maximising of energy efficiency and minimising overall Building power consumption.

All fittings in Workstation/ office areas shall be suitable for false ceiling of 600x600mm size. The Lighting Power Density for this area shall be min 0.5W/sqft.

For luminaries (For Office, labs etc.), 0.75 kV grade multi stranded Copper conductor FRLS PVC insulated wires of area not less than 2.5 sq mm (for Ph+N) & 1.5 sq. mm (for E) shall be laid in 25/32 mm dia. black enamelled MS conduit shall be used.

Wiring shall be concealed in wall below false ceiling with concealed/surface mounted switch board. Minor civil work like chasing wall, cut outs for conduit, switch board, LP in wall, entries for tray, conduits etc. is in CONTRACTOR’s scope.

The BIDDER shall note that any chasing in walls or cut-outs or openings such as fixing of LPs, DBs, switchboards, concealing conduit in wall etc. in walls required shall be made before plastering of brickwork wherever applicable and installation rates quoted shall be inclusive of chasing, cutting & making the plaster as per standard practice/ as instructed

All the cables / wires used in Workstation/ office areas with false ceiling areas shall be FRLS type only.

Lighting panels shall be provided in various areas and circuit wiring/ cabling to the lighting fixtures shall be made from lighting panels. Lighting panel shall comprise of per phase isolation/ without per phase isolation.

For panels having per phase isolation, 1 no. of FP MCB as incomer, along with 3 nos. of DP RCCB (100mA) & 6/8/12/ 24/ 36 SP MCB outgoings shall be considered for RDB/ ELP/ NLP.

For panels without per phase isolation, 1 no. of FP MCB + FP RCCB (100mA) as incomer & 6/8/12/ 24/ 36 SP MCB outgoings shall be considered for RDB/ NLP/ ELP

For all lighting panels, RCCB sensitivity shall be 30mA.

The lighting panel for outdoor lighting shall have a programmable timer for automatic control of lighting along-with contactor, MCB, auto/ manual selector switch.

The lighting panels / receptacle distribution panels shall be minimum IP 54 protected, metal door, wall / column mounted panels

Lighting for street light fixtures/ flood light fixtures shall be carried out with cables. The supply of junction boxes, street light poles & structural steel required for mounting fixtures/ LPs etc. are in the scope of CONTRACTOR.

For outdoor lighting/ street lighting, cable installation from OLP to junction box & further wiring /cabling up to fixture mounted on the pole is in CONTRACTOR's scope.

CONTRACTOR's scope shall also include excavation, preparation of soil bedding, supply and installation of protection cover/ Class A brick, back-filling, supply and installation of cable route markers etc. The rate shall also include arrangement for looping in & looping out arrangement of cables/ wires for circuiting, where ever found necessary.

The scope of the BIDDER shall include the supply, erection, testing and commissioning of the above LPs/ DB boards for supply of power to the various sockets required for computers, Air-conditioning/ ventilation and raw power points. The point wiring from these DBs shall include supply of wires, conduits, cleats/ clamps, support arrangement etc. as may be required and shall be in the scope of electrical CONTRACTOR.

All mounting accessories like base channels, cross angles if required, nuts, bolts etc. shall be supplied by the Bidder under the scope of this contract.

For security reason if Flood/ Boundary lighting is deemed required then the same shall be provided by the CONTRACTOR with 250W Metal halide (MH) light fittings mounted on 8 or 9 m octagonal poles mounted along the boundary fence/ wall.

POINT WIRING:

For lighting circuits, Point wiring covers the wiring between a circuit of the lighting panel to switchboard and then from switchboard to lighting fixtures connected to that circuit of the lighting panel.

For receptacle circuits, point wiring shall cover wiring between circuits of the receptacle DB to receptacles connected to that circuit of the RDB.

Lighting fixtures and ceiling fans/toilet exhaust fans will be grouped on the circuit wherever required. However, separate circuits shall be used for receptacles wiring.

Switchboard shall consist of consisting of piano switches with/without indicator (only receptacle/socket switch shall be with indicator & balance all switches shall be without indicator), white coloured cover plate for modules -as applicable, 1/2 nos.2/3 pin shuttered socket of 6/10/13A and metal flush box/surface mounted box as required.

Point Wiring rate shall include 0.75 kV grade 2.5/1.5 (E) sq mm for lighting points and 4/ 2.5 (E) sq mm for power points, FRLS PVC insulated multi-stranded copper conductor wiring in MS conduit with its complete accessories running concealed/exposed in ceiling and in partition and concealed/exposed on brick wall, earth wire, 25mm MS conduit, clamps, hardware and accessories etc.

Wires of the different phases shall not be laid in the same conduit.

Earthing wire shall be laid along with the Ph and Neutral wires in the same conduit.

Lighting for staircase shall be controlled with flushed modular switch. The conduit for main staircase shall be concealed. Lighting for all staircases shall be with 2 way switch.

The necessary connector if found required for looping of wires from one switchboard to another switchboard shall be included in the scope.

CONTRACTOR shall estimate rate considering span between fixtures referring lighting layouts.

Preparation of conduit layout as per point wiring is included in Installation CONTRACTOR's scope.

Wiring shall be done in wire colour codes. Colour code of wire for phases, Neutral and earth shall be separate.

Wherever found necessary blanking plates shall be provided by CONTRACTOR, for which rates shall be included in point wiring.

Bidder shall consider grouping of lighting fixtures, Control schedule, Switch control for light fitting/ceiling fan/exhaust fans as deemed suitable and justify the same.

Neutral for individual circuit shall be run separate from RDB/LP.

Neutral for individual circuit shall be run separate from DB to individual receptacles.

Time switch: Schneider or equivalent make Digital type Astronomical Timers shall be used for the outgoing feeders of ELDBs & outdoor lighting panel. The time switch shall have remote switching feature. Time switch shall be with A/M/bypass/OFF selection facility (either inbuilt or external through a separate switch).

Casing capping shall be used only in case PURCHASER specifically asks for the same during execution, other wise metallic conduit & it's accessories shall be considered for point wiring.

For computer work station:- Point wiring shall be considered as per the number of receptacle points. 2 Nos. UPS points (2 nos. of 6/10/13A Sockets with switches) and 1 No. Raw power socket point (1 No. 6/10/13A socket with switch) are considered per workstation. 4 nos. of such workstations are considered on one single phase circuit of UPS workstation DB. Whereas, 8 nos. of raw power receptacles

are considered on one single phase circuit of Raw power receptacle distribution boards. For UPS wiring in office area 1.1kV grade, FRLS PVC insulated, stranded copper conductor wires of area not less than 2.5 sq mm shall be used. Neutral for individual circuit shall be run separate from UPS workstation DB. 1.5 sq mm FRLS PVC insulated earth wire shall be considered. Earth wire can be looped for different circuits. These wires shall be laid in raceways/ conduits to be embedded in wall/floor by the Bidder. BIDDER shall quote for average point rate based on the same.

GI Raceways of minimum 75X40mm size or above, as suitable, shall be laid in floor along the fixed furniture line to carry wires for the workstations.

Separate raceways shall be laid for data and power cables/ wires.

Street Lighting Pole:

Hot Dip Galvanised Octagonal Poles shall be used for outdoor lighting to get minimum 15 lux along all the roads. Poles shall be installed at the outer edge of the footpath, wherever footpath is aligned adjacent to the roads. The scope shall be inclusive of civil works such as making pit, foundation, concrete supply, supply & fixing, foundation bolts, base plate, welding, painting of base portion, supply and fixing of 2 nos. 50mm dia flexible DWC pipes for cable entry, integral type junction box with necessary MCB (Schneider / Legrand make MCB C-Curve type) protection, and terminal blocks shall be included. Terminal block (TB) shall be suitable for loop in loop out of the 4CX10/16/25 sq. mm Cu conductor, XLPE insulated, GI armoured cables as well as PVC FRLS wiring from the TB upto the street light luminaire. Each pole & integral JB shall have suitable studs for connection of earthing strip of 25 mm x 6 mm size. Similarly earthing shall be continued till the luminaire by using PVC FRLS wires.

The pole shaft shall be made of single piece MS structure continuously tapered having polygonal (8 sides) cross section and a single longitudinal welding. The welding shall be done as per IS 9595. No circumferential welding shall be allowed in the pole shaft. The MS shall conform to BSEN 10025. Min. sheet steel thickness shall be 3 mm. The structure shall be single section hot dip galvanized as per IS 2629. Internal & External surface of the poles shall be hot dip galvanized to Min. 80 micron DFT.

A suitably designed door shall be provided at 600mm height from the pole base. The door opening will be suitably reinforced for structural strength. The door shall be flushed with pole external surface and shall provide easy access for electrical connections at a maintainable height. Door shall have pad locking facility, which shall be operable using special key.

A Suitable base flange and a top flange shall be welded and suitable reinforcements shall be provided. Foundation accessories shall be as per IS 1367.

LUMINAIRES

Light source should be LED of all the luminaires to be used for the lighting of Command Centre (Indoor and Outdoor). Luminaires in all the areas are non – dynamic in nature and should have following product characteristics.

Optical efficacy of luminaire	90lumen/watt.
Driver efficiency	> 85%.
THD	<10%
CCT	6500 K
CRI	> 80

Luminaires to be designed for L70 B50 lifetime performance.

LED make shall be Lumileds / CREE/ Nichia / LG/ OSRAM

Electrical Specifications of LED Driver

1. Universal Input Voltage 240 V AC ± 5% (140V to 277V Range)

2 Input Frequency 50 Hz ± 3%

3 Surge & Spike Protection > 3 KV

4 Power Factor >0.90

5 THD (I) < 10%

6 Driver Efficiency > 90%

7 Operating Temperature 0 to 50 Deg C

8 IEC Compliance Confirming to IEC- 61347-1 & IEC 61347-2-13,

IEC 61547, 610-3-2, CISPR-15

Selection of Luminaires – The below indicated luminaires are the minimum requirement

Street lighting/outdoor area lighting shall be LED Luminaire - Philips Make Road lighting Luminaire series of Greenline extra or Equivalent of suitable wattage as per the road width.

Passage & lobby, change room, rest room, reception, waiting area, pantry and other similar functional area shall be provided with Recess mounted, IP20, Industrial LED Type with high pressure die cast Aluminium body, soft opal diffuser & glass cover suitable for LED lamps with electronic driver - Luminaire & Lamp shall be Philips make12W RECESSED MOUNTED LED DOWN LIGHTER SIMILAR TO Philips DN296B LED12S PSU WH_LED OR Equivalent

Toilets and other similar functional area shall be provided with Recess mounted, IP20, Industrial LED Type with high pressure die cast Aluminium body, soft opal diffuser & glass cover suitable for LED lamps with electronic driver - Luminaire & Lamp shall be Philips make 8W RECESSED MOUNTED LED DOWN LIGHTER SIMILAR TO Philips DN295B LED8S PSU WH_LED OR Equivalent

Office area, Control Room, Conference rooms, Meeting rooms, UPS, battery, store, and other similar functional area shall be provided with Recess mounted, IP20, Industrial LED Type with high pressure die cast Aluminium body, soft opal diffuser & glass cover suitable for LED lamps with electronic driver - Luminaire & Lamp shall be Philips make 36 W RECESSED MOUNTED LED SIMILAR TO Philips RC380B LED36S-6500 G4 L60 W60_LED OR Equivalent

PERFORMANCE REQUIREMENTS OF LUMINAIRES:

Luminaries shall be guaranteed against quality (including any component failure and deterioration/appearance of corrosion symptoms. This shall also cover any fading (reduction)/ deterioration of reflector coating). In such case the defective luminaire shall be replaced without any cost. In case identical defects are observed on more than 5% of particular type of luminaire (installed quantity), then the complete lot of supplied/ installed luminaires of similar type shall be replaced free of charge).

Offers shall include comprehensive technical details of the luminaires and the lamps being offered. The details must be sufficient to take in to consideration maximizing of energy efficiency and minimizing overall shop power consumption.

Luminaire housing shall be strong enough as not to buckle/ twist while handling (including holding at two ends).

Outdoor luminaires shall be strong enough to withstand strong winds likely to be witnessed at the location.

Luminaires shall be suitable for loop-in & loop-out with suitable terminals & twin cable entry size.

Lamp life specified by bidder shall be at the end of the 50% failure.

Bidder to provide all the technical details, test certificates, data sheets along with the offered luminaire / lamps.

Losses of all luminaires under the scope of supply shall also be guaranteed.

MAINTENANCE REQUIREMENTS

Bidder shall supply maintenance tools including special tools, if required, for attending to the equipment supplied at no extra cost. As far as practicable, the equipment and accessories shall be so designed that no special tools are necessary for installation and maintenance of the equipment. However, if special tools are required, the Bidder shall include price of one complete set for each type of equipment

Bidder shall submit an itemised list of spares, for three (3) years trouble free operation, with prices in his offer. The prices quoted for spares shall be furnished with basic price and all applicable taxes / duties separately. No variation will be allowed in this basic price for order placement up to the end of the guarantee period.

STORAGE AT SITE

CONTRACTOR shall indicate the specific requirements, if any for proper storage of the equipment supplied at site.

In general, while shipping the equipment to site, Vendor shall ensure that each assembly or component shall be crated, boxed or otherwise suitably protected against damage or loss during shipment and to facilitate site storage. All openings shall be effectively sealed with temporary closures to prevent entry of dust, dirt, moisture and other foreign matter.

MISCELLANEOUS:

Below mentioned items shall also part of Supply & Installation scope of CONTRACTOR.

900 mm wide antiskid insulating mat as per IS 15652 and of reputed make to be spread in front of the 11 kV or 33 kV, 415V switch gear panels & power panels etc.

First aid box with all the standard contents.

Artificial Respirator

First aid chart made of cloth for electrical shock treatment printed in English, Hindi and Local Language duly framed with front glasses.

Charts / drawings duly framed with front glass.

11 kV or 33 kV and 415V Single line diagrams in adequate sizes.

Routine maintenance schedule for High Voltage Switchgear, Distribution Transformers, Low voltage Switchgears, APFC panels, Fire Alarm System, UPS system, Battery, etc.

Provision of portable type Class A, B, C, and D type fire extinguishers at various locations & as per elsewhere in the specification documents & in line with the statutory requirements.

Emergency Exit signages of maintained type with 3 hrs. Back up shall be provided at the Entry Exit routes on each floor.

All Junction boxes shall be made of powder coated 1.6mm thick Sheet steel with access on all four sides; mounting arrangement; terminals suitable for 4sqmm loop in- loop out facility.

Degree of Protection

The enclosures of the control cabinets, junction boxes and Marshalling boxes, panels other than mentioned above etc. to be installed shall provide degree of protection as detailed here under

Installed outdoor – IP 65

Installed indoor – IP 52

The degree of protection shall be in accordance with IS 13947 (Part I)/ IEC 947 (Part I)/ IS 2063/ IEC 529

A. LIST OF TECHNICAL SPECIFICATIONS TO BE FURNISHED BY BIDDER

The Contractor shall furnish the following details as a part of technical bid. Contractor shall furnish all relevant catalogues relevant to the equipment required in the proposed building for Electrical Installation Works.

COMPACT SUBSTATION: -

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
GENERAL	**1.0**	**ENCLOSURE SPECIFICATIONS**		
	1.1.	Make		
	1.2.	Applicable Standards		
	1.3.	Rated maximum power of substation	kVA	
	1.4.	Ambient Temperature	°C	
	1.5.	Type of Ventilation for		
		a) Normal Condition		
		b) Hot Condition		
	1.6.	Compartmentalized		□ Yes □ No
	1.7.	Fault level	kA, sec	
	1.8.	Rated temperature enclosure class		
	1.9.	Internal Arc withstand level		
	1.10.	Degree of protection		
		a) MV & LV compartment		
		b) Transformer compartment		
	1.11.	Enclosure material		
	1.12.	Thickness of sheet	mm	

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	1.13.	Paint colour & finish		
	1.14.	Total dimensions of Compact Substation (H X W X D)	mm	
	1.15.	Weight	Kg	
	2.0	CIRCUIT BREAKER		
	2.1.	Type of circuit breaker		
	2.2.	Rated current	A	
	2.3.	Nominal system voltage	kV	
	2.4.	Maximum continuous voltage	kV	
RMU COMPARTMENT	2.5.	Power frequency withstand (one minute) voltage		
		a) Short circuit withstand	kV	
		b) Momentary withstand	kV	
	2.6.	Impulse 1.2/50micro sec withstand voltage	kV	
	2.7.	Trip coil consumption at rated voltage	Watt	
	2.8.	Type of closing mechanism		
	2.9.	Spring charging mechanism		
	2.10.	Spring charging motor power rating & voltage	Watt, Volt	
	3.0	BUSBAR		
	3.1.	Material		
	3.2.	Busbar cross section	Sq.mm	
	3.3.	Continuous current rating under site	A	

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
		condition		
	3.4.	Busbar insulation		
	3.5.	Minimum clearance		
		c) Phase to phase	mm	
		d) Phase to earth	mm	
	4.0	CURRENT TRANSFORMERS METERING& PROTECTION		
	4.1.	Type (Bar/ Wound/ Any other)		
	4.2.	Make		
	4.3.	Class of insulation		
	4.4.	Ratio		
	4.5.	Rated VA burden		
	4.6.	Accuracy class		
	5.0	VOLTAGE TRANSFORMERS		
	5.1.	Type		
	5.2.	Make		
	5.3.	Ratio		
	5.4.	Accuracy		
	5.5.	Type of insulation		
	6.0	INDICATING METERS		
	6.1.	Make		

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	6.2.	Type		
	6.3.	Size		
	6.4.	Mounting, flush type or other		
	6.5.	Accuracy		
	6.6.	Range		
	6.7.	VA burden for each type		
	7.0	PROTECTION RELAYS		□ Electromechanical □ Soli state □ Numerical
	7.1.	Make		
	7.2.	Inverse time over-current relay		
	7.3.	Instantaneous over-current relay		
	7.4.	Thermal overload protection relay		
	7.5.	Earth leakage relay for use with core balance CT		
	7.6.	Earth fault relay for use in the residual circuit of main CTs		
	8.0	TRANSFORMER PARTICULARS		
	8.1.	Make		
	8.2.	Type		
	8.3.	Full load rating	kVA	
	8.4.	Type of cooling		
	8.5.	Rated percentage impedance	%	
	8.6.	Winding connections		

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
		a) HV		
		b) LV		
		c) Vector group		
	8.7.	Tap changer		On load / off load
		a) Total tapping range	%	
		b) Tapping steps		
		c) On HV/LV winding		
	8.8.	Method of earthing - LV		
	8.9.	Windings material		
	8.10.	Type of insulation		
	8.11.	1.2/ 50 micro impulse withstand		
		a) HV	kV	
		b) LV	kV	
	8.12.	One-minute power frequency withstand voltage		
		a) HV	kV	
		b) LV	kV	
	8.13.	Maximum temperature rise of windings	°C	
	8.14.	Max guaranteed load loss at rated current at max winding temperature For ONAN / ONAF / AN / AF	kW	
	8.15.	No load losses at 100% rated voltage and frequency	kW	

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	8.16.	Cooling equipment power loss	kW	
TRANSFORMER	8.17.	Magnetization current at rated voltage and frequency in percent of full load current	%	
	8.18.	Efficiency at max winding temperature at full load, at UPF and 0.8 PF lag at 75% load, at UPF and 0.8 PF lag at 50% load, at UPF and 0.8 PF lag	%	
	9.19.	Noise	dB	
	8.20.	Weight	Kg	
LV COMPARTMENT	9.0	CIRCUIT BREAKER		
	9.1.	Circuit Breaker Type (Air break and / MCCB)		
	9.2.	Rated voltage	V	
	9.3.	Rated current	A	
	9.4.	Rated symmetrical breaking current at rated voltage (Indicate power factor)	kA at PF	
	9.5.	Rated short time withstand rating for 1 sec (For MCCB, BIDDER to indicate the time)	kA	
	9.6.	Operating mechanism type		
	9.7.	Rated operating duty		
	9.8.	Relationship between ICU, ICS & ICW	%	
	9.9.	Have electrical and mechanical anti-pumping features been provided	Yes / No	

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	11.0	FUSE		
	11.1.	Make		
	11.2.	Type		
	11.3.	Rated voltage	V	
	12.0	BUSBARS		
	12.1.	Material		
	12.2.	Busbar cross section	Sq.mm	PH : Neutral :
LV COMPARTMENT	12.3.	Continuous current rating under site conditions	A	
	12.4.	Busbar insulation		
	12.5.	Minimum clearance		
		a) Phase to phase	mm	
		b) Phase to earth	mm	
	12.6.	Short time rating (One Sec.)	kA	
	12.7.	Momentary rating (Peak)	kA	
	13.0	CURRENT TRANSFORMERS		
	13.1.	Type		
	13.2.	Make		
	13.3.	Ratio		
	13.4.	Accuracy		
	14.0	VOLTAGE TRANSFORMERS		
	14.1.	Make		

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	14.2.	Ratio		
	14.3.	Accuracy		
	14.4.	Output per phase	VA	
	14.5.	Class of insulation		
	15.0	INDICATING METERS		
	15.1.	Make		
	15.2.	Type		
	15.3.	Size		
	15.4.	Mounting, flush type or other		
	15.5.	Accuracy		
	15.6.	Range		
	15.7.	VA burden for each type		
MISCELLANEOUS	16.0	DC SYSTEM		
	17.0	AUTOMATIC POWER FACTOR CONTROL (APFC) UNIT		
	18.0	SPARES		
	19.0	COMPLIANCE WITH SPECIFICATION		

415V METAL ENCLOSED SWITCHGEAR

Sr.	Description	Unit	Technical Particulars
	415 V Switchgear and Bus bar Ratings		
(a)	Rated voltage phase and frequency		
(b)	System Neutral Earthing		
(c)	Maximum system voltage		
(d)	One minute power frequency voltage		
	i) Power circuits		
	ii) Control circuits		
	iii) Aux. Circuits connected to Sec of CTS		
(e)	Continuous current rating of Bus bars under site reference Ambient Temperature and type		
(f)	Bus bar insulation		
(g)	Reference Ambient Temperature		
(h)	Maximum Temperature of Bus bars, Droppers and Contacts at Continuous		
	current rating under site ambient temperature		
(i)	Short Circuit current withstand for Bus bars and droppers (i) Short time 1 sec		
	(ii) Dynamic Rating		
	Switchgear Constructional Requirements		
(a)	Type of Construction		

Sr.	Description		Unit	Technical Particulars
(b)	Thickness of sheet steel (i) Frame, Frame enclosures, doors, covers and partitions			
(d)	Colour finish shade			
(e)	Earthing bus	Material		
		Size		
	Earthing conductor	Material		
		Size		
(g)	Minimum clearances in air of live parts (i) Phase to Phase			
	(ii) Phase to Earth			
(h)	Cable entry to cubicles			
	Instrumentation Transformers			
(a)	Current transformer			
	(i) Ratio			
	(ii) Burden			
	(iii) Accuracy Class			
(b)	Voltage transformer			
	(i) Ratio			
	(ii) Burden			
	(iii) Accuracy Class			

Sr.	Description	Unit	Technical Particulars
	Type of Starter for MCC Panel		

LV CAPACITOR PANEL: -

S.	Description	Unit	Technical Particulars
i	General		
(a)	Make		
(b)	Rated Capacity	kVAR	
(c)	Rated voltage	V	
(d)	Rated frequency and phases		
(e)	Ambient temperature	o C	
(f)	Cable gland required		
(g)	Type of cable		
(h)	Size of cable		
(i)	Cable entry		
ii	Constructional Requirement		
(a)	Thickness of sheet steel		
	i) Frame, Frame enclosures, doors covers and partition	Mm	
(b)	Degree of protection		

S.	Description		Unit	Technical Particulars
(c)	Colour finish shade			
(d)	Earthing bus	Material		
		Size	mm x mm	
(e)	Earthing conductor	Material		
		Size	mm x mm	
iii	Design Requirement			
(a)	Insulation level		kV (rms)	
(b)	Capacitor bank connection			
(c)	Short circuit withstand for busbars			
	i) Short time (1 sec)		kA (rms)	
	ii) Dynamic		kA (peak)	
(d)	Type of switching & capacitor			
(e)	Switching steps			
(f)	Rating of contactor			
(g)	Incomer switch current rating			
(h)	Busbars			

HV, LV POWER & CONTROL CABLES: -

S.N.	Description	Unit	Technical Particulars	Technical Particulars	Technical Particulars
			0.415kV power cables	33kV&11kV power cables	Control cables
1	Name of the Manufacturer				
2	Conductor(stranded/solid)				
2.1	Form circular/segmented				
2.2	Nominal diameter in mm				
2.3	Effective cross sectional area sq mm				
3	Whether cores identified by numeral for cable with five core and above.				
4	Whether incremental running lengths are marked on cable at every 1 m interval.	YES/NO			
5	Finished cable				
5.1	Diameter under armour in mm				

S.N.	Description	Unit	Technical Particulars	Technical Particulars	Technical Particulars
			0.415kV power cables	**33kV&11kV power cables**	**Control cables**
5.2	Diameter over armour in mm				
5.3	Overall diameter in mm				
6	Whether cables will carry ISI stamp.	YES/NO			
6.1	If not explain reasons				
7	Cable drums				
7.1	Length of cables in cable drum and tolerance				
7.2	Weight of cable drum without cables				
7.3	Weight of cable drum with cables				
8	Type of end sealing				
9					
9.1	Any other details the CONTRACTOR would like to furnish?				
9.2	List of deviations if any from specification, data sheet-A and				

S.N.	Description	Unit	Technical Particulars	Technical Particulars	Technical Particulars
			0.415kV power cables	33kV&11kV power cables	Control cables
	applicable standard furnished				
9.3	Conductor screen				
9.4	Insulation				
9.5	Insulation screen				
9.6	Sheath				
9.7	Armour				

LIGHTING FIXTURES &ACCESSORIES: -

Sr. No.	Parameter	Technical Particulars (To be filled by BIDDER)
	Type	
	Rated Voltage	
	Expected Frequency	
	Operating Voltage Range	
	Power Factor	
	Operating Temperature Range	

Sr. No.	Parameter	Technical Particulars (To be filled by BIDDER)
	Working Humidity	
	Driver Type	
	Driver Efficiency	
	Driver Life	
	Protection required in Driver module	
	Short Circuit	
	Over Voltage	
	Over Temperature	
	Under Voltage	
	String Open Protection	
	Luminaire IP Protection	
	Minimum Surge Protection	
	THD	
	Rated Minimum LED Life (L70)	
	Rated Minimum Driver Life	
	CRI	
	Junction temperature rise	
	Solder point temperature	
	Maximum temperature rise for Driver	
	Make of LED	

Sr. No.	Parameter	Technical Particulars (To be filled by BIDDER)
	Make of Driver	
	Operating Hours	
	Luminous Efficacy	
	System Efficacy	
	Colour Temperature	
	Illumination Regulation	
	Material used for following	
	Housing	
	Heat Sink	
	Clip / Fasteners	
	Diffuser	
	Maximum temperature of Heat sink	
	IK protection of Optic Cover	
	Wires used Inside Luminaries	
	Cable gland IP protection	
	Ratio of Horizontal to Vertical Illuminance	
	Glare index while viewing from critical observer position	
	Maintenance factor	
	Total of LED fixture	

Sr. No.	Parameter	Technical Particulars (To be filled by BIDDER)		
	Wattage of each fixture			
	Total Power Consumption			
	Average lux			
	Uniformity (Min./Avg.)			
	Uniformity (Min./Max.)			

LIGHTING SYSTEM EQUIPMENT:-

S.N.	Description	Unit	Technical Particulars
1	LIGHTING DISTRIBUTION BOARDS AND LIGHTING PANELS		
1.1	System Particular		
(a)	Voltage		
(i)	3 Phase, 4 wire 50 Hz system		
	Rated	V	
	Maximum	V	
	One minute withstand voltage	V	
(ii)	D.C. system		
	Rated	V	

S.N.	Description	Unit	Technical Particulars
(b)	System short-circuit level		
	(i) At 415 V, A.C.	kA (rms)	
	(ii) At 110 V.D.C.	kA (D.C.)	
(c)	Reference ambient temperature	deg C	
1.2	Indicate the type and routine tests to be carried out		
1.3	Distribution Board/Panels		
(a)	Main, floor mounted distribution boards		
(i)	Main Lighting distribution board(A.C.)		
	Make		
	Type		
	Degree of protection		
	Bus bar material		

S.N.	Description	Unit	Technical Particulars
	Bus bar current rating	A	
	Short circuit current rating	kA	
	Details of Incoming and Outgoing feeders		
	Cable entry		
	Location		
	Each complete board/panel, LxWxD		
	Dimensional drawing enclosed		
	Indicate the type and routine tests to be carried out		
(ii)	Emergency lighting panel (D.C.)		
	Make		
	Type		
	Degree of protection		
	Bus bar material		
	Bus bar current rating	A	
	Short circuit current rating	kA	
	Details of Incoming and		

S.N.	Description	Unit	Technical Particulars
	Outgoing feeders		
	Cable entry		
	Location		
	Each complete board/panel, LxWxD		
	Dimensional drawing enclosed		
	Indicate the type and routine tests to be carried out		
(iii)	Three phase DBs, wall/structure mounting		
	SLDB for indoor area		
	Make		
	Type		
	Details of Incoming and Outgoing feeders		
	Degree of Protection		
(iv)	SLDB for outdoor area		
	Make		
	Type		
	Details of Incoming and Outgoing feeders		
	Degree of Protection		
(v)	Paint Finish		
	Colour shade		
2	MINIATURE CIRCUIT BREAKER		
2.1	Make		
2.2	Type		

S.N.	Description	Unit	Technical Particulars
3	EARTH LEAKAGE CIRCUIT BREAKER		
3.1	Make		
3.2	Type		
3.3	Leakage Current I N	mA	
4	INSTRUMENT TRANSFORMERS		
4.1	Make		
4.2	Type		
4.3	Output		
4.4	Accuracy Class		
5	METERS		
5.1	Make		
5.2	Type		
5.3	Accuracy Class		
6	RELAYS (IF ANY PROVIDED)		
6.1	Make		
6.2	Type		
6.3	Voltage Rating	V	
6.5	Setting Range	%	
	No. of Contacts		
	a)Normally open		
	b)Normally closed		
7	FLAME PROOF ENCLOSURES		
7.1	Make		

S.N.	Description	Unit	Technical Particulars
7.2	Suitable for use in hazardous area		
	a)Area classification		
	b)Gases/Vapour group		
7.3	Dimensional Drawings and Literature of each required equipment flameproof enclosure including fixing details enclosed	Yes/No	
7.4	Approval certificates of relevant statutory authorities enclosed	Yes/No	
8	LIGHT CONTROL SWITCHES		
8.1	Make		
9	RECEPTACLE, PLUG AND SWITCH		
9.1	Make		
10	LIGHTING WIRES		
10.1	Make		
10.2	Applicable Standard		
10.3	Voltage Grade	V	
10.4	Conductor Material	Cu/Al	
10.5	No.of Strands	mm^2	
10.6	Colour Coding		
11	CONDUITS		
11.1	Make		
11.2	Material		
11.3	Finish (Galvanised/Black Enamel/Any special anti-corrosive coating)		

S.N.	Description	Unit	Technical Particulars
11.4	Sizes offered and wall thicknesses		
11.5	Supply of necessary couplings, bends, tees, necessary for conduit routing included	Yes/No	
12	JUNCTION BOXES		
12.1	Make		
12.2	Material and Gauge		
12.3	Painted / Galvanised		
13	CEILING FANS		
13.1	Make		
13.2	Suspension Rod, Regulator and Switch included	Yes/No	

EARTHING & LIGHTNING PROTECTION SYSTEM: -

S.	Description	Material	Technical Particulars
	Main Earthing Grid		
	Buried in earth	MS	
	Buried in floor slabs in buildings	MS	
	Conductor Leads to Equipment (above ground) – Substation Equipment & Structures		
	Circuit Breaker	GS	
	Isolator	GS	

S.	Description	Material	Technical Particulars
	Transformers		Quantity - As per requirement & Sizes – As per Fault level calculations
	(i) Transformer neutral to bottom of tank	GS	
	(ii) From bottom of tank to earth grid	GS	
	(iii) Transformer tanks and radiator bank	GS	
	(iv) Marshalling Boxes	GS	
	Lightning arrester	GS	
	C.T. and P.T. body	GS	
	C.T. and P. T. secondary terminal box	GS	
	Towers and structures	GS	
	Fence posts and gates (Flex. braid)	GS	
	415V switchgear and capacitor panel	GS	
	Motors		
	(i) 415V Motors above 10 kW	GS	
	(ii)415V Motors up to 10 kW	GI wire	
	(iii)Fractional horse power motors	GI wire	
	Other Items		
	Capacitor panel, Battery charger panel, Main lighting D.B, Control panels and sub-lighting distribution boards	GS	
	Hand Rails	GS	
	Cable trays	GS	
	Tanks	GS	

S.	Description	Material	Technical Particulars
	Junction boxes	GS	
	Lighting fixtures, receptacles, lighting conduits	GS	
	Push button stations, limit switches	GS	
	Crane rail	GS	
	Street lighting, flood lighting poles and junctions boxes	GS	
	Metallic non-current carrying structures	GS	
	Lightning Conductors	GS	
	Lightning protection down comers for building	GS	
	Lightning protection horizontal roof conductor for building	GS	
	Electrodes	GS	
	Pipe electrode	GS	
	Maintenance free electrode	copper	

DG SET: -

Sr. No.	Description	Unit	Technical Particulars
1.0	GENERAL		
1.1	Name of manufacturer		

Sr. No.	Description	Unit	Technical Particulars
1.2	Engine model no.		
2.0	DESIGN FEATURES		
2.1	Continuous site output rating at generator terminals	kW	
2.2	Site output rating after auxiliary power consumption and transmission losses at switchyard/ bus bar terminals	kW	
2.3	Maximum site rating of engine (to be not less than 110% of the value indicated in item 2.1 above)	kW	
2.4	Standard engine rating (i.e., under standard atmospheric conditions as per ISO : 3046)	kW	
2.5	Derating factors for site conditions applicable on standard engine rating:	%	
	a) Altitude	%	
	b) Ambient temperature	%	
	c) Relative humidity at inlet temperature indicated in item (b) above	%	
	d) Cooling water temperature at the inlet of charge air cooler	%	
	e) Others	%	
	f) Total deration	%	
	N.B. If the derating factors are different from those indicated in ISO: 3046 the		

Sr. No.	Description	Unit	Technical Particulars
	BIDDER shall furnish details in deviations there from, justifying the deratings as applicable for the offered engine. Derating charts / calculations shall be furnished along with the Bid for various atmospheric conditions		
2.6	Operating speed	RPM	
2.7	Main effective pressure (referred to kW output)	Pa(g)	
2.8	Types of operating cycle		
2.9	Mean piston speed	m/sec	
2.10	Design fuel oil		
2.11	Design lube oil		
3.0	ENGINE PERFORMANCE		
3.1	Continuous engine rating at site at generator (with specified fuel oil) with all coupled to engine	kW	
3.2	10% overload operation as per ISO 3046		Yes/No
3.3	Fuel consumption (with design fuel)		
	a) At 100% engine load	g / KW h	
	b) At 75% engine load	g / KW h	
	c) At 50% engine load	g / KW h	
3.4	Lube oil consumption at 100% engine load	g / KW h	

Sr. No.	Description	Unit	Technical Particulars
3.5	Primary jacket water temperature at engine inlet	oC	
3.6	Primary jacket water temperature engine outlet	oC	
3.7	Secondary cooling water temperature at heat exchangers inlet	oC	
3.8	Secondary cooling water temperature at inlet to cooling tower,	oC	
3.9	Secondary cooling water flow	m3/hr.	
3.10	Maximum Secondary Water pressure drop through heat exchanger at flow value indicated in 3.9 above	Pa	
3.11	Secondary cooling water pressure at heat exchanger inlet	Pa	
3.12	Lube oil temperature at lube oil cooler outlet	oC	
3.13	Lube oil temperature at lube oil cooler inlet	oC	
3.14	Maximum period for which engine can operate without cooling water c		
	a) During cold start of engine	Secs.	
	b) During hot start of engine	Secs.	
3.15	Flue gas analysis at 100% load for specified fuel:		

Sr. No.	Description	Unit	Technical Particulars
	a) SO2		
	b) Nox		
	c) Hydro carbon		
	d) CO2		
	e) CO		
	f) Particulate matter		
	g) Others		
	h) SO2 through stack	Kg/hr	
3.16	Governing Characteristics		
3.16.1	Maximum step load that can be applied to the engine at full rated speed, no load and at normal running temperatures	% of rated load	
3.16.2	Transient speed change resulting from applications of the load indicated in item 3.16.1 above	% of rated load	
3.16.3	Permanent speed change resulting from application of the load indicated in item 3.16.1 above	% of rated load	
3.16.4	Maximum recovery time to permanent speed change of 3.16.3	Secs.	
3.16.5	Transient speed rise resulting from a full load throw-off	% of rated load	
3.16.6	Permanent speed rise resulting from a full load throw-off	% of rated load	

Sr. No.	Description	Unit	Technical Particulars
3.16.7	Maximum recovery time to reach permanent speed rise value indicated in item 3.16.6 above	Secs.	
3.16.8	Transient speed change resulting from a change of load, both ON and OFF, by any step of 25% of the rated full load	% of rated load	
3.16.9	Permanent speed change resulting from change of load, both ON and OFF, by any step of 25% of the rated full load	% of rated load	
3.16.10	Recovery time for attaining permanent speed change value indicated in item 3.16.9	Secs.	
3.16.11	Steady load speed band	% of rated load	
3.17	DG set starting time i.e., ready to take load after “start” impulse	Secs.	
3.18	Maximum noise level at ……. metres from equipment outline	dBA	
3.19	Maximum vibration level (peak to peak)	mm/secs.	
4.0	GENERATOR PERFORMANCE		
4.1	Generator efficiency at 100% rated load	%	
4.2	Generator efficiency at 75% rated load	%	
4.3	Generator efficiency at 50% rated load	%	
4.4	Generator efficiency at 25% rated load	%	

Sr. No.	Description	Unit	Technical Particulars
4.5	Voltage regulator response	%	
4.6	Excitation at full load and under specified variation of voltage and speed		
5.0	ENGINE CONSTRUCTION FEATURES		
5.1	Engine model No.		
5.2	No. of strokes		Two / Four Strokes
5.3	No. of cylinders		
5.4	Arrangement of cylinders		Inline / Vee Type
5.5	Cylinder bore	mm	
5.6	Piston stroke	mm	
5.7	Compression ratio		
5.8	Cylinder block :		
	a) Material of construction		
5.9	Crank case :		
	a) Material of construction		
5.10	Cylinder head :		
	a) Material of construction		
5.11	Cylinder liner :		
	a) Material of construction		
5.12	Crank shaft :		

Sr. No.	Description	Unit	Technical Particulars
	a) Forged / cast		
	b) Material of construction		
5.13	Crank shaft main bearings:		
	a) Nos. provided		
	b) Material of construction		
5.14	Piston :		
	a) Type		
	b) Material of construction		
5.15	Piston rings:		
	a) Material of compression rings		
	b) Material of oil rings		
5.16	Piston pin (Gudgeon pin):		
	a) Material of construction		
5.17	Connecting rod :		
	a) Material of bearings		
	b) Lining for bearing materials		
5.18	Camshaft:		
	a) Material of bearings and lining details		
	b) Mode of driving from crankshaft		
5.19	Engine valves :		Inlet Exhaust Starting

Sr. No.	Description	Unit	Technical Particulars
			Valve Valve Air Valve
	a) Nos. provided per cylinder		
	b) Material of valve body		
	c) Material of valve seat		
	d) Type of valve cooling		
5.20	Oil pan:		
	a) Capacity upto normal working level	m3	
	b) Material of construction		
5.21	Gaskets – Material of construction :		
	a) Between cylinder head and cylinder block		
	b) Between cylinder block and oil pan		
	c) Between cylinder block and end corners		
5.22	Fly wheel with cover		Provided / Not provided
5.23	Fuel injection System :		
	a) Type of system		
	b) Engine driven fuel feed pump provided		Yes / No
5.24	Governing system type		
5.25	Foundation details :		
	a) No. of holding down bolts		

Sr. No.	Description	Unit	Technical Particulars
	b) Anti-vibration springs with visco dampers		Yes/ No
6.0	ENGINE SYSTEMS		
6.1	Fuel Oil system :		
a	Fuel Oil tanks (For each tank)		
	a) Nos. provided		
	b) Working capacity of each tank	m3	
	c) Size of tank :		
	i) Rectangular tank	mxmxm	
	ii) Cylinder tank	Dia(m)xHt(m)	
	d) Material of construction		
	e) Location		
b	Motor operated transfer pumps furnished		Yes / No
	(For each pump)		
	a) Nos.		
	b) Type		
	c) Capacity	m3/hr.	
	d) Motor Rating	KW	
c	Fuel oil filters		2 x 100 % Simplex / 1 x 100 % Duplex
d	Maximum pressure drop across filters in clogged condition		

Sr. No.	Description	Unit	Technical Particulars
e	Through put capacity of fuel oil treatment plant at specified viscosity of fuel oil		
f	No. of fuel oil treatment units provided.		
g	Separating temperature		
6.2	Lube oil System :		
a	Type and grade of lube oil to be used		
b	Capacity of lube oil sump below cylinder block / crane case at normal working level	m3	
c	Lube oil tanks external to engine (For each tank)		Yes / No
d	a) Capacity	m3	
e	b) Material of construction		
f	c) Location		
g	Engine driven / Motor Driven lube oil pump :		
	a) Nos.		
	b) Type		
	c) Capacity	m3/hr.	
	d) Motor Rating	KW	
h	Lube oil cooler :		
	a) Type		

Sr. No.	Description	Unit	Technical Particulars
	b) Cooling fluid		
	Secondary Cooling Water flow / Primary Jacket Water flow	m3/hr.	
i	Lube oil filters :		
	a) Type		2 x 100 % Simplex / 1 x 100 % Duplex
	b) Maximum allowable pressure drop across filter in clogged condition		
j	Lube oil heater :		
	a) Provided		Yes/ No
	b) Type		
	c) If electric, indicate power rating	kW	
k	AC motor driven priming pump :		
	a) Nos. provided		
	b) Type		
	c) Capacity	m3/hr.	
	d) Head	mlc	
	e) Motor rating	kW	
l	Quantity of lube oil required for initial filling	m3	
m	Through put capacity of lube oil		

Sr. No.	Description	Unit	Technical Particulars
	treatment plant at specified viscosity of fuel oil		
n	No. of lube oil treatment units provided.		
o	Separating temperature		
6.3	Primary Jacket Water System		
a	Type of cooling		Radiator cooled / Secondary cooling water cooled
b	Quality of water		
c	Quantity of water required for initial filling	m3	
d	Makeup water quantity	m3/hr.	
e	Expansion tank :		
	a) Working capacity	m3	
	b) Size :		
	i) Rectangular	mxmxm	
	ii) Cylindrical	Dia(m)xHt(m)	
	c) Material of construction		
	d) Inner coating details		
f	Jacket Water Pump and jacket water pre heating pump		
	a) Type		Engine driven / AC

Sr. No.	Description	Unit	Technical Particulars
			motor driven
	b) Capacity	m3/hr.	
	c) Head	mlc	
	d) Mode of driving off engine crank shaft		
	e) Motor Rating	KW	
g	Radiator (if required)		
	a) Type		
	b) Overall size		
	c) Materials of construction :		
	i) Tubes		
	ii) Fins		
	iii) Header		
	d) Location		
	e) Radiator fan :		
	i) Tip diameter	mm	
	ii) Max. speed	rpm	
	iii) Flow at above speed	m3/hr.	
	f) Air temperature rise across radiator		
	g) Mode of drive from engine crank shaft		
	h) Material of construction of fan :		

Sr. No.	Description	Unit	Technical Particulars
	i) Blades		
	ii) Hub		
	i) Air ducting details :		
	i) Material of construction		
	ii) Inside clear dimensions	mmxmm	
	iii) Type of fixing arrangement between air duct and radiator		
	j) Fan guard provided		Yes / No
	k) Fan motor rating	KW	
h	Heat Exchanger :		
	a) Designation		
	b) Type		Shell & tube type / plate type
i	Jacket water heater :		
	a) Nos. provided		
	b) Type		
	c) If electric, power required	kW	
6.4	Air intake system :		
a	Intake silencer type		
b	Air cleaner :		
	a) Type		Wet/ Dry
	b) Nos. provided		

Sr. No.	Description	Unit	Technical Particulars
	c) Design air flow	m3/hr.	
	d) Materials of construction:		
	i) Body and cover		
	ii) Filter element		
	e) Type of oil to be used for wet type		
	f) Frequency of oil cleaning filter element cleaning		
	g) Location		
c	Turbocharger (exhaust gas driven) :		
	a) Speed	Rpm	
	b) Air pressure at outlet	Pa(g)	
	c) Air temperature at outlet	oC	
	d) Maximum air flow	Nm3/hr.	
	e) Blade material		
	f) Casing material		
d	Supercharger (engine driven) :		
	a) Type		Roots type
	b) No. of lobes		Two / Three
	c) Speed	rpm	
	d) Air flow	Nm3/hr.	
	e) Air outlet pressure	Pa(g)	

Sr. No.	Description	Unit	Technical Particulars
	f) Air outlet temperature	oC	
	g) Material of construction :		
	i) Lobes		
	ii) Casing		
	iii) Shafts		
	iv) Bearings		
	v) Seals		
	vi) Timing gears		
	b) Type of drive from engine crank shaft		
e	Charge air cooler :		
	a) Type		
	b) Nos. provided		
	c) Cooling water type		
	d) Design water flow required	m3/hr.	
	e) Pressure drop at above flow	mlc	
	f) Inlet water temperature	oC	
	g) Temperature rise	oC	
	h) Charge air temperature at cooler outlet	oC	
	i) Material of construction :		
	i) Tubes		

Sr. No.	Description	Unit	Technical Particulars
	ii) Fins		
	iii) Cover		
	iv) End plates		
6.5	Exhaust gas system:		
6.5.1	No. of streams provided		
6.5.2	Exhaust silencer		
	a) Nos. provided per exhaust pipe		
	b) Type		
	c) Location		
6.5.3	Exhaust Duct		
	a) Size		
	b) Material		
6.5.4	Lagging details :		
	a) Lagging material		
	b) Lagging thickness		
6.6	Air starting system :		
6.6.1	Nos of compressors motor driven		
6.6.2	Nos of compressors diesel engine driven		
6.6.3	Compressor details		
	a) Manufacturer		

Sr. No.	Description	Unit	Technical Particulars
	b) Type		
	c) Rating		
	d) Speed	rpm	
6.6.4	Air receivers / air bottles		
	a) Nos. provided		
	b) Air capacity of each air receiver	m3	
	c) Normal air pressure in air receiver	Pa(g)	
	d) No. of starts of engine from each receiver		
6.6.5	Normal air pressure for starting	Pa(g)	
6.6.6	Minimum air pressure for starting engine	Pa(g)	
6.6.7	Quantity of free air per start	Nm3/hr.	
6.7	Common base frame for engine and generator:		
	Type		
	Material of construction		
6.8	Engine generator coupling :		
a	Type		
b	Whether fixed directly to fly wheel :		Yes / No
c	Clutch with engaging / disengaging arrangement provided?		Yes / No

Sr. No.	Description	Unit	Technical Particulars
d	Coupling guard material		
e	Coupling guard for clutch provided ? If 'Yes' indicate type		Yes / No
7.0	GENERATOR AND ACCESSORIES		
7.1	Name of manufacturer		
7.2	Design rating	kW	
7.3	Continuous output rating	kW	
7.4	Maximum rating	kW	
7.5	Power factor		
7.6	Rated voltage	Volts	
7.7	Rated current/ phase	Amps	
7.8	Speed	rpm	
7.9	Frequency	C/s	
7.10	Field current at rated output and voltage	Amps	
7.11	Insulation class :		
	a) Stator		
	b) Rotor		
7.12	Temperature rise above ambient of 45oC (by thermometer):		
	a) Stator	oC	
	b) Rotor	oC	

Sr. No.	Description	Unit	Technical Particulars
	c) Cores	oC	
7.13	WR2 of rotating mass in diesel engine, generator, exciter, etc.	kgm2	
7.14	Generator parameters :		
7.14.1	Synchronous reactance Xd:		
	a) Unsaturated	Ohms	
	b) Saturated	Ohms	
7.14.2	Transient reactanceX'd:		
	a) Unsaturated	Ohms	
	b) Saturated	Ohms	
7.14.3	Sub-transient reactance X"d:		
	a) Unsaturated	Ohms	
	b) Saturated	Ohms	
7.14.4	Zero sequence reactance Xo	Ohms	
7.14.5	Negative sequence reactance X2	Ohms	
7.14.6	Open circuit transient time constant	secs.	
7.14.7	Open circuit synchronous time constant	secs.	
7.14.8	Open circuit field time constant T	secs.	
7.14.9	Short circuit ratio		
7.14.10	Resistance of field winding at operating temperature	Ohms	

Sr. No.	Description	Unit	Technical Particulars
7.14.11	Resistance of stator winding at operating temperature	Ohms	
7.15	Generator performance :		
7.15.1	Full load losses	kW	
7.15.2	Armature copper loss	kW	
7.15.3	Rotor copper loss	kW	
7.15.4	Core loss	kW	
7.15.4	Stray losses	kW	
7.15.5	Efficiency :		
	a) ¼ load	%	
	b) ½ load	%	
	c) 3/4 load	%	
	d) Full load	%	
8.0	MAIN EXCITER		
8.1	Rated voltage	Volts	
8.2	Rated current	Amps	
8.3	Ceiling voltage at zero load and rated speed	Volts	
8.4	Ceiling voltage at rated current and rated speed	Volts	
8.5	Excitation system response ratio		
8.6	Insulation class:		

Sr. No.	Description	Unit	Technical Particulars
	a) Stator		
	b) Rotor		
9.0	AUTOMATIC VOLTAGE REGULATOR		
9.1	Type		
9.2	Burden of AVR on CTs and PTs		
	a) CTs	Va	
	b) PTs	Va	
9.3	Dead band (if any)		
9.4	Field discharge resistor	Ohms	
9.5	Type and rating of field breaker		
10	TESTING		
10.1	BIDDER to indicate whether the following tests will be conducted :		
10.2	Dimensional accuracy of individual components		Yes / No
10.3	Hydro testing of all jacket water passages		Yes / No
10.4	Hydro testing of all lube oil lines		Yes / No
10.5	Hydro testing of fuel oil lines		Yes / No
10.6	Checking all lube oil passage for free flow of oil		Yes / No
10.7	Rig testing of governor assembly		Yes / No
10.8	Rig testing of individual injectors		Yes / No

Sr. No.	Description	Unit	Technical Particulars
10.9	Shop testing of engine with all the engine driven equipment in position		Yes / No
11	WEIGHTS		
11.1	Weight of fully assembled engine	kg	
11.2	Weight of generator	kg	
11.3	Weight of common base frame	kg	
11.4	Weight of fully assembled engine generator	kg	
11.4	GD2 for DG set	Kg/m2	
11.5	Weight and name of heaviest part to be lifted during : Erection b) Maintenance	kg	
12	DIMENSIONS		
12.1	Overall dimension of engine		
12.2	Overall dimension of generator		
12.3	Height and name of longest part to be lifted during maintenance		

LIST OF DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

Following drawings, calculations & schedules shall be submitted to Employer/ DISCOM for approval before procurement, fabrication and Installation of equipments at site,

S.	Deliverables
1.0	Design Basis Report
2.0	Single Line Diagram of Complete Electrical System based on the design criteria.
3.0	Drawing details, Bill of quantities for conversion yard comprising of 2/4 pole structure, GOD, DO Fuse, LA, etc
4.0	**Ring Main Unit**
a	General arrangement drawing shall indicate the overall dimensions, net weights, crane requirements, foundation details and the general constructional features.
b	General arrangement drawing of the showing plan, front elevation and side elevation complete with all accessories and fittings, detailed dimensions, cable entries, earthing terminals, foundation/floor fixing details, crane lift, size of lifting lugs and eyes, and bill of materials etc.
c	Quality Action Plan
5.0	11kV Cable Route layout indicating number of pipes, electrical cable chamber location, RMU connection details.
6.0	Electrical Substation General Arrangement and sectional Layouts of substation showing locations of various Equipment including Compact substation, DG Sets , cable trenches, RMU Panel, LT Panels, control & relay panels and other allied equipments and associated systems.
7.0	Bill of quantities for Substation
8.0	**Compact Substation**
	General arrangement drawing shall indicate the overall dimensions, net weights, quantity of oil, crane requirements for assembly and dismantling of transformers, and the general constructional features.
	General arrangement drawing of the transformer showing plan, front elevation

S.	Deliverables
	and side elevation complete with all accessories and fittings, detailed dimensions, cable entries, earthing terminals, foundation/floor fixing details, jacking pads, crane lift for untanking, size of lifting lugs and eyes, clearances between HV terminals, between LV terminals, between HV and LV terminals, between HV & LV terminals and ground and bill of materials etc.
	Valve schedule, Rating, diagram and terminal marking plates, complete with polarity and vector group.
	OCTC/OLTC cabinets: schematic circuit diagram and actual detailed wiring diagram giving terminal numbers.
	Bushings Plan, elevation, terminal details, mounting details, make and type number, current and voltage rating, creepage distances and principal characteristics.
	Control wiring diagram for marshalling box.
	QAP
9.0	**DG Sets**
	General arrangement drawing shall indicate the overall dimensions, net weights and the general constructional features.
	General arrangement drawing of the DG Set showing plan, front elevation and side elevation complete with all accessories and fittings, detailed dimensions, cable entries, earthing terminals, foundation/floor fixing details, and bill of materials etc.
	Control wiring diagram for Synchronizing / AMF Panel
10.0	**Cabling system**
a.	Details of Installation of Cables in Trenches, on cable trays, racks directly buried etc., at all locations as specified including cable trays.
b.	HT & LT Cable routing layout inside and outside the building.
c.	Bill of quantities of HT &LT cables, lugs , glands & Termination Kits.

S.	Deliverables
d.	Cable termination and mounting Kit Layout drawing.
11.0	**Earthing system**
	Detail calculations of earthing network including main grid calculations.
	Earthing notes including detail write up and drawings of earthing conductor layout, equipment & structural earthing, joints, cable earthing, instrument earthing and special earthing.
	Details such as material, sizes, etc. of the earth conductor and electrode pits
	Earthing layout drawing showing interconnection of equipment earthing to the grid and earth pits
12.0	**Lighting System**
a.	Detailed Room wise Lighting Layout with type of fixture details and Circuit diagram showing phase wise load distribution and interconnection between switches, fixtures, Lighting panel, receptacles etc & Detailed lux level calculations.
b.	Conduit layout showing room wise routing of wires from lighting panel to lighting fixtures, receptacles etc.
c.	Lighting fixing arrangement, mounting structure details etc.for outdoor area lighting.
d.	Technical Datasheet for lighting fixtures, pole, feeder pillar, junction box, etc. with type test reports and QAP.
13.0	**VCB / LBS/ LT Switchgear**
	Design Calculations for Bus bar sizing, CT Sizing of all type etc. for each Switchboard along with a copy of relevant standard referred for the same
	Guaranteed Technical Parameters
	Equipment GA & Section drawings with dimensions, clearances, locations of components- CT, Terminals, etc. of each type of switchboard with component

S.	Deliverables
	layouts like LV Compartment, etc with general notes
	Base frame and Foundation GA drawings with dimension and details
	Electrical Control drawing for all panels with general notes like sizes, type, Material details and other details
	Bill of material along with make, quantity, model no and ratings
	All the Type Test certificates to prove the compliance with the requirements and submit certificates before award of contract.
	All civil drawings related to substation building & foundation of all the electrical items.
14.0	**Calculations**
	Distribution Transformer, DG Sizing Calculations
	Fault level Calculations
	Co-ordinated protection study with latest available version of ETAP software.
	HT & LT cable sizing
	Lightning protection Calculations
	Earthing Sizing Calculations
	Room wise Lighting Calculation
	Capacitor Sizing Calculation
	External lighting calculation
15.0	**Schedules**
	Cable Schedule
	Protection Relay Setting Schedule

S.	Deliverables
	Interconnection schedule
	Junction Box Schedule

All equipment/system sizing calculations/drawings shall be submitted to the Employer for approval whether specifically mentioned or not.

TEST ON COMPLETION:

Completion and Post Completion Activities: -

Mechanical completion is said to occur, when all erection/installation and commissioning of all electrical works and minor civil works under the scope of the Contractor are completed to the satisfaction of the Client's Representative with

(a) All installation alignment checks.

(b) All panels and equipment erected, grouted, with all cabling and wiring, terminations, routing, clamping, dressing, tagging, and ferruling duly completed including continuity and megger testing, and all installation checks.

At the stage of Mechanical completion, the Contractor shall ensure that all physical, aesthetic and workmanship aspects are totally completed, and the plant is fit and sound for undertaking pre-commissioning checks followed by commissioning.

Upon achieving mechanical completion, the Contractor shall notify the Client of such mechanical completion upon which the Client shall proceed with the checking of the works.

The Client may inform the Contractor regarding deficiencies for rectification by the Contractor within a jointly agreed period before the pre-commissioning checks could be undertaken. Alternately the Client, when the defects are of minor nature may undertake the pre-commissioning checks, permitting the Contractor to concurrently undertake rectification of such

defects. Rectification of all defects, so notified by the Client, to his satisfaction shall be a prerequisite to issue of Taking over Certificate.

Testing and Commissioning: -

The Contractor shall carry out commissioning tests in the presence of the Client's representative. The evaluation of test results and decision passed by the Client's representative regarding the test results will be final and binding on the Contractor. Any additional tests or repetition of tests to establish satisfactory operation of any equipment shall be carried out by the Contractor, if so desired by the Client's representative at no extra cost.

The completion checks and commissioning tests to be carried out shall include, but not be limited to, those described in subsequent paragraphs, as applicable to the individual equipment/system.

All checks and tests shall be as per the Manufacturer's drawing manuals, relevant codes of installation and commissioning checklists described in subsequent paragraphs.

Among other commissioning tests, the following shall be carried out at site after completion of installation. Contractor shall ensure to use calibrated test equipment having valid calibration test certificates from standard laboratories traceable to National Standards / International Standards. All tests to be carried out in the presence of Client's representatives.

(a) **Switchboard:** Power frequency high voltage test, IR test, operation tests

(b) **Relays:** Check internal wiring, relay settings

(c) **Cables**

All new LT cables shall be megger tested before terminating / jointing. After terminations / joints shall be megger tested by 1000V megger.

All HT cables shall be megger tested before terminating / jointing. After terminations / joints shall be megger tested by 5000V megger.

Cable core shall be tested for

- Continuity

- Absence of cross phasing

- Insulation resistance to earth

- Insulation resistance between conductors

(d) Earthing System

Continuity of all conductors and joints shall be checked. The Client's representatives may ask for earth continuity tests, earth resistance measurements and other tests, which in his opinion are necessary, to prove that the system is in accordance with design, specification, code of practice and CEA Regulations 2010. Earth resistance value should be not greater than one (1) ohm or as per local regulatory requirements, the stringent one to be applicable.

(e) Lighting System

Commissioning tests stipulated in applicable standards and code of practice covering all lighting system equipment

The Contractor shall carry out insulation resistance tests by a megger of following rating

Control circuits up to 220 V 500 V megger

Power circuits up to 1.1 kV 1000 V megger

In general, the following checks shall be carried out on all the equipment/systems, as applicable.

Name plate details according to approved drawings/ specifications

- Any physical damage or defect and cleanliness
- Tightness of all bolts, clamps and connections
- Oil leakages and oil level
- Condition of accessories and their completeness
- Clearances
- Earthing connections
- Correctness of installation with respect to approved drawings/specifications
- Lubrication of moving parts
- Alignment
- Correctness and condition of connections

Commissioning Tests
The following commissioning tests are to be carried out on all the equipment/systems, as applicable and as desired by EMPLOYER/ STATUTORY requirements.

- Insulation resistance measurement of equipment, accessories, cabling/wiring etc.
- Dielectric tests on equipment, accessories, cabling/ wires etc.
- Phase sequence and polarity
- Voltage and current ratios
- Vector group
- Resistance measurement of winding, contacts etc.
- Continuity tests
- Calibration of indicators, meters, relays, etc.
- Control and interlock checks
- Settings of equipment and accessories
- Checking of accuracy/error
- Checking of operating characteristics, pick-up voltages and currents, etc.
- Operational and functional tests on equipment, accessories, control schemes, alarm/trip/indication circuits, etc.
- Operational Checks for all the equipments for Auto and Manual mode.
- Measurement of guaranteed/approved design values including lighting levels, earth resistance measurement, etc.
- Complete commissioning checks of the system

Specific Tests to be carried out for various Equipments are as follows;

HT Switchgear Panels: -

a) Check of electrical wiring.

b) Tests on auxiliary and control circuits.

c) Check of electrical operation of safety (interlocking, automatic changeover, Local / Remote operations in test as well as service position including all electrical interlocks etc).

d) Check of mechanical operations (insertion and withdrawal of removable parts, locks and interlocks system, operation of safety shutters, Anti pumping device operation etc.).

e) Protection system operation stability and sensitivity by primary injection testing method including testing of metering circuits

f) Check of setting of all protective and measurement devices (e.g. protection relays, smart devices, etc...).

g) IR values of power and control circuits

h) Panel indication, annunciation, space heater circuits

i) Spare contact for customer use

CONTROL CIRCUIT

a) Operational test of control circuits to be tested as per schematic drawing.

b) Indications/Alarm/Annunciation circuit to be tested as per control schematic drawing.

c) Check for panel space heater and illumination circuits.

LT SWITCHGEAR PANELS

a) Check of electrical wiring.

b) IR Values of power circuits & control circuits

c) Tests on auxiliary and control circuits.

d) Check of electrical operation of safety (interlocking, automatic changeover, Remote closing / Tripping circuits etc…).

e) Check of mechanical operations (insertion and withdrawal of removable parts, locks and interlocks system, operation of safety shutters, charging - closing - tripping of breaker etc..).

f) Check of setting of all protective and measurement devices (e.g. protection relays, smart devices, Secondary injection testing of protective relays/releases, Trip circuit healthiness and tripping through relays/ release etc...).

g) Indication / Annunciation / Panel space heater circuit / Space contacts for customer use

h) CT testing for polarity, ratio, IR values and magnetization for class PS characteristics

i) PT testing for ratio, IR values

j) Testing of modules for DOL/ Star-Delta/ATS/ Soft Starter starting or any other starting method as per the schematic drawings applicable.

HV & LV POWER CABLE, CONTROL CABLE & CABLE ACCESSORIES

a) IR Values before Hipot

b) Hi Pot test for MV & HV cables.

c) IR Values after Hipot

INDUCTION MOTOR

a) Measurement of insulation resistance on motor windings, built-in RTDs, anti-condensation heaters and bearing insulation, if any.

b) Tests on auxiliary and control circuits-Interlocks and simulation tests Auto/ Manual and local / remote operations

c) Bump start to check direction of rotation to match with driven equipment. Bump start shall be performed with motors uncoupled to prevent damage to equipment by reverse operation.

EARTHING SYSTEM

a) Earthing resistance of each electrode

b) Earth continuity check.

c) Overall resistance of earthing installation.

LIGHTING SYSTEM

a) Check of electrical wiring.

b) Functional tests.

c) Lux level measurement for each area.

APPLICABLE PERMITS

The Contractor shall obtain, as required under the Applicable Laws, the following Applicable Permits:

(a) Liasoning and approval from State Electricity Board / DISCOM to complete the work.

(b) Any other permits, clearances or approvals required under Applicable Laws.

(c) It shall be the Contractor's responsibility to arrange for inspection of all electrical equipments by the inspector or local authority. However, the actual deposited fees, if any for the inspection shall be borne by the contractor. The Contractor shall also be responsible for follow up action and obtain and deliver to the Owner/Employer the license/ permit required under the local/ provincial / national regulations/bye-laws free of cost. Nothing extra whatsoever on this account shall be paid to the contractor.

TECHNICAL SPECIFICATIONS (INSTRUMENTATION & CONTROL)

1.1 SCOPE OF WORKS FOR I&C SYSTEM

1.1.1 Supply, erection and commissioning of all field instruments (gauges/ sensors/ transmitters/ switches etc.) for control/ monitoring/ alarm annunciation for complete Automated Waste Conveying System (AWCS) at Q-block & Automated Waste Segregation and Compaction System (AWSCS) equipment & systems at Central Waste Handling Facility (WHF) on as required basis together with specified requirement detailed subsequently.

1.1.2 Supply, erection & commissioning of PLC based control system for complete AWCS & AWSCS comprising of vertical garbage chutes, temporary storage section, discharge valve, air blowers & associated suction system equipment complete with all hardware, software, system cabinets, marshalling cabinets, interfaces & accessories as required with specified requirement detailed subsequently.

1.1.3 Supply, erection & commissioning of microprocessor based proprietary control system for Mechanical Segregator comprising of conveyors, magnetic metal separators, atomising air blowing & material separation mechanism etc. complete with all hardware, interfaces & accessories as required.

1.1.4 Supply, erection & commissioning of relay based local control panel for Compactors comprising of contact type proximity sensors, mechanical (hydraulic) press & conveyor system complete with all hardware, standalone conventional panel, interfaces & accessories as required with specified requirement detailed subsequently.

1.1.5 Supply, erection & commissioning of all erection hardware and accessories like branch cable trays from field sensors to junction boxes, junction boxes for terminating field sensors etc. as required for erection of field instruments/ sensors/ PLC Control system/ local panel etc. for complete scope of work.

1.1.6 Supply, erection & commissioning of Local 110 V AC UPS Power supply distribution boards & distribution to Bidder’s I&C system equipment.

1.1.7 Supply, laying & termination of Instrumentation & Control cables as required for complete control/ monitoring of entire AWCS & AWSCS plant. Scope also includes preparation of engineering documentation like cable schedule and Inter-connection schedule.

1.1.8 Supply of necessary consoles & other furniture & accessories to mount MMI & peripherals including two (2) Nos. good quality high back cushioned wheeled chairs each in WHF LCR envisaged at Electrical and I&C common building.

1.1.9 Supply of Commissioning and Essential spares as following:

a) Commissioning Spares: On as required basis.

b) Essential Spares: As specified subsequently.

1.1.10 Submission of engineering documentation as specified.

1.1.11 Provision of any other Instrumentation and control equipment not specified but required for proper functioning of the system.

1.2 SPECIFIC I&C SYSTEM EQUIPMENT REQUIREMENT (INCLUDED UNDER BIDDER'S SCOPE)

1.2.1 PLC Based Control System

a) PLC controllers as required complete with required I/O modules to be located at plant local control room (air conditioned) in Central Waste Handling Facility (WHF). Number of PLC controllers (each hot redundant) to be based on I/O handling capacity, specified I/O spare philosophy and controller spare loading requirement..

b) Total one (1) No. PC based VDU/ Keyboard type Operator Cum Engineering Station (OES) complete with SCADA MMI software to be located in plant local control room (LCR) complete with associated furniture for mounting the same.

c) One (1) No. A3 size colour laser printer.

d) Provision of minimum two (2) Nos. communication ports/ hardware for redundant OPC communication link (Ethernet on TCP/IP protocol) for future interfacing with City Control & Command Centre (CCCC)/ management information system.

e) Provision of minimum two (2) Nos. communication ports/ hardware for redundant serial communication link (MODBUS protocol) for interfacing with Segregator system unit.

1.2.1.1 I/O Quantity: I/O channel as required considering the I/O spares philosophy specified below.

1.2.1.2 I/O Channel Redundancy: All I/O rack and I/O cards shall be redundant for control applications and non-redundant for monitoring applications.

1.2.1.3 Spare philosophy for PLC I/O channel provision for field signals shall be as follows:

a) 20% spare I/O Channel in each I/O module/ card

b) 10% hot spare installed I/O module/ card

c) 10% spare I/O slots in PLC Controller cabinet.

1.2.1.4 Earthing connection within the panels, cabinets and between bidder's panels, cabinets for both frame and electronic earth to independent Instruments earthing pit are included in Bidder's scope (Refer Electrical systems section for more details). The Bidder shall furnish the requirement of different earthing requirement for Power and PLC.

1.2.2 Field instruments shall be provided as follows but not limited to:

1.2.2.1 General field instruments (minimum) requirement for AWCS &WHF:

a) Pressure indicator (PI) at blower fan I/L & O/L for local supervision

b) Pressure indicator (PI) at Air Compressors common discharge header for local supervision

c) Pressure transmitter (PX) at blower fans/ air compressors common discharge header for monitoring/alarm/ interlock

d) Differential pressure transmitter (DPX) across exhaust air line flow element (venture) for alarm/ interlock

e) Non-contact (Photo-electric) type Level indicating switch high each at garbage bags storage area of Discharge valve I/L for alarm/ interlock

f) Temperature indicator (TI) at blower fans/ air compressors common discharge header for local supervision

g) Temperature element (RTD) at blower fans/ air compressors common discharge header for remote monitoring

1.2.2.2 Interface with Segregator system unit:

Hardwired signal exchange along with additional redundant serial communication link between Segregator unit & PLC shall be provided for Segregator unit remote monitoring/ alarm/ indication.

1.2.2.3 Interface between Q-block located sensors/ equipment &WHF located PLC:

Signals from level switches at temporary storage sections & discharge valves open/ close command & feedback signals shall be suitably interfaced to PLC at WHF through data bus between remote I/O cabinet to be considered at Q-block & PLC system envisaged at WHF.

1.3 OPERATION PHILOSOPHY

1.3.1 Complete operation & monitoring of complete AWCS & AWSCS (except operation of Compactors) will be carried out from local control room (air conditioned) through VDU/KB based Operator Station (OS) to perform normal start-up, shutdown and emergency operations.

1.3.2 When operated from Operator Station operator shall be able to call for various types of displays for all parameters as required on the screen and to perform normal start-up, shutdown and emergency operations of the system/ equipment.

1.3.3 In addition to the control room (LCR) operation/ monitoring facility, local start/ stop operation facility from local pushbuttons (LPB) shall be provided for all Motor drives as a testing and maintenance facility as detailed below:

a) Local Start operation (without local monitoring facility) through local push button is envisaged for all uni-directional motor drives. Start command will be interfaced to respective control system. Emergency stop push button will be directly wired to MCC for emergency stop and the operation of the same will be monitored in control system through OS.

b) Local open/ close operation (without local monitoring facility) through local push buttons is envisaged for all bi-directional motor drives except for Solenoid operated drives. Open/ close command will be interfaced to respective control system.

c) Local/ remote operation location selection will be carried out from LCR located OWS.

1.3.4 Operation & monitoring of two (2) Nos. mechanical press (hydraulic) systems shall be from Local Control Panel (LCP) located near respective equipment through push buttons, indicating lamps, selection switches and necessary hardware/ equipment as required. The control shall be implemented in PLC system. Additionally, monitoring facility of shall also be available at LCR located OWS.

1.4 CONTROL PHILOSOPHY

1.4.1 Complete control and monitoring of complete AWCS with associated auxiliaries and electrical system shall be carried out in respective plant PLC based control system. Control System Configuration for AWCS is detailed in attached dwg. No. TCE.5946A-IC-SK-04.

1.5 CONTROL SYSTEM DESIGN PHILOSOPHY

1.5.1 General Requirement

1.5.1.1 The safety interlock system for the complete AWCS shall include complete protection for operating personnel and equipment under conditions that may jeopardise their safety without causing unnecessary trips or imposing undue delay

during start-up from a standstill condition or following a trip.

1.5.1.2 The design of the safety interlocking system is based on the following basic principles and is intended to shut down the plant and/ or disconnect the plant equipment from the electric power supply under certain abnormal operating conditions.

a) To trip the minimum equipment in the sequence during abnormal operating conditions leaving all the other equipment running which may safely be permitted to continue operation.

b) To indicate initiating cause for tripped equipment.

c) To prevent restarting of equipment until safe conditions are restored.

d) To retain as much flexibility of operation as is consistent with safety.

e) To operate from rugged, reliable initiating elements independent of normal control or alarm devices.

f) To prevent mal-operation of equipment on interruptions and restoration of control voltage.

g) To eliminate the necessity for any manual bypassing of an interlock to permit starting and stopping of equipment.

h) To emphasise eliminating false trips by providing component reliability.

1.5.2 Specific Requirement for AWCS:

1.5.2.1 Temporary storage section

Each temporary storage section shall be with pneumatically operated discharge valve (DV). Opening of DV shall be based on storage section level high signal activation. The air blower shall start based on any of the level signals activation. After creating sufficient suction for sucking the garbage bags load, respective DV shall open & garbage bags shall be conveyed to WHF through transporting pipes. At a time only one (1) out of four (4) DVs shall operate & other DVs shall remain in closed condition.

1.5.3 Specific Requirement for WHF:

1.5.3.1 Segregator System

Segregators shall be automatic. Metal, plastic, papers & non-recyclable materials shall be automatically segregated under Segregator units. There shall be one (1) working & one (1) standby segregator for entire facility. Working-standby logic shall be implemented in PLC based control system.

1.5.3.2 Compactors

Proximity switches shall be provided for the hydraulic based mechanical press for compacting recyclables/ non-recyclables into respective compactor units. Load cells shall be provided to maintain log for the plant outgoing material for recycling or landfill purpose.

1.6 Specific I&C system Design Requirement

1.6.1 Sensors shall be provided for pre-trip alarm for all protection conditions.

1.6.2 Instrument range selection criteria to be followed:

a) For pressure and draft measurements, the maximum operating pressure will be within 70 to 80% of the maximum scale range. All pump suction measurement and steam pressure measurements in extraction steam and in heaters will cover the negative pressure range also and all draft gauges will cover the negative pressure as well as the positive pressure as the case may be.

b) For pressure switches and temperature switches, the set points shall fall within 40% to 70% of the scale range selected.

c) For level measurement, the maximum of the range shall cover the overflow point or six inches below the top of the vessel and the minimum of the range shall be six inches above the bottom of the vessel. Also, the gauge glasses shall be stacked with overlap to cover permissive, alarm and trip levels.

d) For flow measurement, the maximum range shall be fixed at about 10 to 15% above the maximum operating flow.

e) For temperature measurement, the maximum operating temperature will be within 80 to 90% of the maximum scale range.

f) Size of Tapping point stub and root valve for Pressure and differential pressure measurement shall be 15 NB and for level & flow measurement shall be 25 NB.

1.6.3 Signal exchange for motor drives between PLC & MCC are detailed in TABLE-1. Control system design for the AWCS &WHF system shall meet the specified requirement.

1.6.4 I&C cables usage shall be as follows:

1.6.4.1 For analog & other low level signals (4-20 mA, DC), mV etc. with circuit voltage upto 48 V DC, individual pair shielded & overall shielded instrumentation cables to be used.

1.6.4.2 For binary signals with circuit voltage upto 48 V DC only overall shielded instrumentation cables to be used.

1.6.4.3 For RTD signals, individual pair shielded & overall shielded TRIAD cables to be used.

1.6.4.4 For circuit voltage above 48 V DC/ power supply applications etc. control cables to be used.

1.6.5 In all I&C cables, spare cores/ pair to be provided as follows:

Up to 5 signals, only 1 pair/ 2 cores spare to be provided. Above 5 signals & upto 24 signals 2 pair/ 4 cores spare to be provided.

1.6.6 110 V AC UPS power supply to be used for I&C system equipment including solenoid valves. Any other voltage required for Bidder's equipment is to be derived from 110 V AC UPS power supply. Distribution of complete power supply for Bidder's equipment is included in Bidder's scope of work.

1.6.7 Name tag shall be provided for all instruments, control equipment etc.,

1.6.8 All panels, cabinets local panels, JBs etc. shall comply with protection class indicated below:

a) Indoor air-conditioned area – IP 32

b) Outdoor – IP 65

1.6.9 For solenoid valves or other pneumatic devices instrument lines separate & independent air filter regulator (AFR) to be provided.

1.6.10 Tagging procedure to be followed for complete package.

1.7 SPECIFICATION OF I&C SYSTEM EQUIPMENT

1.7.1 Field Instruments

All the necessary field instruments like RTD, Level Switches, Pressure & Flow Sensors etc., and Instruments required for other associated systems shall be included in Bidder's scope. All the sub-vendors, make, model, Technical features, QAP tests are subject to Purchaser's approval.

1.7.1.1 Pressure Indicators

Direct reading, pipe mounted Pressure gauges of Stainless Steel with 6 inch phenolic dial (white dial with black numerals), 316 SS Bourdon tube, nylon movements and micrometer type adjustable aluminium pointer with accuracy of +/-0.01% of span including accessories like siphons for steam services, snubbers for pump discharge applications and chemical diaphragm for corrosive and oil

services and name plate, etc. Material of accessories shall be SS. IP65 degree of protection for enclosure. Over range protection shall be 50% above maximum pressure. Armoured capillary of 15 M shall be provided as required.

1.7.1.2 **Pressure Transmitters/ DP Transmitters**

Micro-processor based 2 wire indicating type (LCD display), rack mounted with accuracy of +/-0.075% of span, external zero and span adjustment, self diagnostics, temperature sensor for compensation. Power supply 24 V DC; output signal of 4-20 mA DC. IP 67 or equivalent degree of protection. Housing-Aluminium with epoxy coating / SS304, Accessories like snubbers for pump discharge applications and chemical diaphragm. 10 m PVC covered SS armoured capillary for corrosive and oil services, three way manifold, nameplate etc. Material for accessories shall be SS. Turn down ration 100:1. Load impedance 700 ohm (min). Process connection-1/2''NPT (M). 2 valve manifold for absolute pressure, 3 valve manifold for gauge/vacuum and 5 valve manifold for DP/level/flow measurements.

1.7.1.3 **Level Switches**

Side mounted Photo-electric type level switches for temporary storage sections shall be supplied with appropriate surface protection to suit the requirement. Micro switch with 2 SPDT contacts rated for 0.2 A, 220 V DC. Material of sensor body shall be 316 SS & cage material shall be fabricated steel and the material of accessories shall be SS. IP65 degree of protection for enclosure.

Accessories like name plate, gaskets, fasteners, bolts & nuts, etc. shall be supplied.

1.7.1.4 **Thermometers**

Thermometers shall be Industrial type, Bi-metallic for low temperature applications (< 800 C), inert gas actuated vapour pressure type for above 800 C of SS bulb and capillary. Body material-Die-cast aluminium. Dial size-150 mm with white dial and black numerals and process connection-1/2''NPT (M). Accuracy-+/- 1% of span. IP 65 protection class. Accessories include nameplate, mounting brackets and SS Thermo well. Thermowell process connection- M33X2 and 1/2''NPT (F) on thermowell for thermometer.

1.7.1.5 **Thermowells**

Pipe/equipment mounted temperature test wells of 316 SS with a process connection of M33x2 thread and instrument connection of ½" NPT (F) in general or 150 RF flanged. Accessories like name plate, plug with chain, etc. shall be provided. Material of accessories shall be SS. Thermowell shall be hex head of barstock assembly. In case flanged wells are required for any specific application, the same shall be supplied as required. The thermo well construction shall meet the ANSI 19.3 (latest) requirements. Thermo well shall be designed

such that the resonant frequency is above the exciting frequencies generated by vortex shedding in the process fluid. All Test thermo well shall have the plug of SS316. IBR certification as applicable shall be provided.

1.7.1.6 Resistance Temperature Detectors (RTD)

Duplex type, PT – 100, with accuracy of +/-0.5% of span, response time 1-2 seconds; Spring loaded mineral insulated three (3) wire RTD assembly with 316 SS Thermo well housed in aluminium casing (epoxy coated) having a process connection of M33 x 2 thread and instrument connection of ½" NPT (F) in general or 150 RF flanged. IP 65 or equivalent degree of protection for enclosure. Material of accessories (name plate, etc.) shall be SS. Thermo well with hex head with screwed cover & SS chain, barstock assembly. Element lead size shall be 18 AWG. The insulation resistance at 540 Deg C shall not be less than 5M ohms. Repeatability over full range shall be better than 0.02%. RTDs shall be ungrounded. RTD shall be supplied as an assembly complete with thermo wells meeting ANSI 19.3 (latest) requirements.

1.7.1.7 Flow Elements

316 SS long radius, welded type flow nozzles as per ASME PTC 19.5 or BS-1042 for all steam and feed water services with D and D/2 pressure tappings; 316SS concentric orifice plate assembly as per ASME PTC 19.5 or BS-1042 for all water services with flange tap connections. Beta ratio of 0.34 to 0.7 for orifice and around 0.7 for flow nozzles.. The material of accessories shall be SS. Refer to Table-5 for provision of flow elements. All the flow elements shall have 3 pairs of differential pressure tappings complete with root valves. Orifice plate shall be3 mm thick for nominal pipe diameter upto 300 mm & 6 mm thick for pipe diameter > 300 mm. The thickness of the flow nozzle shall be as per the application. The flow elements shall be supplied as assemblies with High/low pressure tappings, root valves as required. Performance Guarantee flow elements shall be provided separately. Butt welded edges shall be prepared as per ANSI 16.25 & flanged connections shall be as per ANSI 16.5 standards. Orifice assembly complete with nipples & valves to be supplied by Bidder shall be one meter long with ANSI class 150 RF SS flanges at the ends including gaskets, bolts & nuts. Isolating valves shall have SW end connection. Accessories like nameplate, gaskets, bolts & nuts, reservoirs (condensing chambers), 6 nos. shut off valves per assembly, nipple, welding adapters, etc. shall supplied. Bidder shall submit assembly drawing and flow vs DP curve for each flow element.

1.7.1.8 Load Cell based Weighing Platform

Min. 6 Nos. cells per platform; with accuracy of +/-0.1% of span of overall weighing system; Load cell sensor- Compression type; sensitivity: 2 ± 0.5% mV/V; MOC: SS316; signal output: mV DC (2 wire); Power supply: 110 V AC, single phase (UPS); Operating range: -40^{O}C to +80^{O}C; temperature compensation, hermetically sealed & protection against shock and vibrations; Overload handling

capacity: 150% of span; Housing enclosure: IP66.

Load cell mounting assembly MOC: MS with epoxy painted.

Signal conditioning unit/ transmitter (microprocessor based): input signal- load cell mV DC signal (2 wire); Output signal shall be 4-20 mA DC; Local indication with zero & span adjustment; with necessary interconnection cables & junction boxes.

1.7.1.9 **Junction Boxes (JB)**

Wall/ column mounted junction boxes having 32 (2x16) terminals and cable entry only at the bottom and sealed with fire proof compound with quantity as required shall be provided.

1.7.1.10 **System/ Marshalling Cabinets**

These cabinets shall house signal-conditioning cards, input/ output cards, processor cards & associated power supply units. Indoor located, free standing vertical type system cabinets with IP-42 enclosure and with 3 mm thick sheet metal of cold rolled steel; double doors with neoprene gaskets; anti-vibration pads of 15 mm thick; blower & louvers in each cabinet with brass mesh; fire proof compound (50 mm thickness) for sealing cable entry (bottom); fire detector for each cabinet. Beacon lamp shall be provided in each cabinet to indicate the cabinet having fault condition. The colour of the cabinets shall be indicated at detailed engineering stage. Doors shall have concealed type of hinges and swing of 100^{O}. The doors shall be provided both at the front and rear. Power supply distribution shall be provided on per cabinet basis with all associated MCBs, protections, etc. The system cabinets, racks in system cabinets, slots in the racks & the terminals shall have identification numbers. A stainless steel metal tag (plate) shall be fixed to the inside of the door & the layout of the racks, slots & details of the card type/ service shall be inscribed on this metal tag. Each cabinet shall be provided with one each 3 pin receptacles for 220 V AC, 1¢, 50 HZ and for +24V DC. Cabinet shall be delivered totally wired. All electronics shall be mounted & wiring connections at these hardwares shall be terminated by Bidder. Quantity shall be as required. All cabinets shall have common key for the locks. In each cabinet a 24 V DC Voltmeter shall be provided to check the Field Interrogation voltage.

1.7.1.11 **Local Panels**

Indoor/Outdoor located, free standing vertical type local panels with 2 mm thick sheet material of cold rolled steel; ant vibration pads of 15 mm thick; fluorescent lighting; Double doors with neoprene gaskets at every 1.5 m; blower & louvers in each section with brass mesh; fire proof compound (50 mm thick) for sealing cable entry (bottom); space heater with thermostatic control for each section (strip type). IP 55 degree of protection for enclosure. Removable cover plates with locking facility shall be provided along the bottom of the front desk continuously to facilitate maintenance work. The length of each cover plate shall

not exceed 1 m. Fluorescent lamp of 40 W shall be provided from one end of the panel to the other end at continuous length and shall be operated by the door switches as well as by manual switches. Nameplates shall be provided for all instruments/inserts with Tag. No. & short description of service engraved. These shall be phenolic overlays (1.6 mm thick), black background with white lettering & shall be fixed to the panel by stainless steel screws (counter sunk). Each section of the panels shall be provided with one each 3 pin receptacles (Indian Standard) for 240 V, 1Phase, 50 Hz UPS and receptacles for +24V DC. Terminal blocks shall have marking strips for point identification. Panel shall be delivered totally wired. All instruments, inserts and annunciation windows shall be mounted & wiring connections at this hardware shall be terminated at site by Bidder. Quantity shall be as required.

All the Terminal Blocks shall be rust proof and corrosive resistant for outdoor mounted panels. Terminal Blocks housing material shall be 6.6 polyamide and metallic portion shall be coated against rust/corrosion.

In each Local Panel, a 24 V DC Voltmeter shall be provided to check the Field Interrogation voltage.

1.7.1.12 Instrumentation & Control Cables

Instrumentation cables shall be 1100 V AC grade, stranded high conductivity annealed, tinned copper, twisted pair (with min. 20 twists for meter) extruded PVC insulated with overall and/ or individual screening, extruded PVC inner sheathed, galvanized steel wire armoured, extruded outer sheathed with FRLS PVC compound. The conductor size shall be min. 0.5 sq. mm. Triplex cables similar to instrumentation cables can be used for RTDs. Instrumentation cables carrying digital signals shall have overall screening along with drain wire and analogue signal carrying cables shall have each pair screening and overall screening along with each pair drain wire and overall drain wire.

1.7.1.13 Control Cables

Control cables shall be 1100 V AC grade, multicore, minimum 1.5 sq. mm. cross section, stranded copper conductor having 7 strands, PVC insulated inner FRLS PVC sheathed of type ST-1, galvanized steel wire armoured and outer sheath made of FRLS PVC compound of type ST-1. In situation where accuracy of measurement or voltage drop in control circuit, warrant, high cross sections as required shall be used. For all CT & PT cables, minimum 2.5 sq. mm. Cables shall be used. Solenoid valve Power supply cables shall be minimum 2.5 sq. mm.

1.7.1.14 Interposing Relay (IPR)

Electromagnetic type IPRs with plug-in type connections, suitable for channel/ rail mounting in cabinets; coil rating 24V DC. 2 set of change over contacts rated for 0.2A 220V DC. Freewheeling diode across relay coil and self reset type status

indicator flag (electronic) shall be provided.

1.7.1.15 **Solenoid valves**

Direct operated solenoid valves with shut of class (leakage) IV, body rating ANSI 150 material of SS 304 plunger material of 316 SS, rated for continuous duty. IP 65 equivalent protection class for enclosure. Operating Voltage solenoid valves shall be 110 V AC. Insulation class of “F” for the solenoid, moulded type of coil, single/ dual coil.

1.7.2 **Programmable Logic Controller (PLC)**

1.7.2.1 Microprocessor based programmable logic controller shall be of reputed make and the equipment supplied shall be of their latest series with proven performance record.

1.7.2.2 The Equipment to be supplied shall comprise PLC complete with processor, I/O cards, memory modules, racks, mounting accessories completely wired and tested. The other modules, in the scope of supply shall include power supply modules, PC based Programmer, printer, operating file, system cabinets and signal distribution hardware.

1.7.2.3 The PLC system shall be with hot redundant configuration with redundancy in processor, power supply and communication.

1.7.2.4 AI/ AO cards shall be of 16 channel type (maximum) and DI/ DO cards 32 Channel type (maximum).

1.7.2.5 All digital inputs shall be potential free and the interrogation voltage from PLC shall be 24 V DC. The digital outputs from PLC shall be 24V DC logic level signal which drives the interposing relays (IPR). IPRs for motorised drives will be located in MCC.

1.7.2.6 The System Features shall include but not limited to the following:

a) Scan time for digital/ pulse inputs not greater than 60m.sec.

b) Scan time for analog inputs not greater than 500m. sec.

c) Execution time not greater than 120 m sec.

d) Controller loading (Processing & memory capacity): Max. 60% under worst loading conditions.

e) Overall accuracy of measurement signals: + 0.5%.

f) Extensive self diagnostic alarms/ power supply failure alarms.

g) Key board command to field equipment to be executed: Within 1 sec.

1.7.2.7 PLC shall meet the following specific requirements:

a) Redundant Processor/ controller of PLC which shall have 1:1 processor redundancy for hot back up and meets the following requirement:

(i) Automatic synchronization of primary processor/ controller of PLC with secondary processor/ controller.

(ii) Bumpless switchover to secondary processor/ controller of PLC when the primary fails.

b) Communication speed shall be min 2 MBPS

c) PLC with extensive self diagnostic capability. Self diagnostic shall include both module level diagnostics as well as channel level diagnostics.

d) Automatic program and data equalization of primary processor/ controller of PLC.

e) Automatic 'Forcing Bit' update in the secondary processor/ controller of PLC when any Forcing is applied in the primary processor/ controller of PLC.

1.7.2.8 The hardware of the PLC system shall support the following design features:

a) Optical isolation for all digital inputs & outputs

b) Galvanic isolation/ optical isolation for all analog inputs & outputs.

c) Power supply to sensor transmitter at +24V DC from the PLC

d) In rush current limiter to driving circuit

e) All circuits shall be short and voltage surge proof.

f) Modular type of cards.

g) PCB shall be epoxy fibre class, plug in type with gold plated

h) All cards shall be tropicalised.

i) All analog inputs shall be provided with individual fuse.

1.7.2.9 The PLC system shall support the following functional requirement:

a) The digital outputs shall be NO/ NC/ Change over contact/ field selectable

b) For all digital signals time delay of 5-10ms for denounce time shall be provided.

c) All digital outputs shall be NO/ NC type and these shall be connected to the powered interposing relays located in the switchgear of the respective drives

d) The contact interrogation voltage shall be 24V DC derived from AC/ DC power supply unit supplied by the BIDDER.

1.7.2.10 The processor shall support/ perform the following functions:

a) Data acquisition

b) Self diagnostics

c) Generation of boolean functions

d) Logic functions

e) Monitoring ADC/ DAC and alarming (for analog inputs)

f) Digital filtering

g) Validation of all inputs & outputs

h) Point identification by tags upto 8 characters long

i) Point description: min 24 characters

j) Facility to delete or return of any point from scan/ processing

k) Communication with I/O modules

l) Communication controls & monitoring

m) Battery backup of not less than 72hrs.

n) Processor: 32 bit with floating point ability

o) Processor capability: As per input/ output requirements

p) Capacity of non-volatile memory of each processor

q) Volatile memory to store dynamic plant data, control programmes and self diagnostic routines.

1.7.2.11 PLC system shall meet the following

a) Power supply variation with limits: Voltage variation + 10%; Frequency variation + 5%; Voltage & frequency combined variation + 10%

b) All card replacements on power on conditions etc.

1.7.2.12 The PLCs processors and TFT based operator terminal shall be mounted in standard cabinets/ consoles and these cabinets shall be located in the WHF System control room.

1.7.2.13 The OES shall have a 20.1" LCD TFT Monitor with latest processor (Dual/ Quad core 64 bit/ Xeon), CPU speed ≥3 GHz, min. 4 GB RAM (>900 MHz), 520 GB SCSI HDD, DVD R/RW and Multimedia Speakers.

1.7.2.14 Operator station and peripherals shall be capable of handling minimum 75 displays 30 real time trends, 50 historical trends, 20 standard, 20 free formatted logs and 100 current and 300 logged alarms. Historical storage back up should be at least one month or better for complete data base. Compact disc drive for permanent storage & retrieval shall be offered.

1.7.2.15 The PLC offered to be compatible to standard OPC communication with Ethernet on TCP/IP protocol for establishment of redundant link with the future envisaged CCCC for entire unit.

1.7.2.16 DVD's shall be provided for data handling facility for control system software features of control and engineering. Provision shall be made for accessing DVDs and this shall enable easy file handling/ data transfer.

1.7.2.17 PLC system located in air-conditioned area shall also be designed to operate for short periods (minimum 2 hours), when air-conditioning system is not available without loss of any function.

1.7.2.18 Refer TABLE-3 for PLC system requirements.

1.8 TRAINING REQUIREMENT

Vendor shall provide training course on offered PLC system in the following areas:

a) Maintenance training

b) Hardware training

c) Application Software training

d) Operation training

1.9 TESTS

1.9.1 Bidder shall include Integrated factory acceptance test (FAT) of the system at his works. This shall include inspection by Purchaser or Purchaser's representatives. FAT procedure is subject to Purchaser's approval and the duration of FAT shall be minimum 7 days.

1.9.2 On site tests: Bidder shall include testing and commissioning of the PLC at site as Site Acceptance Test (SAT).Inspection of equipment on arrival/ Preliminary on site checks/ tests/ Start-up test/ Trial operation test/ System documentation checks/ Acceptance tests-Similar to the authorisation to ship test but with actual inputs/ outputs.

1.9.3 Availability Guarantee test: System availability shall not be less than 99.7% and shall be demonstrated by an analysis of system availability during system design.

1.9.4 Tests to be included for individual instruments shall be as per enclosed TABLE-2.

SPARES

1.10.1 Startup spares shall be as required

1.10.2 Essential spares shall be supplied as detailed below:

a) For field instruments, air filter regulators, E/P converter and junction box and drive modules a minimum of one (1) No., or 10% of the quantity of each type and range, whichever is higher, shall be provided.

b) PLC System

i) All modules like Signal distribution modules, signal conditioning modules, I/O modules, Processor modules, Power supply modules, Network cards etc., – 10% of each type, or minimum one (1) No. whichever is higher.

ii) Each type of fuse – 5 Nos., or 30% of each, whichever is higher.

c) System Cabinets

10% of each type, or minimum one (1) No. whichever is higher shall be supplied for the following

i) Fuses of each type and rating.

ii) MCB of each type.

iii) Terminals of each type

iv) Male & female parts of pre-fabricates Cables – 6 Nos., of each type.

d) Solenoid valves (for each valve):

i) Coil – 2 Nos., of each rating and insulation.

ii) Plunger – 1 No. of each type and size.

iii) Seat – 1 No. of each type and size

iv) Gaskets – 2 sets of each type and size.

v) O-rings – 5 sets of each type and size.

vi) Diaphragm – 2 Nos., of each type and size.

e) Wiring, Termination & Accessories.

10% of each type, or minimum one (1) No. whichever is higher shall be supplied for the following

i) Fuses of each type & rating.

ii) Miniature circuit breaker of each type & rating

iii) Terminals of each type.

iv) Space heater with thermostatic controls.

v) Fire detectors.

vi) Blower.

vii) Blank CD's for software back-up: 30 Nos.

viii) Cable clamps each type.

ix) Male & female pre-fabricated cables – 6 Nos., each type.

x) Spare terminal in each terminal block in all cabinets.

xi) Spare space for counting additional terminal blocks in all cabinets.

xii) Wiring raceways to accommodate additional 30% space of total quantity.

DOCUMENTS TO BE SUBMITTED ALONG WITH BID

a) System PIDs

b) System write up

c) Control/ Operation/ Design Philosophy

d) PLC system configuration With Technical Literature & PLC Requirements (Refer TABLE-3)

e) PLC Sizing Details

f) List of Spares

g) Quantity of PLC Cabinets With tentative dimensions

h) Power consumption details for I&C equipments-List of Feeders with Feeder Loads

i) Confirmation of all the clauses of the specification/ deviations

DOCUMENTS TO BE SUBMITTED BY VENDOR AFTER AWARD OF CONTRACT

1.12.1 Following documents shall be furnished by vendor

a) System PIDs

b) System write up

c) Control Schemes/ Control logics with write-up

d) PLC I/O List

e) G.A Drawing For PLC cabinets

f) List of Feeders with Feeder Loads for 110 V AC (UPS)

g) Data sheet along with catalogues of manufacturer's for all field instruments and equipments supplied by vendor.

h) Junction Box Grouping Details

i) Cable Schedule

j) Interconnection Schedule

k) Data sheet along with catalogues of manufacturer's for all field instruments and equipments supplied by vendor

l) QA Plan For I&C Equipment

m) Final List Of Essential Spares

n) Earthing requirement for PLC system cabinets.

1.12.2 Vendor to furnish engineering documents in the format as detailed in TABLE-4.

TABLE – 1

SIGNAL EXCHANGES BETWEEN PLC & MCC FOR DRIVE CONTROL

Sl. No.	From	To	Signal Description	Remarks	PLC Signal Type
A	**FOR LT UNI-DIRECTIONAL MOTOR DRIVES**				
1	PLC	MCC	Command To Start	CMD to MCC	DO
2	PLC	MCC	Command To Stop	CMD to MCC	DO
3	MCC	PLC	Motor Running	Feedback to PLC	DI
4	MCC	PLC	Motor Stopped	Feedback to PLC	DI
5	MCC	PLC	Motor Tripped (Thermal Overload)	Feedback to PLC	DI
6	MCC	PLC	Motor Ready To Start (By anding Thermal O/L not Operated/ Control Supply available/ MCC not isolated)	Feedback to PLC	DI
7	MCC	PLC	Motor Current (4-20 mA DC)	Feedback to PLC (For Motor KW> 30)	AI
8	LPB	PLC	Local Start Command	CMD to PLC	DI
9	LPB	MCC	Emergency Stop Command	Wired to MCC	-
10	LPB	PLC	LPB Emergency Stop Command Operated	LPB Stop Operated Feedback to PLC	DI
11	N/E SWGR.	PLC	N/E Bus Undervoltage	Feedback to PLC (Common for all applicable N/E Swgr. Service drives)	DI
B	**FOR MOV WITH BI-DIRECTIONAL MOTOR DRIVE**				
1	PLC	MCC	Command To Open	CMD to MCC	DO
2	PLC	MCC	Command To Close	CMD to MCC	DO
3	MCC	PLC	Motor Tripped (Thermal Overload)	Feedback to PLC	DI
4	MCC	PLC	Motor Ready To Start (By anding Thermal O/L not Operated/ Control Supply available/ MCC not Isolated)	Feedback to PLC	DI
5	Actuator	PLC	Open Limit Switch Operated	Feedback to PLC	DI

Sl. No.	From	To	Signal Description	Remarks	PLC Signal Type
6	Actuator	PLC	Close Limit Switch Operated	Feedback to PLC	DI
7	Actuator	PLC	Open Torque Switch Operated	Feedback to PLC	DI
8	Actuator	PLC	Close Torque Switch Operated	Feedback to PLC	DI
9	Actuator	MCC	Open Limit Switch Operated	For power cut-off in MCC	-
10	Actuator	MCC	Close Limit Switch Operated	For power cut-off in MCC	-
11	Actuator	MCC	Open Torque Switch Operated	For power cut-off in MCC	-
12	Actuator	MCC	Close Torque Switch Operated	For power cut-off in MCC	-
13	LPB	PLC	Local Open Command	CMD to PLC	DI
14	LPB	PLC	Local Close Command	CMD to PLC	DI
15	LPB	MCC	Emergency Stop Command	Wired to MCC	-
16	Actuator	PLC	Position Feedback (4-20 mA DC)	Feedback to PLC (For Inching services)	AI
17	N/E SWGR.	PLC	N/E Bus Undervoltage	Feedback to PLC (Common for all applicable N/E Swgr. Service drives)	DI
C	**FOR PNEUMATIC/ HYDARULIC BI-DIRECTIONAL DRIVE/ SOLENOID DRIVE**				
	I. SINGLE COIL SOV WITH OPEN STATUS FB				
1	Actuator/ SOV	PLC	Open Limit Switch Operated	Feedback to PLC	DI
2	PLC	SOV Through Power Board	Command To Open/ Close	CMD to SOV	DO
	II. SINGLE COIL SOV WITH OPEN/ CLOSE STATUS FB				
1	Actuator/ SOV	PLC	Open Limit Switch Operated	Feedback to PLC	DI
2	Actuator/ SOV	PLC	Close Limit Switch Operated	Feedback to PLC	DI
3	PLC	SOV	Command To Open/	CMD to SOV	DO

Sl. No.	From	To	Signal Description	Remarks	PLC Signal Type
		Through Power Board	Close		
	III. DOUBLE COIL SOV WITH OPEN/ CLOSE STATUS FB				
1	Actuator/ SOV	PLC	Open Limit Switch Operated	Feedback to PLC	DI
2	Actuator/ SOV	PLC	Close Limit Switch Operated	Feedback to PLC	DI
3	PLC	SOV Through Power Board	Command To Open/ Close	CMD to SOV	DO
4	PLC	SOV Through Power Board	Command To Open/ Close	CMD to SOV	DO
D	**FOR MANUALLY OP. BI-DIRECTIONAL DRIVE**				
1	Actuator	PLC	Open Limit Switch Operated	Feedback to PLC	DI
2	Actuator	PLC	Close Limit Switch Operated	Feedback to PLC	DI

NOTES (FOR TABLE-1):

1 All 'DI' signals to be interfaced to PLC are Potential Free Contact (PFC) type.

2 In case of uni-directional & Bi-directional motor drives, all 'DO' commands from PLC to MCC are 24 V DC logic level type. 24 V DC IPR to be located in MCC (vendor's scope of supply).

3 In case of SOVs, all 'DO' commands from PLC are potential free contact type taken from 24 V DC IPR (in PLC vendor's scope of supply).

TABLE – 2
TESTS TO BE PERFORMED FOR FIELD INSTRUMENTS

1.1 Accuracy, repeatability, Calibration tests, hydro test (1.5 times max. pr), over range test (1.5 times range) shall be provided for all field measuring instruments.

1.2 Material test (for all temp. meas.ins), insulation test (for RTD & T/C), Bore concentricity test: ±5% for thermometers, RTDs, T/Cs &±1.5 % for temperature switches.

1.3 Functional tests, temperature rise test, HV test, insulation tests, and contact rating test for Inter Posing Relays.

1.4 Verification of Degree of protection, type & routine tests as per relevant Indian Stds. for local, system panels.

1.5 Compensating cables: Thermo-emf characteristic/ Continuity test/ Measurement on capacitance, inductance and loop resistance/ Insulation resistance/ High voltage test as per latest IS/ Tensile and elongation test/ Oxygen index test/ Any other test applicable.

TABLE – 3
PLC SYSTEM REQUIREMENTS

Sl. No.	DESCRIPTION	REQUIREMENT	Bidder response
1.0	Type of Control system	Programmable Logic Controller (PLC)	
1.1	Offered PLC System- Make/ Model	Latest system available/ being marketed in the international market by the vendor/ collaborator with minimum 3 years of proven performance record.	
1.2	Operating System	Windows –XP or better	
1.3	CPU speed	> 3 GHz	
1.4	Minimum HDD capacity	520 GB	
1.5	Hierarchical protection for operator & engineer functions	At least 3 levels of security is required	
1.6	Response time (Maximum) for Analog input RTD Digital Input/ output Loop cycle time inclusive of controller processing time	250 m sec 1 sec	
		60 m sec	
		250 m sec (Analog); 100 m sec (Digital)	
1.7	Auto switchover time to backup/ redundant component at a) Processor level b) Communication level c) Power supply level	Instantaneous and bump-less (Bidder to indicate the time)	
1.8	Display Call up time in HMI monitor	1-2 sec	
1.9	Dynamic update time of parameters in the HMI monitor for measurement and control	1-2 sec	

Sl. No.	DESCRIPTION	REQUIREMENT	Bidder response
1.10	Key board command to field equipment for command execution	Max. 1 sec	
1.11	Spare capacity required in the control processor considering spare I/O channels and future I/O modules to be located in the spare I/O slots	Minimum 40 %	
1.12	Output status on controller failure	Configurable in Engineering station	
1.13	Output status on power supply failure	Configurable for switching to fail safe mode	
1.14	Status indication for each channel in DI/ DO card	LED indication required	
1.15	Power supply healthiness status in all modules	LED indication required	
1.16	Optical Isolation for DI/ DO	Required	
1.17	Galvanic isolation for AI/ AO	Required	
1.18	Control processor with floating point arithmetic capability	64 bit processor, RISC based	
1.19	Capacity of RAM	4 GB minimum	
	Spare capacity in RAM	Minimum 40 % including spare I/O	
	Processor Redundancy	Dual redundant hot stand-by	
	Battery back up for RAM	Rechargeable Ni-Cd	
	Duration of battery back up for dynamic memory	72 Hrs	
1.20	Open loop control (Logic, Protection & Interlock)	Redundant I/O modules	
1.21	Maximum number of channels in I/O modules -		
	Analog I/O modules	16 Channels	
	RTD, Thermocouple	16 Channels	
	Digital I/O modules	32 Channels	
1.22	Diagnostics	Upto card/ component for hardware faults & software	

Sl. No.	DESCRIPTION	REQUIREMENT	Bidder response
		faults	
1.23	Provision of individual fuse for all analog signals	Required.	
1.24	2 Nos. serial & 2 Nos. OPC communication link ports	Required.	

TABLE – 4
ENGINEERING DOCUMENTS FORMAT

Bidder shall prepare the engineering documents in this table & submit for PURCHASER/ CONSULTANT review & approval. The engineering documents shall have all fields as listed under 'Details of Fields' in this table and the Bidder shall furnish all the engineering documents in CD or DVD in addition to hard printout for each revision. Finally Bidder shall submit as installed and commissioned drawings/ documents.

SL. NO.	TYPE OF DOCUMENTS	DETAILS OF FIELDS
1.	Drive List	1, Sl. No. (*), tag number. 2. General Data (a) Bidder: Motor (Bidder's name) (*), drive equipment (*). (b) Type/ Form: Type (*), reference standard (*), manufacturer's dwg. No. (c) Mounting, coupling method (*). (d) Motor Equipment Location: Layout dwg. No. co-ordinates, elevation. 3. Data required for electrical engineering: (a) Rating: Output (kW) (*), full load speed (RPM) (*), voltage. (b) Enclosure, Indoor/ Outdoor, starting method, direction of rotation, winding insulation class, Integral starter, Integral starter wiring diagram No. (c) Space Heater: Number provided, Rating (kW) (d) Performance at rated volts & Hz: Rated current (IFL) Amps (*) starting % IFL (*), starting current %IFL (*), power factor (*), starting torque %IFL, pull out torque. (e) Terminal box: Cable size (mm2), cable OD (mm), location. 4. Data required for instrumentation & control Type of control (interlocked/ non-interlocked), Type of operation, Type of actuator, Control cable gland size, status/ position feedback, actuator wiring diagram No., local control panel operation, control system scope. 5. Solenoid Valve Data (*) (a) Sl. No. Service, fluid (*), quantity (*)

		(b) Type: 2 way, 3 way, 4 way. (c) Size: Pipe, Body, Orifice (d) Operating conditions: Pressure – (kg/cm2) (e) CV: Selected, Rated (f) Action: Coil # 1, (E/DE), Coil # 2 (E/DE) (g) Coil: Single coil (h) Voltage 110V AC, 220V DC. (i) VA: Normal, Inrush.
2.	Inputs to Bidder from Purchaser's System	Sl. No. signal category (analog/ digital), signal type (isolated 4-20 mA DC/ NO/ NC/ CO), No. of signals required by Bidder, Vendor tag No., signal description, signal range/ set value, signal destination in Bidder's system, purpose, reference dwg. No. Remarks.
3.	Outputs from Bidder's System to Purchaser's System	Sl. No. signal category, signal type, No. of signals available to purchaser, vendor tag No., Signal description, signal range/ set value, signal location in Bidder's system, purpose, Reference dwg. No., contact rating, Remarks.
4.	Junction Box Schedule	Vendor JB No. service description, instrument/ signal tag. No., terminal No., -/ com, terminal No. SH/ NC, Incoming cable type, Incoming cable No., JB location, Remarks,
5.	Terminal Details – Analog	Sl. No., signal description, signal category (AI/ AO), source equipment, source equipment tag No., vendor tag No., signal type (RTD/ T/C/ 4-20 mA DC), terminal block No., terminal numbers (+, -, SH), Reference dwg. No.
6.	Terminal details – Digital	Sl. No. signal description, signal category (DI/ DO), source equipment, No., vendor tag No., contact type (NO/ NC/ CO), terminal block No., terminal numbers (NO, C, NC) Reference dwg. No., Remarks
7.	Schedule of Instruments with Settings	(a) Sl. No., (Service Status condition to be indicated for contact signals), Scope, Instrument type, (Indicator/ Switch/ Transmitter, etc.) (b) General Data Vendor tag, Location in elevation/ rows/ columns, flow diagram reference (c) Design Data: (i) Pressure: (Kg/cm2, unit shall be mm wcl for sub-atmospheric pressure): Normal operating pressure, maximum operating pressure, design pressure, design temperature.

		(ii) Temperature (0C): Type of element (For RTD – PT100, C4-53 & for T/C – K.R.S.J, etc.,) normal operating temperature, maximum operating temperature, and design temperature. (iii) Flow: Fluid, pipe size, velocity (mts/sec), viscosity, maximum pressure loss, normal flow (m3/hr), maximum flow (m3/hr), design flow (m3/hr), DP at maximum flow (mmwcl). (iv) Level: Normal level, maximum level, instrument range, engineering units. (v) Accessories, body rating (ANSI), remarks (redundancy of instruments to be indicated here).
8.	List of panels/ cabinets & control room mounted equipment	Sl. No., control room layout reference, description, tag No., panel/ cabinet, location, qty/ unit, scope, dimensions – height (mm), width (mm), depth (mm), weight (kg), power dissipation (watts), reference dwg. for panel mounting dwg. No. showing external wiring, remarks.
9.	3rd party instrument list	Sl. No., description, vendor tag No., location, qty./ unit, scope, dimensions-height (mm), width (mm), depth (mm), weight (kg), power dissipation (watts), reference dwg. No., showing mounting details, reference dwg. No. showing external wiring, remarks.
11.	Equipment List	Equipment, equipment code, equipment location, remarks.
12.	Cable List (For all cables in Bidder's scope)	Cable scope, cable No., cable type, source, source location, destination, destination location, signal tag No., service description, remarks, cable length in metres.

13.	Loop Drawings	Loop Drawings shall be submitted for all signals between the field instruments & system cabinet/ local panels in Bidder's scope of supply. The loop drawing shall indicate the field instrument tag No., service, field JB No. (to which the instrument is connected), system cabinet No., TFT/ CPU indicator/ to Purchaser's system. The drawing shall also indicate the terminal numbers, polarity & cable numbers for all junctions & hardware/ components forming the loop. Loop drawing shall be prepared for each & every signal going to Bidder's system.

LIST OF APPROVED MAKE

A. Mechanical Equipments :

i) EOT Cranes
   a) Electromech
   b) Eddycranes
   c) Tractel
   d) Demag Cranes

B. InstrumentationEquipments :

Sr. No.	Item	Recommended make
1.	Pressure indicator	• General instruments • AN instruments • M Guru
2.	Pressure transmitter	• Yokogawa • ABB • Emerson process • Honeywell
3.	Flow element (Venturi)	• Star-Mech Controls • Scientific Devices (Bombay)
4.	Differential pressure transmitter	• Yokogawa • ABB • Emerson Process • Honeywell
5.	Level Switch – Proximity(Photo-electric type)	• Pepprl+Fuchs • Proximon
6.	Load cell based weighing platform	• Nova weigh • Sartorius Mechatronics • Transweigh
7.	PLC System	• ABB • GE Fanuc • Rockwell Automation
8.	System/ Marshalling Cabinet	• Rittal India • Pyrotech Controls • Flameproof Equipment

Sr. No.	Item	Recommended make
		• Industrial & Commercial Enterprises
9.	Junction Box	• Hensel Electric India • Flameproof Equipment
10.	Instrumentation Cable	• Associated Cables • Associated Flexibles & Wires • Cords India • Delton Cables • TCL Cables
11.	Control Cable	• Associated Cables • Associated Flexibles & Wires • Cords India • Delton Cables • TCL Cables
12.	Interposing Relay (IPR)	• O.E.N India • Omron
13.	Solenoid Valve (SOV)	• Avcon Controls • Dembla Valves • Rotex Automation
14.	Instrument tubes & fittings	• Swagelok

C. Electrical Equipments :

Note:*The below makes are minimum suggestion to be offered. Other makes if approved by PWD may also be considered with prior approval of client*

Sr. No.	Material/ Equipment	Vendor
1.	Switchgear / Switchboard MV–VCB / RMU/ LBS	Siemens ABB Schneider Electric

Sr. No.	Material/ Equipment	Vendor
2.	Compact Substation	Siemens ABB Schneider Electric
3.	Distribution Transformer	Schneider Electric Crompton Greaves Limited Transformers & Rectifiers India Limited C&S
4.	Static Power Meter & Logger (Trivector Meter)	As per DISCOM Company
5.	Protection Relays (Numeric / Electro mechanic Type)/ Auxiliary relays)	ABB Schneider Electric Siemens Alstom GE
6.	Potential & control Transformer (CT/PT)	Gilbert & Maxwell Precise Kappa Pragati Anant Powertech
7.	Current Transformer (Cast Resin Epoxy Coated)	Gilbert & Maxwell Precise Kappa Pragati Anant Powertech

Sr. No.	Material/ Equipment	Vendor
8.	Electronic Digital Meter (A/V/PF/HZ/KWH) /MFM with LCD/LED Display.	Schneider Siemens Secure Socomec L & T **APPENDIX 1:** ABB
9.	HRC Fuse and Fuse Fitting	ABB GE Siemens L&T
10.	ACB / MCCB/ Contactors	ABB Schneider Siemens L&T
11.	Change over switch (automatic/ manual)	HPL Hager ABB Socomec GE
12.	Thermister relay	Alstom/ Minilec/ Siemens
13.	Push Buttons	ABB L&T Schneider Siemens

Sr. No.	Material/ Equipment	Vendor
		BCH
14.	A. Power Distribution Panels & Boards Totally Type Tested Assembly (TTA) (As Per IEC61439- 1 & 2). To be sourced directly from OEM or authorized licensed partner. To be manufactured at manufacturer's own factory.	Advance Panels & Switchgears (P) Ltd. Adlec Power Pvt Ltd Jackson C&S Electric Ltd
15.	Switches, Time Delay Relay	Schneider Siemens Hager Legrand
16.	Indicating Lamps	Siemens Schneider ABB L&T BCH Esbee
17.	HT Power Cables	Universal KEC International CCI Polycab
18.	LT Power& Control Cables	Universal KEC International

Sr. No.	Material/ Equipment	Vendor
		CCI Polycab Finolex
19.	HT/ LT Jointing Kit & Termination Kit	Birla-3M Raychem M seal
20.	Termination (Lugs)/ Cable Glands(Double compression)	Commet Dowell Jainson
21.	Selector Switches	Kaycee ABB Siemens Schneider
22.	Alarm Annunciators (solid state type with LED illumination) / Facia Annunciator	Industrial Instruments & Controls Minilec Alstom ICA
23.	Cable Management Systems-Raceways/Floor Boxes/ Trunkings , Cable trays	Legrand OBO-Betterman MEM
24.	Earthing strips	MARS MEM OBO STEELCO

Sr. No.	Material/ Equipment	Vendor
25.	Cable tray hangers and Supports	Gripple Hilti
26.	MS Black Stove Enameled ERW Conduits/GI pipes(ISI Approved) & accessories	AKG RMCON Precision TATA Steel
27.	UPVC Conduit/JB/flexible conduit / tees/ Bevels, elbow & accessories	AKG Plaza Avon Plast Precison
28.	Copper Conductor PVC Insulated Wires/ Stranded Flexible Wires (FRLS) / HFFR (including panel wiring)	Finolex RR Kabel LAPP India Polycab
29.	Non-insulated Copper Earthing conductors	Gupta Industrial Corporation (Vasai, Palghar) Bharat Wires & Ropes Diamond Cables
30.	Modular Switches, Socket Outlets And Wiring Accessories With Moulded Cover Plate.	Legrand Schneider MK Crabtree
31.	Metal Clad Plug & Socket (Industrial)	Legrand Schneider Neptune (Balls)

Sr. No.	Material/ Equipment	Vendor
32.	MCB/RCCB/ SPD/RCBO/ MPCB	Legrand Schneider Siemens ABB EATON
33.	Distribution Boards(MCB DBs)	Legrand Schneider Siemens ABB L & T EATON
34. a.	Light Fixtures-General	Wipro Philips Crompton Greaves Bajaj
35.	Occupancy/Motion Sensor	Wipro Philips OSRAM Schneider ABB
b	LED / Driver	Cree Nichia Philips Lumiled

Sr. No.	Material/ Equipment	Vendor
		Osram
36.	Exit lights	Prolite Legrand Philips Zumtobel
37.	Ceiling Fan (5 star rating)	Crompton Bajaj USHA ORIENT Havells
38.	Exhaust Fans (5 star rating)	Crompton Almonard Havells Orient
39.	Street & Landscape Lighting	Schreder Wipro BAJAJ Philips Lighting technologies Keselec
40.	MS Tubular / Octagonal / Decorative Poles	Bajaj Schreder

Sr. No.	Material/ Equipment	Vendor
		Valmount K-lite Keselec
41.	Lightning Protection System	DEHN Elpro Oblum Crompton Greaves
42.	Lightning & Surge Voltage Protection	ABB Hager OBO Betterman DEHN
43.	Fire Sealant &Fire Retardant Paint	3 M India Ltd. HILTI Promat
44.	Fire Barriers / Sealing	Brattberg Roxtec Signum Navell Multikil
45.	Water barriers/sealing system	Roxtec Rayflate (Tyco Electronics)
46.	Insulating mats	Electromat Dozz Raychem RPG
47.	Terminal Blocks /connectors	Jainson Elmex

Sr. No.	Material/ Equipment	Vendor
		Connect well Wago
48.	Single Phase Preventers	Minilec Siemens Schneider Electric L&T
49.	Selector Toggle Switch	Kaycee Salzer (Larsen & Toubro) ABB
50.	Sealed Maintenance Free Batteries	Amar Raja Exide Hitachi
51.	Battery Charger	Caldyne Chhabi Electricals Amar Raja Hitachi
52.	Water barriers/sealing system	Roxtec Rayflate (Tyco Electronics)
53.	Fire Survival cables	INDIA-IMPEX(FRTEK) LEONI Bonton

Sr. No.	Material/ Equipment	Vendor
		Fusion Polymer
54.	DG Set (Engine)	Caterpillar Cummins MTU Mitsubishi
55.	DG Set (Alternator)	Cummins(Stamford /AVK) Leroy Somer BHEL
56.	Anti Vibration Mountings	Gerb Resistoflex Kanwar
57.	Timers	Schneider Siemens L&T Legrand
58.	HSD – Storage Tank	Engineers Syndicate Multi Engineering Sermes Hydrotherm Engineering
59.	Flexible Coupling	Resistoflex Kanwal
60.	Residential Silencer	Nelson Cummins

Sr. No.	Material/ Equipment	Vendor
		Sterling Power Catter Pillar
61.	MS Pipes for Exhaust System	Jindal Hissar Tata SAIL
62.	MS Pipes/ GI pipes for fuel system	Jindal Hissar Tata SAIL
63.	Pressure/Temperature Gauges	H Guru Feibig Emerald
64.	Vibrator Eliminator	Kanwal Resistoflex Dunlop
65.	Semi Rotary type hand fuel filling pump	Rotodel Kitty Binks
66.	Polycarbonate Sockets	Clipsal MANNEKER Legrand
67.	Water Tight Polycarbonate Boxes	Hensel Legrand Phraser

Sr. No.	Material/ Equipment	Vendor
68.	Astronomical Timer	The ben ABB Siemens
69.	Capacitor Panels	Schneider EPCOS ABB P2Power
70.	Capacitor (APP) / Seriesreactors / APFC relay	Schneider EPCOS ABB L & T
71.	UPS	Emerson Schneider Eaton Socomec

CONTENTS

PART - 1

TECHNICAL AND GENERAL SPECIFICATIONS FOR O & M

1.1 GENERAL

This section applies to carry out operation and maintenance of the facility in meeting its objective. The section pertains to the specifications of plant and equipment including materials used for operation and maintenance, the workmanship, period for routine maintenance, specifications for the satisfactory performance of Automated Solid Waste Collection, Segregation and Transportation system, maintenance of records, and responsibilities during operation and maintenance period. The Contractor shall be responsible for providing continuous improvement in the plant operation, the instrumentation system, communication system, PLC/SCADA, Plant and Machineries, all ancillary buildings, campus area, for period of five years, and to prevent any further sudden failure or breakdown through maintenance works on plant operation and its operation works. It is essential that Employer and contractor need to have sufficient information on operational issues under normal and emergency condition.

Notwithstanding as to what is specifically stated under MAINTENANCE SCHEDULE of Appendix - D, it shall be responsibility of the contractor to attend to all the preventive &routine maintenance and repairs and breakdown services including replacement of necessary parts and components.

The list of Mechanical & Electrical equipment applicable for Operation and Periodic Maintenance activities are listed as follows, including but not limited to:

The Automated Solid Waste Collection, Segregation and Transportation system shall

Comprise the following:

1. Feeder System

- Temporary Storage Sections.
- Waste Level Switch
- Discharge Valve
- Air Inlet Valves with Silencers
- Inspection chambers and access covers

2. Waste Conveyance Pipe Network

- Pipe Network
- Valves & Fittings
- Inspection chambers and access covers as required

3. Central Waste Handling Facility

- Exhausters
- Compressed Air System
- Air-waste separation system
- Waste Segregator with bins
- Waste Compactors
- EOT Cranes
- Exhaust air cleaning system
- Fire Alarm system & Portable type fire extinguishers

4. Residue transportation system.

- Detachable type containers
- Hydraulically operated truck for transportation of detachable containers

5. Electrical System

- 33kV Package Substation with dry type transformer
- 415V WHF Main PMCC Panel
- Variable Frequency Drive (VFD)
- 415V Capacitor and APFCR panel
- Main Lighting and Power DB
- UPS with Battery & Battery Charger
- Equipment Panels
- Fire Alarm System with Fire Alarm & Control Panel
- Lighting system
- Power cables
- Earthing & Lightning Protection system

6. Instrumentation & Control Systems

- PLC/ SCADA system hardware & MMI peripherals
- Local Control Panel (LCP) for each Compactor unit
- Pressure, Level, Flow, Load sensors
- UPS for I&C equipment
- Field accessories viz. JBs, cable trays/ raceways
- Instrumentation and Control cables

1.2 PERFORMANCE GUARANTEE

The Contractor shall guarantee & maintain the design parameters as stated in Basis of Design, WHF and Section 8 throughout the Operation & Maintenance Period of 5 years.

1.3 DUTIES AND RESPONSIBILITIES

The Contractor shall operate and maintain the Automated Solid Waste Collection, Segregation and Transportation system on a regular and systematic basis.

- Employer will provide only raw water and power. Rest all Responsibility lies with the Contractor.
- The contractor shall manage plant operations so as to restrict power consumption and chemical usage within the specified functional guarantees.
- The contractor shall ensure satisfactory operation and maintenance of the whole works so that the plant operation provides reliable, consistent performance and is economical at all times.

The following activities and materials are to be provided by the contractor.

- Daily Operation of the system
- Periodic maintenance of the system on weekly, monthly and yearly basis as per standards
- Consumables such as grease, filters, limit switches, active carbon for deodorizing systemThe following additional activities and materials shall be provided by the contractor.
- Payment of utility connection and consumption charges for Water, Electricity, Telephone
- ADSL [Internet connection and service]
- Electrical energy for system operations
- Container transportation from the site to the landfill

1.4 DEFINITION OF MAINTENANCE

Maintenance covers all the techniques and systems which, by means of regular monitoring of equipment and scheduled maintenance procedures, prevent failures and, in the event of problems, enable repairs to be carried out with the minimum disruption of the process. Maintenance is therefore a combination of technical, administrative, and management activities. Maintenance consists of preventive and corrective procedures.

Preventive Maintenance

Preventive maintenance consist of all the regular work carried out in order to sustain the conditions necessary or smooth operation of the plant and to keep the performance of the equipment as close as possible to its original performance level. Its purpose is to reduce the probabilities of failure of deterioration of equipment of the plant. In simple terms, preventive maintenance involves the elementary operations such as lubrication, mechanical servicing, electrical and instrumentation servicing.

Corrective or Remedial Maintenance

Corrective or remedial maintenance consists of all work needed to re-establish the conditions necessary for an apparatus or set of equipment to operate properly subsequent to failure or deterioration of the results produced by the equipment. It includes the following operations,

- Dismantling of equipment,
- Replacement of parts

The work may be scheduled for the short or medium term in accordance with the checks carried out as part of the preventive maintenance procedure, the number of hours an apparatus has been operating , or an alarm factor (abnormal noise, repeated cut-out, weakening of the insulation, etc), or may be dictated by an unexpected breakdown.

MAINTENANCE WORK

The work consists of inspection work and maintenance work as mentioned below:

- Inspection work, that includes physical appearance, inspection and measurement with testing equipment to verify and survey that the plant performance whether operation is normal or not.
- The inspection work shall be daily executed by each technical specialist as a routine and/or regular inspection and shall be recorded every time. The evaluation on the collected data shall be immediately reviewed by the chief operational engineer to instruct the staff member for operation on the same day and/or make a plan of detail inspection and/or make repair schedule to make sure continuous plant operation without any problem.
- Maintenance work, for which main task-work shall include activities, such as lubrication, overhaul, replacement of parts, repair, adjustment, detail examination and test, cleaning, to maintain the plant in a good condition, performance consistent and low cost operation

based on a regular and preventive maintenance schedule including attending sudden Equipment breakdown and to achieve high operational efficiency.

OPERATION WORK

This work consists of operation work and monitoring work:

- Operation work is executing the plant operation based on the scheduled process and procedureto meet designed criteriafor automated collection, segregation and transportation.
- Monitoring work is to confirm the operation data, and readout it's measurement value on panels, and check-up the working performance of plant appropriately, as well as keep the records of the out-put.

1.5 SPECIFICATIONS

The specification of materials used for repairs shall be the same as have been used in the original work. Specifications for any materials which were not used during construction shall be approved by the Engineer prior to commencement of the operation and maintenance period and must be incorporated in the O&M manual. Without being limited by this clause, during O&M period the Contractor shall use appropriate material for repairs even if material required for such repairs has not been approved earlier, and no delay in making such repairs shall be subjected to such limitation.

Table A: List of Execution Schedule

Items	Description
Maintenance of plant/ facilities	List of unit process, Capacity of equipment, Method/ Frequency of maintenance.
Operation of plant/facilities	List of plant/equipment, Items to be monitoring/operation,Method of system control and its note, How to input data into computer, operation of backup, Period of Power failure and generator operation, communication method.
Countermeasure against accident and risk	Damage prediction, Simulation of public relations, Method of recovery, Contact address, Rescue activity and emergency

management	team.
Renewal	Replace of pipes, Replace of equipment & Facilities.
Subcontracting	Method of contract out, Scope of works, limit of responsibility.
Evaluation & Report	Method of data analysis, Evaluation of collected data, Improvement program, Reporting.
Organization and administration	Executive organization chart, Segregation of duties, List of stuff member, Experience, Health certificate of staff member, type of insurance, Criminal record, Personnel name of taking record and make soft data, method of data control, Operation and maintenance cost.

The scope of Bidder includes Operation & Maintenance of Automated Solid Waste Collection, Segregation and Transportation system.

The list of equipment applicable for Operation and Periodic Maintenance activities of the Automated Solid Waste Collection, Segregation and Transportation system, as listed in the Scope of Work, WHF Section 6, including but not limited to the same.

The Contractor shall deploy Qualified Staff having knowledge of Automated Solid Waste Collection, Segregation and Transportation system.

1.6 WORKS COVERED UNDER O & M SCOPE

1.6.1 Scope of Operation and Routine Maintenance Work

A Operation and routine maintenance work shall include the day to day operation, inspection, performance logging, maintenance, servicing, periodic testing and calibration of the AWCS installation.

B Any tools, equipment, testing instruments, consumable items and sundry materials required for the operation and routine maintenance work shall be provided by the Contractor. Safety and protective equipment such as safety helmet, shoe, eye protectors, ear shields, etc. shall also be included.

C Uniform shall be provided for wearing by workers at all time while on duty and shall bear the Contractor's company name. The cost of such provision shall be borne by the Contractor.

D Remote Operation- Operation shall be carried out remotely using the designated remote control software.

For day to day, monthly, quarterly, yearly maintenance, refer Appendix D,WHFSection 9.

1.6.2 Inspection, Maintenance and Servicing Log

A The Contractor shall report immediately to the Employer any anomalies in the operation of the system or the components found during routine inspection and servicing work

B A filling system shall be used to record any major repair, calibration or replacement work that has been conducted. Inspection/ maintenance checklist shall be included to ensure all the routine servicing work is carried out as required

C Except where mentioned in the routine maintenance and servicing requirements, no replacement of any part of the system shall be carried out unless prior approval has been obtained from the Employer

D Any repair or replacement work directed by the Employer shall be filed and stored for the record

1.6.3 Cost of Repair and Replacement Work

The Contractor shall be responsible for the cost of consumable items required for the operation of the system within the maintenance period.

Spares

In accordance the General Conditions the contractor shall provide all spare parts necessary for proper maintenance of the AWCS during the maintenance period as per the submitted list of recommended spare parts .

- Maintaining;
  - Repair history of all mechanical, electrical and instrumentation control equipment in Automated Solid Waste Collection, Segregation and Transportation system;
  - Every day power availability/ power failures, hourly readings of input voltage and current, frequency, power factor, kWh, kW in HT Switchgear cubicles.
  - Logbooks through PLC system;
  - Daily log of operations of all the important equipment such as Waste Level switches,Exhausters, conveyor belts, air waste separator, air compressors, segregator, compactors, pneumatically actuated valves, etc., with time tag;
  - Daily list of alarms with time tag;
  - Logbook format and the data to be included in the logbook shall be decided during commissioning in consultation with department;
  - Last periodic maintenance done for all equipment/buildings of the system;

In addition to maintenance of above logbooks, the Contractor is required to maintain one inspection book at the plant and machinery area. The complaints entered in the complaint register must be investigated and remedial measures must immediately be taken.

- Providing required spares, special tools and test equipment and maintaining adequate inventory of required accessories or equipment itself for repair of system so that the electrical, mechanical, instrumentation and control system, pipe and the communication system can work efficiently as per the guarantees given or minimum required efficiencies asked for in the Contract, without any additional costs to department. The Contractor may use spares and tools and tackles supplied with the Contract as required by him. However at the end of the Contract the Contractor shall hand over the full spares, tools and tackles as supplied with the Contract by replacing the used items with fresh supplies of the same specifications.
- Providing manpower for the required repairs of all facilities along with the manpower and materials for repair of the roads, buildings and campus area utilities.
- Proper maintenance of Water Supply, Sewerage, Roads, Paths, lawns including trimming and upkeep of gardens etc.
- Proper maintenance and housekeeping along with provision of all tools & equipment.
- Maintaining stores for the electrical, mechanical and instrumentation and control equipment as well as that for the chemicals and laboratory consumables. The maintenance of stores will include but shall not be limited to:
    a) Loading / unloading of materials received and issued for works;
    b) Proper arrangement of material in stores to ensure its safety and easy availability;
    c) Maintaining store areas in a neat and tidy condition;
    d) Keeping records and accounting for the incoming materials,
    e) Keeping records and accounting for the consumed materials.
- The Contractor shall be solely responsible for the safety and security of the goods in the store and will be responsible for any loss or damages in stores for any reason.
- Periodic routine maintenance of structures/buildings of Central Waste Handling facility and others built in the Contract. Such maintenance must ensure adequate cleanliness, ventilation, illumination and structural safety. In addition to this, the general hygienic standards must be maintained and adequate plantation, horticultural activities must be taken up to maintain the total environment of the campus / building pleasant.
- Updating and periodic submissions of the operation and maintenance manual as defined in specifications for O&M works. The Contractor shall take up all periodic maintenance works provided in the approved O&M manual.
- Submission of monthly report.

- Co-ordination with other contractors and/ or agencies responsible for the execution, operation and maintenance.
- The Engineer shall be entitled to audit any aspect of the system and the contractor shall ensure remedial action as directed.
- Safety reporting: Brief reports of all accidents and hazardous incidents including descriptions of causes,extent of injuries,action taken,and precautions instituted to prevent repetition of such events.

➢ Insurance: The Contractor shall, without limiting his or the Employer's obligations and responsibilities, undertake the following;

- The insurance shall be at the Contractor's cost and shall cover the Employer and the Contractor against all losses or damages from whatsoever cause arising from the start of the O&M until the date of completion of O&M in respect of the facility or any section or part thereof as the case may be.
- Insurance shall cover for civil works .
- Insurance shall cover for all the mechanical, electrical and instrumentation works together with material and plant to the full replacement cost.
- Any amount not insured or not recovered from the insurer shall be borne by the Contractor.

General Obligation

The Contractor shall operate and maintain the entire Plant under this contract for the period specified in this contract. The Contractor will submit a detailed operation and maintenance plan for approval of Engineer. All operation and maintenance activities shall be carried out strictly in accordance with the approved plan.

The services shall include but not be limited to the following items.

a) Operation and maintenance of the complete plant.

b) Training for the O & M staff of designated by Employer's requirement.

c) Generation and maintenance of periodic reports.

Operational Services

- The Contractor shall operate the complete plant, and other associated services on a continuous 24- hour basis.

- The Contractor shall operate and utilize the control and monitoring systems provided. If found necessary, he shall make adjustments (within the operation range) of the control system and equipment.
- The Contractor will be required to furnish the details of format for all plant operation and monitoring including electricity consumption in the format prescribed by the Engineer.
- Contractor will be responsible for any penalty due to power factor, hence Contractor has to maintain power factor in the limit.
- The Contractor shall provide all consumables and spare required for operating and maintaining the Plant in good condition. Any garbage generated in the plant shall be removed from the site on daily basis.
- The Contractor shall provide all tools & special tools, equipment, testing and checking instruments, monitors, safety items etc required for operation & maintenance of complete electrical system, Lighting system & earthing system.
- The Contractor at his own expense shall provide all tools, cleaning, and housekeeping equipment, security and safety equipment.

Contractor Care of Entire Plant

The Contractor shall take full responsibility for the care of the entire plant and all other systems like control rooms, pipelines, valves and other allied systems during the contract period till it is handed over to the Employer at the end of 5 years of O&M.

If any loss or damage occurs to any system, during the period for the contractor is responsible, the contractor shall rectify such loss or damage, at his cost, so that it conforms to its condition when the contractor took possession of the entire plant at the commencement of the contract.

Instrumentation, Control & Automation (ICA)

GENERAL MAINTENANCE

A comprehensive maintenance program is critical to attaining long-term reliable performance of PLC based SCADA System/ ICA systems. Periodic instruments/ device calibration, preventive maintenance and testing allow potential problems to be identified before they can cause mission failure. Prompt corrective maintenance assures reliability by minimizing downtime of redundant components.

PREVENTIVE MAINTENANCE

The PLC/ SCADA system should be part of the overall preventive maintenance (PM) program for the facility.

Recommended maintenance activities and frequencies for SCADA systems and their components are as follows:

Preventive maintenance schedules for SCADA components and subsystems should be coordinated with those for the mechanical/ electrical systems they serve to minimize overall scheduled down time.

Many components of SCADA systems, such as dead-bus relays, are not required to function under normal system operating modes. For this reason the system should be tested periodically under actual or simulated contingency conditions. These tests should approach as closely as possible the actual off- normal conditions in which the system must operate. For example, SCADA for Dual Redundant system should be tested by interrupting the utility source as far upstream of the normal service as possible.

Periodic system testing procedures can duplicate or be derived from the functional performance testing procedures.

The SCADA software maintenance should include timely updates of any new versions from the supplier and testing to verify proper installation on the SCADA computer. In addition, software antivirus updates should be maintained. This should be performed any time after the computer is connected to the Internet or the antivirus patch should be downloaded as and when the updates are available. Normal operation requires that the PLC/ SCADA computer not be connected to the Internet. Faulty Instruments, sensors, transmitters, communication modules, computer hardware should be replaced with new components. Repair of the failure items would not be accepted. Instruments, modules would have to replace with a new instruments and components.

Following maintenance activities shall be exclusively carried out for instruments/ sensors:

Temporary storage section level sensor surfaces shall be cleaned once in a month to avoid malfunction due to deposition of unwanted garbage on sensor surface.

Load cell based weighing mechanism at compactors shall be physically monitored for any displacement from its actual position caused during operation & to be calibrated once in a month to adjust its drift.

1.7 APPLICABLE STANDARDS

Operation & Maintenance Procedures of Automated Solid Waste Collection, Segregation and Transportation Equipments shall conform to the latest applicable standards specified below. In case of conflict between standards and this specification, this specification shall govern.

i) Municipal Solid Waste (Management & Handling) Rules, 2000

ii) Environment (Protection) Act, 1986 (29 of1986)

iii) Indian Electricity Rules - 1956 updated

iv) ASHRAE 2007 Systems and Application Handbook (with latest amendments)

Other sources of information must be consulted (e.g., manufacturer's recommendations, unusual operating conditions, personal experience with the equipment, etc.) in conjunction with the maintenance recommendations.

1.8 EXPERIENCE & QUALIFICATION OF STAFF

Requirements

Operation and maintenance staff shall have sufficient experience, good health condition and adequate educational/technical qualification in addition to possessing best knowledge, abilities and skills.

Knowledge and abilities

a) Knowledge of total Automated Solid Waste Collection, Segregation and Transportation of similar capacity, unit operation;

b) Knowledge of the method, materials, and equipment of Automated Solid Waste Collection, Segregation and Transportation system;

c) Knowledge of unit operation, maintenance, and servicing of blowers, conveyors and other plant equipment and machinery;

d) Abilities to make repairs and/or adjustments to all equipments and to keep records and prepare reports;

e) Abilities to read and interpret gauges and recording devices used in the Automated Solid Waste Collection, Segregation and Transportation system;

f) Abilities to work efficiently with others.

For all operation and maintenance works, the Contractor shall provide skilled staff, which has adequate qualifications and sufficient experience of similar works.

CV of General Manager, Plant Supervisors, Shift-in-charge, Electrical Engineer and PLC/SCADA Engineer etc. will have to be got approved from the Employer. The following Table describes the minimum levels of staffing, and their minimum qualifications and experience in similar works, theta the Contractor will be required deploy for carrying out the O&M functions:

Operating Personnel

Operation Staff**:**

The contractor shall deploy the following persons as detailed in the General conditions of contract.

Plant In Charge:

An Engineer with Degree in Mechanical Engineering having knowledge of related electrical equipment and system with at least 5 years of experience in operation and maintenance of similar kind of Automated Solid Waste Collection, Segregation and Transportation system. He shall be over all In charge for Automated Solid Waste Collection, Segregation and Transportation system. He shall be posted in General/Day shift (9AM - 5:30PM) and responsible for functioning of Automated Solid Waste Collection, Segregation and Transportation system. Arranging shut downs, programming for maintenance, co-ordination between Owner and other agencies involved etc. Working knowledge in Hindi& English language is essential. Computer literate with knowledge of MS Word, Excel &MS Project.

Shifts In Charge:

Engineers Diploma of Mechanical Engineering having knowledge of related equipment and system with at least 3 years of experience of shift duties of similar kind of Automated Solid Waste Collection, Segregation and Transportation system. He shall be posted in shift of 8 hours. There will be three Engineers per day and one as a Reliever. He shall be responsible for operation of Automated Solid Waste Collection, Segregation and Transportation system. He shall be shift In charge. Responsible for reporting to the Plant In charge. Working knowledge in Hindi& English language is essential. Computer literate with knowledge of MS Word, Excel & MS Project.

Electrical Shifts In Charge:

Engineers Diploma of Electrical Engineering and at least 3 years of experience of shift duties of similar kind of Solid Waste management facility. He shall be posted in shift of 8 hours. There will be three Engineers per day and one as a Reliever. He shall be responsible for operation of the Plant. He shall be shift In charge. Responsible for reporting to the Station In

charge. Working knowledge in Hindi, English language is essential. Computer literate with knowledge of MS Word, Excel & MS Project.

Operators:

The Operator is having Diploma of Mechanical Engineering or ITI having knowledge of related electrical equipment and system and adequate experience of shift duties of similar kind of Automated Solid Waste Collection, Segregation and Transportation system. One operator shall be posted in each shift of 8 hours. There will be three operators per day and a reliever. He shall be responsible for maintaining log books, operations during his shift. Working knowledge in Hindi English language is essential. Computer literate with knowledge of MS Word, Excel &MS Project.

Maintenance Crew

The maintenance crew would consist of

Maintenance Engineer

Engineer having Degree or Diploma of Mechanical Engineering having knowledge of related equipment and system and having adequate experience of Maintenance of similar kind of Automated Solid Waste Collection, Segregation and Transportation system. He shall be posted as and when required and responsible for routine and breakdown maintenance of Automated Solid Waste Collection, Segregation and Transportation system.

Electrical Maintenance Engineer:

Engineer having Degree or Diploma of Electrical Engineering and having adequate experience of Maintenance of similar kind of Automated Solid Waste Collection, Segregation and Transportation system. He shall be posted as and when required and responsible for routine and breakdown maintenance of Automated Solid Waste Collection, Segregation and Transportation system.

Additional Staff

The additional staff comprising of skilled, unskilled workers headed by Engineer shall be posted for routine, yearly, half yearly maintenance during break downs and shut downs as per requirement and quantum of work. Apart from above, the Testing engineers along with skilled staff shall visit Automated Solid Waste Collection, Segregation and Transportation system for annual relay testing and in event of emergency whenever their services are required for smooth functioning of Automated Solid Waste Collection, Segregation and Transportation system.

Operation staff shall be exclusive and not utilized for regular, periodic and breakdown maintenance works. All the persons of the contractor shall have working interaction with the Engineer in charge to enable the contractor.

Note:

a. *The above requirement is minimum only. The Contractor will arrange extra work force, as and when required, so as to smoothly run the operation and maintenance including preventive maintenance, repairs etc. and general cleanliness of the installations.*

b. *The above staff strength is exclusive of leave reserve required for different category of staff. The Contractor shall ensure availability of the personnel given in the above table for all seven days in a week.*

c. *The Contractor shall make appropriate arrangements for maintenance of items like road work, buildings, arboriculture, patrolling and maintenance of civil structures, vehicle operations and other activities defined to fulfill its obligations under O&M Contract.*

d. *In the event of absent of staff during the O&M, the deduction of payment shall be done on per day basis for the number of days absent, as per relevant Sub-clause.*

1.9 DEFECT LIABILITY

A defect liability period of 90 days shall commence upon issue of the Contract Completion Certificate or Taking Back Certificate (as applicable as per contract), by the Engineer.

During defect liability period, the contractor shall be responsible for the followings:

a. Provide to Employer the advisory services and follow-up training required.

b. Complete any outstanding work notified to contractor in Contract Completion Certificate or Taking Back Certificate (as applicable as per contract), issued by the Engineer under this clause.

c. If during Defect Liability period, any defect should be found in the system, the contractor shall promptly, in consultation and agreement with the Employer / Employer regarding appropriate remedying of the defects, and at its cost, repair, replace or otherwise make good as the contractor shall determine at its discretion, such defect as well as any damage to the facilities caused by such defect.

<u>Extension of Defect Liability Period</u>

The defect liability period shall be extended by the period during which any part of the works could not be used by reasons of a defect or damage, for which contractor was liable.

Failure to Remedy Defects

If the contractor fails to remedy any defect or damage within a reasonable time, a date may be fixed by the Engineer, on or by which the defect or damage is to be remedied.

If the contractor fails to remedy the defect or damage by such date, the Employer may carry out such works himself at the contractor's risk and cost. Such cost, determined by the Engineer, shall be final and binding.

Defect Liability Certificate

Within 28 days of the expiry of the defect liability period, Engineer shall issue a Defect Liability Certificate stating the date by which the contractor completed all his obligations under O & M, including remedying all the defects, to his satisfaction.

The decision of the Employer on all the sub clauses of this clause shall be final and binding on the contractor.

1.10 OPERATION & MAINTENANCE EQUIPMENT

All tools and tackles required for the safe and satisfactory operation and maintenance including preventive and break down maintenance of the Automated Solid Waste Collection, Segregation and Transportation system and related equipment covered under this tender shall be provided by the contractor.

The tools and tackles, apart from other things, must comprise of

1. Voltage and community tester
2. Volt-ohm-milli-ammeter with temperature adapters
3. Stroboscope tachometer
4. Vibration meter
5. Temperature recorders
6. Sound level meter
7. Digital pressure gauges
8. Pressure and vacuum gauges
9. Grease pump
10. Voltage recorder
11. Soldering gun kit

12. Combination wet/dry vacuum cleaner
13. Barrel with hand pump set
14. Electric short circuit locator
15. Megohmeter
16. Electrical cable testers
17. Hand oil pump
18. Punch and chisel set
19. Pipe wrenches
20. Screwdrivers, Phillips head and Allen wrenches
21. Steel work benches
22. Inside and outside calipers
23. Bench vise
24. Claw hammer
25. Rubber mallet
26. Machinist’s square
27. Dividers
28. Level
29. Tap and die sets
30. Files, cabinets and tool kits
31. Ratchet wrench and socket set, multiple drives and depths
32. Set of open and box-ended wrenches
33. Pipe and fitting chain wrenches
34. Strap wrenches
35. Heavy-duty pipe cutter
36. Locking pliers
37. Set of pipe taps
38. Pipe threader set
39. Pipe reamer
40. Pipe cutter and tri-stand
41. Gasket-cutting tool
42. Complete set of all sizes of Double ended, Ring, Tubular &box spanners - 2 sets.
43. Complete set of all sizes of screw drivers - 2 sets

44. Complete Tool Box -2 nos.
45. Minimum two sets of heavy duty hand gloves of highest voltage rating available in the market, 6 nos Helmets, 6 nos. safety belts &Safety shoes.
46. 2 nos of heavy duty dry cell or rechargeable (without acid) torches. Rain coats and gum boots as required.
47. First aid box
48. 1 No. Insulation tester 5 kV capacity 1 No. Insulation tester 1 kV capacity 2 nos. Multi meter Analog &Digital Tong tester
49. Temperature Gun
50. Cable crimping tools of adequate capacity etc. Extension Power supply boards(single phase) Phase Sequence meters
51. Laptop for PLC programming & system diagnostics

Consumables

i) Minimum 20 kg of Petroleum jelly.

ii) Minimum 5 bottles of Carbon tetra chloride(CTC) Minimum 5 bottles of contact cleaner spray

iii) M seal, epoxy compound, sealing compound, paint, red oxide etc. Fuse wire, Insulation tape, emery paper, HT tape etc.

iv) 20 kg of Silica gel, Gaskets sheet, cotton tape, Teflon tape etc.

v) Cotton waste, muslin cloth, waste cloth, cleaning agents etc. Transformer oil for topping up of Transformer, SF6 Gas Cylinder

vi) All major consumable like Transformer oil, SF6 gas and its filling kit, indicating lamps, Luminaries, control and power wires/ cables, Battery solution, etc.

1.11 MANDATORY SPARES

Proper preservation norms are to be adopted to perform periodic Condition Monitoring tests on spares to keep them healthy and usable.

The practice of removing sub-assemblies from main spares during emergencies needs to be regulated properly. Any component removed needs to be replenished as early as possible so that the main spares are always kept complete. Proper transportation cases also need to be kept at central stores to avoid transportation delays when transported to the required destination.

i) All spares recommended by manufacturers of equipment as given in **Appendix – E** shall

be installed in the Automated Solid Waste Collection, Segregation and Transportation system.

ii) Nuts, bolts, washers of sizes used in Automated Solid Waste Collection, Segregation and Transportation system and other systems.

iii) Fuse holders and HRC fuses, terminal links, control wires and lugs of rating used in the entire plant.

The contractor shall keep ready stock of all items/ consumables for day to day maintenance/ repairing works.

1.12 MAINTENANCE SCHEDULES

Maintenance scope include both preventive and breakdown maintenance. Preventive maintenance shall be routinely carried as per details provided herein below.

Breakdown maintenance shall be provided as and when situation warrants with a failure or fault in the system. The breakdown maintenance shall be attended at the highest priority so to make good the faulted system and putting into operation. For breakdown maintenance the contractor shall coordinate / liason with Engineer In charge and the original equipment manufacturer for replacement parts and services as necessary. Infrastructure, tools and tackles and site support shall be provided by the contractor for such jobs with priority and without unnecessary delays. OEM parts and services, if any, required for the completion of breakdown services shall be approved and cleared for execution by appropriate authorities.

During the preventive (routine) maintenance, the contractor shall carry out the following as listed for various system components given in **Appendix - D**

Though the list in **Appendix – D** contains several individual jobs they could be executed in a combined scope as in servicing or overhauling of the component.

The maintenance jobs which are specifically underlined in the following list shall be carried out by OEM supplier or their authorized service provider only. The contractor shall be required to provide proof for the same before executing the job.

In addition to the Equipments given in **Appendix - D**, visual Inspections and Required periodic Maintenance should also be carried out on the following:

i) Control circuits
ii) Cranes and Hoists Motors and their wiring
iii) Electrical Drawings
iv) Emergency Lighting
v) Fuses
vi) Motors

vii) Personnel Protective Equipment
viii) SCADA System

Apart from the above Maintenance Schedules, Preventive Maintenance Procedures, Condition Based maintenance, Residual life Assessment of all the Automated Solid Waste Collection, Segregation and Transportation Equipment should be carried out.

Operations

Hourly:

Taking readings of all meters installed at control panel. AC DB's, Battery Charger etc. Air and Gas pressures of Gas circuit breakers.

Winding temperatures of Transformers.

Checking any sparking or flash over / hot spots in the Plant.

Daily:

Visual Checking contacts of Isolators are in proper position or not.

Checking gas leakages if any for Package substations,taking appropriate action for its timely repair

Cleaning of premises, Control panels etc.

Maintaining log books and daily check list.

Checking Locks and doors of the Plant are in good condition.

Checking no leaks have developed in the roof, ventilating systems.

Checking the heating systems are working normally.

Checking the prescribed safety aids are in place and in good order.

Checking the earthing connections is unbroken.

Checking the packing of cables entering and leaving the trenches or tunnels within the premises are intact.

Checking the ventilating louvers are not damaged.

Trouble shooting and repair of Electrical circuits components in case of any abnormal conditions.

Weekly:

Checking the Plant and control room lighting.

Monthly:

Checking earthing points and their contact, tighten wherever required.

Preparation of monthly checklist and events log for the month.

Events:

Logging the breakdown events with relay indications etc.

Logging shut down events, log of operations during shut down period.

Logging of on / off of feeders in the 33kV and 415V distribution system. Maintaining visitors registers along with their comments and details of their visits.

1.13 DOWN TIME

The Plant shall never be operated at less than its design capacity due to maintenance and repair reasons. The period of such exceptional operation shall not exceed two consecutive days and shall not be more than three days a month.

The maximum downtime of the whole Plant shall not exceed 8 hours (should be carried on off-week days and holidays). The periods for repairs and maintenance have to be communicated to the Engineer at least one month in advance. For machinery and equipment which requires maintenance to be carried out by manufacturer/ manufacturer's authorized representative, the down time shall not exceed 30 days. Employer reserves the right to impose Liquidated damages, should there be any default by Contractor on this account. The Liquidated damages amount will be deducted in the next O & M bill if adequate reasons are not furnished by the Contractor for delay.

Applicable rate for Liquidated damages have been given else where in the document.

1.14 FACILITIES TO CONTRACTOR

The Contractor will be permitted to use the premises developed under the Contract for use by his staff during operation and maintenance to the extent agreed and approved by the Engineer.

1.15 PAYMENTS

The Contractor, at the time of bidding, will be responsible to ensure the completeness and adequacy of his Bid Price to fulfill the entire responsibilities as described above. His bid price, as quoted on a yearly basis in the Schedule of Prices, shall include all costs for carrying out all O&M responsibilities, except for the following items for which the Employer will bear the cost:

The cost of electric power consumed, which will be paid directly by the Employer

1.16 MAINTENANCE FORMATS

The contractor shall follow the Maintenance formats of various system components as listed out in **Appendix – F**

1.17 CONTRACTORS OPERATION & MAINTENANCE LABOUR REGULATIONS

The contractor shall follow the Operation & Maintenance Labour Regulations as stated in **Appendix – G**

Signature of Applicant with Seal

PART - 4

TERMS AND CONDITIONS FOR O & M PRICE BID SUBMISSION

(TO BE SIGNED & SUBMITTED AS A TOKEN OF ACCEPTANCE BY BIDDERS)

The rates mentioned in the price bid submission for Operation and Maintenance is quoted on the following terms and conditions:

1) We shall engage adequately qualified and experienced team members on the job as specified in this document. The personnel proposed to be engaged by us will be subjected to such test / assessments as necessary by you to determine their competence to carry out the work, before deployment.
2) Payment for the work will be based on the above rates. Operation work will generally be performed by the one team members for 8 hours with lunch plus tea break included. In case of exigencies, they would be asked to put in 2 more extra hours, subject to a maximum of 20 hours in one month without any compensation.
3) No advance payment for the above work will be payable to us.
4) We shall abide and be liable to discharge all conditions of Labour Laws as applicable from time to time included Provident Fund, Workmen Compensation Policy, Bonus etc. we shall produce a Insurance Policy from the Insurance Corporation within one month from the date of issue of work order.
5) Proof for payment of Employees &Employer share to the Provident Fund office on behalf of our personnel working under this contract shall be made available to you in the following month without which the bill amount for the subsequent months will not be released.
6) The entire work handled by our personnel shall be treated as confidential. Our personnel shall not retain copy of any material handled by them. They shall not divulge any information coming to their knowledge during the course of execution of the work.
7) The number of team members to be provided by us is likely to vary from time to time depending upon your need for operation and maintenance works.
8) Our personnel will not be eligible for any concessional facilities available to the BSCDCL staff. They will have no claim for employment in BSCDCL.
9) In case of violation of manpower requirement or unauthorized leaves without the intimation of Engineer-in-charge, we will be liable to give penalty as per the Penalty clause mentioned in

Section-3 of this Tender.

10) Under the provision of contract labour Act, we shall make payment to our personnel which shall not be less than the minimum wages applicable under the Law and the monthly payment to our personnel will be made in the presence of your representative and certificate to this effect will be obtained on the acquaintance roll.

11) For smooth and effective working of contract we will deploy a station-in-charge separate from the actual manpower for day to day coordination and other miscellaneous works. This person will be located at the site and will facilitate for carrying out of the above obligations. He will be available on daily basis at site and interact with the Engineering- In-Charge.

12) I hereby also undertake to provide the following:

    i) Bio-data of the probable persons with photo will be submitted along with the tender without which the tender will be treated as disqualified.

    ii) Persons of required level will be provided within 14 days after award of work.

    The candidates will be produced by the undersigned to BSCDCL for interview within 14 days from the date of opening of tender.

    Non-adherence to the above will lead to disqualification of tender.

PROVISION OF FACILITIES:

- Under Contractor's scope:

Office space (one-room) for Engineers &safe storage will be provided.

Spares for replacement as and when required.

Boarding &lodging to his personnel.

Medical facility &Insurance coverage.

All tests, Measuring instruments &tools with valid calibration certificate as mentioned above.

Any facility not mentioned in 'A'

Uniform to staff as per specs given by BSCDCL before placement of order.

PC for data entry and printer for printout of technical reports.

Safety gears like helmets, shoes and safety belts, aprons and gloves (general and insulated type).

Transport facility for contractor staff.

Stationery as per work requirement.

Equipments like Filter Machine.

ACCEPTED

(SIGNATURE OF CONTRACTOR WITH SEAL)

APPENDIX D

MAINTENANCE SCHEDULES

D-Daily, W-Weekly, M-Monthly, QY-Quarterly, HY- Half Yearly, Y-Yearly, 2 Y- Once in 2 years, 3 Y- Once in 3 years, 4 Y- Once in 4 years, SOS - as and when required.

Always use a periodic maintenanceprogram to ensurethe best possible unitperformance and efficiency.

The maintenance schedules to be adopted by O & M Personnel are:

1.1 Day to Day Operation of AWCS

A The AWCS shall be online for operation 24x7daily, seven days a week and all year round. The Contractor shall provide remote operation and supervision in addition to periodic and emergency attendance throughout the program of AWCS operation to ensure optimum system efficiency; carry out regular logging of plant operating conditions and performance; provide maintenance, lubrication and adjustment to the system. The Contractor shall also be responsible for re-programming and adjusting the AWCS operation.

B In the event of pipe blockage or breakdown in any part of the system, the Contractor shall isolate, as far as practicable, only the parts concerned to allow the central plant to continue serving other parts of the system and clear the problem within a reasonable period of time. The Contractor shall also be responsible for the garbage chute risers inside the buildings including but not limited to the inlet doors, blockages and chute cleaning system

C The Contractor shall be responsible for the manual refuse collections and disposal to dumping areas in the event of system breakdown due to misuse, negligence or accidents like fire, flooding, mechanical damage etc. caused by others.

D The Contractor shall be responsible for the transportation of filled containers of waste from the collection station at the appropriate time when the containers are full.

1.2 Routine Maintenance Service

The Contractor shall dispatch competent and specially trained technicians to carry out routine maintenance and servicing work for the AWCS installation and any other work required to maintain the optimum system efficiency and working condition to the satisfaction of the Employer.

Routine maintenance and servicing work shall in general include checking and necessary adjustment, cleaning, greasing, oiling, painting if required, supply and replacement of any parts or equipment.

The following is a brief outline of the preventive maintenance work required to be carried out by the Contractor and is by no means exhaustive. The Contractor shall base on his

own engineering judgment and recommendation of the AWCS manufacturer to include any other items of work which are essential to the proper and efficient operation of the installation. Detailed maintenance proposal shall be submitted to the Employer for approval.

A Daily and weekly maintenance services

Daily maintenance services including visual check of all rotating and translating (sliding) parts for any abnormal vibration or noise, applying lubricants if necessary, clearing fluid/debris/dust accumulation, replenishing oil/consumables items, replacing burnt fuses/ luminaries, etc

Weekly maintenance services including general cleaning, check for any damage, detector or sensor location adjustment, cleaning of detectors or sensors, etc. shall be provided for, but not limited to, the following equipment

i. Compactor
ii. Air Compressor
iii. Air Dryer
iv. Air Cooler
v. Rotating Screen
vi. ECC Panel
vii. Frequency Driver
viii. Sgregator
ix. Dust Filter
x. Deo Filter
xi. Record keeping

B Monthly Maintenance Services

Monthly maintenance services shall be provided for, but not limited to, the following equipment and include, where appropriate, fixing and tightening of loosen bolts and nuts, doors, electrical components and wiring, etc. ; lubricating and greasing rollers, pins, bearings, hinges etc.; motor starter contact check and rectification; belt tension check and adjustment; oil level check and replenishing; detector or sensor location adjustment, cleaning of detectors or sensors, etc; check for excessive wear of moving parts; check for any damage, leakage, abnormal vibration or noise; clearing accumulated fluid, debris or dust; general cleaning; replacing filters; replenishing consumable items, etc

i. Electrical equipment
ii. Collection station leakage
iii. Compactor
iv. Separator, photocells
v. Container
vi. Rotating Screen
vii. Segregator
viii. Air Speed Measurements
ix. Exhausters
x. Pipe system, leakage test

xi. Air compressor
xii. Compressed air system
xiii. Air dryer
xiv. Air Cooler
xv. Collection Station

C Quarterly Maintenance Services

The following quarterly maintenance services shall be provided for, but not limited to, the equipment listed

i. Refuse compactor
ii. Refuse separator
iii. Rotating Screen
iv. Dust & Deo Filter
v. Refuse container
vi. Exhauster
vii. Air compressor set
viii. Air speed gauge
ix. Plant room

D Runtime Maintenance Services

Runtime maintenance is applied in addition to the regular maintenance in order to ensure that the manufacturer's specifications are followed

1. Compactor
2. Exhauster
3. Air Compressor
4. Segregator
5. Air Waste Seperator
6. Valves

1.3 Reactive Maintenance

The Contractor's staff shall monitor the operation of the AWCS and its components on a daily basis to ensure optimal performance of the system. Reactive maintenance is considered an event that was not predicted and to be performed only after a machine, component or pipe work fails or experiences problems. The priority and response parameters for reactive maintenance shall be assessed upon the occurrence of a failure or problem and the Employer notified accordingly.

For the avoidance of doubt, the following activities are excluded from the main Scope of Work and shall require a variation to be raised in accordance with

- Blockage clearance in the vertical garbage chute
- Repair of damaged chute inlet doors

1.4 Periodic Testing and Calibration Work

A The Contractor shall carry out periodic testing and calibration work ad any other testing as required to ensure proper performance and functioning of the AWCS

B Functional test shall be carried out for all the control and monitoring facilities. Testing and calibration of electronic/ analogue detectors, controllers, etc. shall be carried out on yearly basis or more frequently as necessary to ensure the complete system is always operating within the designed ranges and conditions.

1.5 Other Equipments

(i) Electrical motors

Sr. No.	Maintenance or test	Recommended Interval
1	Check for vibration or unusual sounds	D
2	Check bearing temperature	D
3	Check frame temperature	D
4	Remove any dirt or debris from slip rings and brush holder area	D
5	Check brush up/down movement, length and downward pressure	M
6	Check bearing grease and lubricating oil levels and fill if necessary	HY
7	Measure coil insulation resistance (MΩ).	HY
8	Check working order of flow relays, pressure switches, and temperature switch, protective devices, etc.	HY
9	Performance test	Y
10	Replace bearing grease and lubricating oil.	Y
11	Terminal connection checking	HY
12	Overhauling	SOS

(ii) HT panels

Sr. No.	Maintenance or test	Recommended Interval
1	Cleaning of bus bars, insulators, etc.	Y
2	Relay testing	Y
3	Tightness of all electrical connections	Y
4	Checking of indicating meters	Y
5	Alignment Checking of isolators	Y

(iii) Ventilation Fans & Air-conditioning units

Sr. No.	Maintenance or test	Recommended Interval
1	Fan guard attached	D
2	Fan fastened tightly to post	M
3	Check fan orientation	M
4	Clean fan guards	HY
5	Clean motor and controls	HY
6	Lubricate fans	Y
7	Repaint corroded metal	Y
8	Check total electrical circuit	Y
9	Cleaning of suction air filters	QY
10	Check for unusual noise & vibration	QY
11	Checking of all interlocks	Y

A) TRANSFORMERS

(i) Without shut down activities

Sr. No.	Maintenance or test	Recommended Interval
1	Checking condition of silica gel in breather	M

(ii) Shut down activities

Sr. No.	Maintenance or test	Recommended Interval
1	Cleaning of all equipment as per O & M Manual	Y
2	Marshalling boxes of transformer	
3	(i) Cleaning of marshaling boxes of transformer	Y
	(ii) Tightening of terminators	Y
	(iii) Checking of contractors, space heaters, illumination, etc	Y
4	Checking of all remote indicators (WTI and Tap position indicator)	Y
5	Electrical checking/testing of pressure relief device, checking of alarm/trip and checking/replacement of the gaskets of the terminal box	Y
6	Frequency response analysis	SOS
7	Tan measurement of bushings	Y
8	Recovery voltage measurement	SOS
9	IR measurement of Windings(Polarization Index and D.A. Ratio)	2Y

Sr. No.	Maintenance or test	Recommended Interval
10	Tan measurement of Windings	2Y
11	Checking and cleaning of diverter contacts	2Y
12	Checking and calibration of WTI	2Y
13	Measurement of Windings resistance at all tap positions	4Y
14	Testing of bushing CT's	SOS
15	Measurement of Windings Ratio	SOS
16	Checking of earthing connections	Y
17.	Cleaning of all equipments as per O & M manual	Y

Note:

- Insulation resistance measurement, tan delta of winding resistance at all taps to be carried out once before expiry of warranty and then to be continued as per schedule.
- FRA at factory and during pre-commissioning is preferable to serve as base signature.

(iv) LT panels

Sr. No.	Maintenance or test	Recommended Interval
1	Cleaning of bus bars, insulators, etc.	Y
2	Relays testing	Y
3	Tightness of all electrical connections	Y
4	Checking of indicating meters	Y
5	Check for change-over facility, if provided	Y

Sr. No.	Maintenance or test	Recommended Interval
6	Check operation/Indications in Off-load conditions of CB	Y

(v) LT switchgears

Sr. No.	Maintenance or test	Recommended Interval
1	Functional Checking (Trip, close, etc.) of MCCB's & MCB's	Y
2	Measurement of operating timings	Y
3	Cleaning of insulators and tightness of terminal connections of CB's, CT's, PT's, Isolators, etc.	Y
4	Alignment Checking of isolators	Y

(vi) CURRENT TRANSFORMERS

Sr. No.	Maintenance or test	Recommended Interval
1	Measurement of tan delta and capcitance	2Y*
2	I R measurement (DAR)	2Y
3	Measurement of CT secondary resistance	SOS
4	Magnetization characteristics	SOS
5	CT ratio test	SOS
6	Checking of burden on the second winding	SOS

**To be repeated before one year from commissioning and then as per schedule*

(vii) LIGHTNING ARRESTORS

Lightning arresters are static devices which require fairly infrequent maintenance. Most maintenance must take place while the associated circuit is de-energized. However, crucial visual inspections can take place while energized.

Maintenance Schedule for Lightning Arrestors:

Sr. No.	Maintenance or test	Recommended Interval
1	Checking of leakage current (Third harmonic resistive current)	Y
2	Testing of counters and leakage current meters	Y
3	Checking of earth connection between surge arrester, surge monitor and earth	Y

(viii) PROTECTION SYSTEMS

Calibration and Periodic functional testing is recommended to ensure the integrity of protection circuits.

Sr. No.	Maintenance or test	Recommended Interval
1	Calibration of tariff energy meters	-
2	Checking of voltage (in service) for relays	Y
3	Checking of DC logic circuits for trip and annunciations including timers by simulation	Y
4	Calibration of panel meters (Indicating/recording instruments along with the transducers)	4Y

(i) Under voltage relay

Sr. No.	Maintenance or test	Recommended Interval

Sr. No.	Maintenance or test	Recommended Interval
1	Starting and pick up of the relay as per plug setting	Y
2	Relay Operating time as per relay characteristics	Y
3	Operation of alarm and trip contacts	Y
4	Verification of input voltage on relay terminals	Y

(ii) Over voltage relay

Sr. No.	Maintenance or test	Recommended Interval
1	Starting and pick up of the relay as per plug setting	Y
2	Relay Operating time as per relay characteristics	Y
3	Operation of high set element/instantaneous unit at voltage setting, if applicable	Y
4	Operation of alarm and trip contacts	Y
5	Verification of input voltage on relay terminals	Y

(iii) Over current and earth fault relay

Sr. No.	Maintenance or test	Recommended Interval
1	Starting and pick up of the relay as per plug setting	Y
2	Time of Operation as per relay characteristics	Y
3	Operation of high set element/instantaneous unit at current setting, if applicable	Y

Sr. No.	Maintenance or test	Recommended Interval
4	Operation of alarm and trip contacts	Y
5	Verification of input currents	Y
6	Verification of directional feature, if applicable	Y

(iv) Instantaneous current operated relays

Sr. No.	Maintenance or test	Recommended Interval
1	Pick up value of the relay at the selected setting	Y
2	Operating time of the relay	Y
3	Operation of alarm and trip contacts	Y
4	Verification of input voltage on relay terminals	Y

(ix) Ventilation Fans & Air-conditioning units

Sr. No.	Maintenance or test	Recommended Interval
1	Fan guard attached	D
2	Fan fastened tightly to post	M
3	Check fan orientation	M
4	Clean fan guards	HY
5	Clean motor and controls	HY
6	Lubricate fans	Y

Sr. No.	Maintenance or test	Recommended Interval
7	Repaint corroded metal	Y
8	Check total electrical circuit	Y
9	Cleaning of suction air filters	QY
10	Check for unusual noise & vibration	QY
11	Checking of all interlocks	Y

(x) TELEPHONE EXCHANGE

Sr. No.	Maintenance or test	Recommended Interval
1	Maintenance of EPABX as per recommendations of the manufacturers	SOS

(xi) BATTERIES AND DC DISTRIBUTION SYSTEM

Battery system maintenance should have highest priority. Computerized, online battery monitoring systems can greatly reduce maintenance required on battery systems and actually improve battery reliability and increase battery life. Battery chargers, important to the health and readiness of battery systems, require regular maintenance as well.

Maintenance Schedule for Batteries:

Sr. No.	Maintenance or test	Recommended Interval
1	Measurement of specific gravity and voltage of cell	M
2	Checking electrolyte level and topping up with DM water, if required	M
3	Checking of Emergency DC lightening to control Room	M
4	Checking of any earth fault (If E/F relay not provided)	M

Sr. No.	Maintenance or test	Recommended Interval
5	Checking of electrical connections of charger panel for tightness and cleanliness	Y
6	Checking of electrical connections for batteries and application of petroleum jelly on cell terminal, if required	Y
7	Checking control cards of charger and measurement of test point voltage values	Y
8	Battery impedance testing (Optional)	Y
9	Testing of DC E/F and under voltage relays	Y
10	IR measurement of charger transformer	Y
11	Discharge test of battery set	3Y

B) FIRE PROTECTION SYSTEM

(i) Fire alarm system

Sr. No.	Maintenance or test	Recommended Interval
1	Sequence test for annunciation in control room panel	M
2	Smoke test	M
3	Cleaning	M
4	Battery electrolyte level checking	M

(ii) Fire extinguishers

Sr. No.	Maintenance or test	Recommended Interval
1	Re-filling of fire extinguishers	SOS

C) ANNUNCIATORS

Annunciators provide essential Switchyard condition status information to O&M personnel. Two aspects must be considered:

(1) correct operation of the annunciator itself and

(2) integrity of the alarm devices and interconnected wiring.

Annunciator operation is easily tested using the “Test” button provided on most annunciators and is considered an “operations” activity. Verifying integrity of the alarm devices and interconnecting wiring requires a “functional test” of these circuits. Functional testing is accomplished by

(1) resetting the annunciator,

(2) closing (or opening) contacts at the alarm device, and

(3) verifying that the correct annunciator window is activated.

Maintenance Schedule for Annunciators:

Sr. No.	Maintenance or test	Recommended Interval
1	Operational test	Each shift – staffed Each visit –

Sr. No.	Maintenance or test	Recommended Interval
		unstaffed
2	Functional test	Y

(i) CABLES

Maintenance tests can detect problems in cables that are approaching failure without accelerating the insulation deterioration process due to operational or environmental conditions. Except for infrared scanning, de-energize the cable circuit before maintenance.

Maintenance Schedule for Cables:

Sr. No.	Maintenance or test	Recommended Interval
1	Equipment Ratings	5Y
2	Visual inspection of cables	M
3	Checking and recording or IR values of all cables with megger of suitable range.	M
4	Checking all cable terminals &joins for overhauling / loose connections and tightening, terminating, rejoining, if required	M

(ii) EARTHING SYSTEM

Sr. No.	Maintenance or test	Recommended Interval
1	Checking of all earthing connections, joints and cleaning and tightening thereof	QY
2	Putting adequate quality of water in earth pits.	QY

Sr. No.	Maintenance or test	Recommended Interval
3	Checking and recording of earth resistance of all points, pits and taking corrective action to improve it, if required.	QY

(iii) METERS

Sr. No.	Maintenance or test	Recommended Interval
1	Checking of each meter (analog/digital) for its correct operation	Y
2	Calibration of indicating meter.	M

(iv) PLANT ILLUMINATION, ETC.

Sr. No.	Maintenance or test	Recommended Interval
1	Checking of Plant lighting	SOS

D) SCADA SYSTEM

Sr. No.	Maintenance or test	Recommended Interval
	Pneumatic Systems/Components/Instruments	
1	Check Regulators and Filters	M
2	Inspect Tubing and Piping	M
3	Valve Actuators servicing	M
4	Actuate Pressure Switches	QY

5	Calibrate Switches and Sensors	HY
6	Calibrate Pressure Gauges	HY
7	Calibrate Level Transmitters	HY
8	Calibrate Flow transmitters	HY
9	Calibrate Pressure Transmitters	HY
10	Calibrate Temperature transmitters ,Vibration & bearing monitoring sensors	HY
	Electronic Systems	
11	Verify Alarms	W
12	Inter site Communication Network	W
13	UPS setting with SCADA	W
14	Network Redundancy	W
15	Lamp Test/Verify Indicators	M
16	Inspect Enclosures for Dirt, Water, Heat	M
17	PLC Communication Modules	M
18	Test Automatic control Sequences	M
19	Anti-virus Definition Updates	M
20	Inspect Wire, Cable and Connections	M
21	Communication Interface, Interface Panel	M
22	PLC Redundant Power back up	M
23	SCADA Redundancy	M
24	PLC Hot-Standby	M

25	Historian Package & ODMS package(Storage & archiving Capacity)	M
26	General Data Archiving	M
27	Run PLC Diagnostics	QY
28	Software Maintenance and Patching	QY
29	Dead Bus Relays	QY
30	Calibrate Sensors and Transmitters	HY
31	RTU Batteries	HY
32	Calibrate Meters	Y
33	PLC Batteries	Y

TYPICAL TROUBLE-SHOOTING

Parameters	Description
System/operation	Higher /lower discharge rates, extra pump operation to make up the flow,Overflows,Pump cavitations, excess power consumption, water hammer, etc.
Unit process(Mechanical)	Power switch, Mechanical performance, Over load, Noise, Vibration, etc
Unit process (Electrical)	Transformers, Meters, Over load-Motors, Moisture cut heaters, Overload protection, Wiring and connection, Lamp test etc
Precaution, Safety & Health	Handling any accidents, its emergency measure/first-aid treatment, Handling heavy load, Physical damage, Shock hazard, etc.

AIR COMPRESSOR YEARLY MAINTENANCE SERVICE SCHEDULE

1. Check the compressor motor assembly as follows:
   a. Record voltages.
   b. Measure and record motor winding resistance.
   c. Lubricate open motor system.
   d. Check the alignment on open motor assembly.

e. Check the coupling.
f. Check all seals and gaskets.
g. Check inlet vane operator and linkage; lubricate and calibrate where required.

2. Check the compressor oil system as follows:
   a. Change oil, oil filter and dryer. Oil shall be disposed in legal manner by MSO. Copy of laboratory oil analysis will be given to the owner.
   b. Submit sample of compressor oil to independent laboratory for analysis. Analyze results of test and provide recommendations for corrective action if required (e.g., change oil). Oil to be changed as per manufacturer's instruction.
   c. Check oil pump, seal, and motor.
   d. Clean the dirt leg.
   e. Check heater and thermostat.
   f. Check all other oil system components, including cooler, strainer and solenoid valve.

3. Check the solid-state motor starter as follows:
   a. Run diagnostic check.
   b. Clean contacts or recommend replacement.
   c. Check linkage.
   d. Measure the motor.
   e. Check all terminals and tighten connections.
   f. Check overloads and dash pot oil; calibrate.
   g. Clean or replace air filter where required.
   h. Dry running starter (or before start-up); check status lights.

4. Review the control panel for the following items:
   a. Run diagnostic check of microprocessor control panel.
   b. Check safety shutdown operation.
   c. Check all terminals and tighten connections.
   d. Check accuracy of display data and set points.

5. General items must also be included:
   a. Repair insulation removed for inspection and maintenance procedures.
   b. Clean equipment and surrounding area upon completion of work.
   c. Consult with operator and provide any additional training needed.
   d. Ascertain availability of factory training courses.
   e. Report deficiencies and repairs required.

The contractor shall regularly check & maintain the Piping Network for leakages

Note: All the above checks are the minimum requirements; contractor shall update the same as per applicable standards and code.

APPENDIX E

MANDATORY SPARES

A) COMPRESSORS

Sl. No	Description of Equipment	Quantity
	(Applicable spares for centrifugal compressors)	
1	Compressor	1 no of each type and capacity
2	Complete set of suction valves and discharge valves	1 no of each type and capacity
3	Valve plate spring plate, seating washer suction & discharge valves required for all compressors.	30% of total population
4	Bearings	1 set of bearings for each rating of compressors
5	Gaskets	2 sets of each rating of compressors
6	Oil Filter & Refrigerant Filters	1 No. Each
7	'O' rings & oil seals.	2 sets of each rating of compressors
8	Crank case heater.	1 no for each rating of compressor
9	Piston rings	2 sets of each rating of compressors
10	V belts for compressor	50% of total sets required for all compressors
11	Suction filter elements	4 sets for each rating of compressors

12	Compressor shaft seal assembly	2 nos for each rating of compressor
13	Oil pressure failure safety switch	1 No. for each rating of compressor
14	Piston	1 set of each rating of compressor
16	Differential pressure switch	1 No.
17	Solenoid valve 2 way	1 No.

B) CENTRIFUGAL FANS/EXHAUSTERS

Sl. No	**Description of Equipment**	**Quantity**
	(For each model/ capacity)	For each type & capacity
1	Impeller	1 set
2	Bearings	2 sets
3	Shaft	1 set

C) AIR HANDLING UNITS & VENTILATION FANS

Sl. No	**Description of Equipment**	**Quantity**
	(For each model/ capacity)	For each type & capacity
1	Fan & Motor assembly	1 set
2	'V' belts for AHU blower	6 sets
3	Filters	4 set

D) COMPACTOR

Sl. No	Description of Equipment	Quantity
	(For each model/ capacity)	For each type & capacity
1	Compacting blade	1 set
2	Hydraulic Valves	1 set
3	Pressure Switch	1 set
4	Limit Switches	1 set

E) SEGREGATOR

Sl. No	Description of Equipment	Quantity
	(For each model/ capacity)	For each type & capacity
1	Conveyor Blade	1 set
2	Hydraulic/Pneumatic Valves	1 set each
3	Pressure Switch	1 set
4	Limit Switches	1 set

F) AIR INLET VALVE

Sl. No	Description of Equipment	Quantity
	(For each model/ capacity)	For each type & capacity
1	Valve seal ring	1 set
2	Pneumatic Cylinder	1 set
3	Pressure Switch	1 set

4	Solenoid valves	1 set

G) DISCHARGE VALVE

Sl. No	**Description of Equipment**	**Quantity**
	(For each model/ capacity)	For each type & capacity
1	Valve seal ring	1 set
2	Pneumatic Cylinder	1 set
3	Pressure Switch	1 set
4	Solenoid valves	1 set

H) CONTROL

Sl. No	**Description of Equipment**	**Quantity**
	(For each model/ capacity)	
1	HP/ LP cutout	4 nos
2	Thermostatic expansion valve	2 nos
3	Humidistat	2 nos
4	Duel pressure stat	2 nos
5	Anti-freeze thermostat	2 nos
6	Modulating thermostat (each type)	4 nos each

I) VARIABLE FREQUENCY DRIVE (VFD) SYSTEM (IF APPLICABLE)

Sl. No.	Description	Quantity
1	Electrical cards	
a	Control modules	2 Nos. of each type and rating
b	I/O module	2 Nos. of each type and rating
c	Power supply modules	2 Nos. of each type and rating
d	Thyristor gate module including gate transformer	100% of installed quantity
e	Exciter module	1 No.
2	Thyristor bridge leg	10%
3	Over voltage limiter and surge suppressor network	2 sets
4	Semi conductor fuses for thyristor	1 set
5	Power and control fuse	100% of installed quantity
6	Control transformer	1 No. of each type and rating
7	Contactor/ breaker	2 nos.
8	CT/VT	1 No. of each type and rating
9	Indicating lamps	100% of each type and rating
10	Auxiliary contactors and relays	15% of installed quantity

Sl. No.	Description	Quantity
11	Panel mounted meters	1 no. of each type and rating
12	Panel mounted printer	1 no.
13	Indicating lamp holder full set	15% of each type/colour
14	Parameter tuning device	1 no.

J) MEASURING INSTRUMENTS

Sl. No.	Description	Quantity
1	Electronic transmitters	
a	Transmitters of all types, ranges and model no. (for the measurement of Pressure, differential pressure flow, level, etc.)	10% or 2 no. of each type and model, whichever is more
b	Electronic cards / PCB's for each type and model and model of transmitters	10% or 5 nos. of each type, whichever is more
2	Temperature Elements	
a	RTDs* of each type & length	10% or 2 nos. whichever is more
b	Thermocouples of each type like K-type, R-type, metal etc. and length *	10% or 2 nos. whichever is more
c	Cold junction compensation boxes of each model	10% or 2 nos. whichever is more
d	Thermostatic units for each model	10% or 2 nos. whichever

Sl. No.	Description	Quantity
		is more
e	Thermo wells	10% or 2 nos. whichever is more
3	Local Indicators like temperature, pressure, differential pressure, flow gauges and flow meters etc.,	5% or 1 no. of each make, model and type whichever is more (to be divided to various ranges in proportion to main of all make, model, type population)
4	Process actuated switch devices Including all types of pressure, differential pressure, flow, temperature, differential temperature, level switch devices	5% or 1 no. of each type and model whichever is more
5	Indicators/Recorders	
a	Digital Indicators of each model, type & range (including relevant is digital indicators of electrical system)	10% or 2 nos. min. whichever more
b	Vertical Indicators of each type & model	5% or 1 no. of each model whichever is more.
c	Recorders for each type and model	5% or 1 no. whichever is more
d	Consumables for continuous recorders Charts Ink capsules	25 rolls per recorder/ 25 nos. per recorder/ 20 nos. per recorder / Ink Pads /Pens

Sl. No.	Description	Quantity
e	Consumables for multi point recorders	
	• Charts	5 nos. per recorder
	• Ink pads	5 nos. per recorder
	• Print mechanism/ print head assembly	10% or 5 nos. of each type whichever is more.
f	Level transmitters (displacer type)	
	• Electronic cards / PCB's of level transmitters	5% or 1 no. whichever is more for each type and model
	• Level transmitters	5% or 1 no. of each type, displacer length and model whichever is more
g	PD type flow transmitters	5% or 1 set of each type and model whichever is more

K) TRANSFORMERS

Sl. No.	Description	Quantity
1	Bushings	1 No. of each type
2	Gaskets and 'O' rings	
3	Expansion joint	
4	Local winding temp. indicator	

Sl. No.	Description	Quantity
5	Remote winding temp. indicator with sensing device and matching unit	
6	Pressure relief device	
7	Cooler fan with motor	1 No
8	Set of valves	1 set
9	Set of starters, contactors, relays and switch for electrical control panel	1 set
10	Remote tap position indicator	1 No
11	Diaphragm/air cell for conservator	
12	Terminal connector	
13	Auxiliary transformer for control power for cooler control cabinet	1 No

L) CURRENT TRANSFORMER

Sl. No.	Description	Quantity
1	Complete CT	1 No of each type
2	Terminal connectors	1 No
3	Primary Terminal bushings	1 Set

M) VOLTAGE TRANSFORMER

Sl. No.	Description	Quantity
1	Complete PT	1 No
2	Terminal connectors	1 No

N) LIGHTNING ARRESTOR

Sl. No.	Description	Quantity
1	Complete LA with insulating base	
2	Surge counter and accessories	

O) BATTERY AND BATTERY CHARGER

Sl. No.	Description	Quantity
1	Spare battery cell without electrolyte	
2	Terminator connectors with bolts and nuts	5 Nos
3	Float level indicators	10 Nos
4	Vent plugs	10 Nos
5	Set of control cards for charger	
6	Set of relays	
7	Smoke detectors	
8	Rectifier transformer	

Sl. No.	Description	Quantity
9	Control transformer	1 Set
10	Series inductor	1 Set
11	Micro-switches	1 Set
12	Filter capacitors	1 Set
13	Thristor/diode	1 Set
14	Set of switches	1 Set
15	Set of wound resistors	1 Set
16	Potentiometers	1 Set
17	Fuses of thyristor with indicators	2 Sets

A) L.T.SWITCHGEAR

Sl. No.	Description	Quantity
1	Relays	1 Set
2	CT's and PT's	1 Set
3	Switches, push-buttons and meters	1 Set
4	TPN Switches/MCB	1 Set
5	Aux. contact sets	1 Set
6	Busbar seal off insulators	2 Sets
7	Arc-chutes	1 Set
8	Moving contacts	1 Set

Sl. No.	Description	Quantity
9	Arching contacts (fixed/moving)	1 Set
10	Springs (closing/opening)	1 No
11	Closing coil	2 Nos
12	Tripping oil	2 Nos
13	Aux. finger contact	1 No
14	Limit Switches	1 Set
15	Jaw contacts	1 Set
16	Busbar insulators	5 Nos
17	Interphase barrier	2 Nos
18	Bus bar strip (aluminium)	5 Mts

B) LIGHTING

Sl. No.	Description	Quantity
1	Fluorescent tube set complete unit	10%
2	Sodium vapour/mercury vapour lamps unit	10%
3	Incandescent lamp complete fittings of all types	10%
4	Single pole MCB	2% of each rating
5	Triple pole MCB	2% of each rating
6	Switches and sockets	5%
7	Junction box	2%

C) POWER AND CONTROL CABLES

Sl. No.	Description	Quantity
1	Power cables upto 185 mm square	200 mts
2	Power cables more than 185 mm square	150 mts
3	Control cables 5/10/19 crore 2.5 sq.mm	200 mts each

Note : The mandatory spares listed above are the minimum required, contractor shall update the same for the satisfactory functioning of the system.

APPENDIX F

MAINTENANCE FORMATS

Maintenance schedules listed in the manual are to be adhered to by the Operation and Maintenance staff of the Automated Solid Waste Collection, Segregation and Transportation system and Observation so made during such inspections are required to be properly recorded giving complete details of the activity, observed parameters, remarks/views about the inspection carried out. Such observations are to be duly signed by the Maintenance engineer in-charge of the entire system and deviations with reference to acceptable norms/limits are to be approved by the competent authority having requisite experience and expertise since this is considered very vital for providing reliable and quality power to the consumers. The typical formats for inspection checks of various equipments are as follows

ANNUAL MAINTAINANCE PLAN

SCHEDULED SHUT DOWN MAINTENANCE ACTIVITES

REGION: FOR THE YEAR:

SL. NO.	NAME OF LINE	SCHEDULE MONTH	MAINTENANCE DONE		IF NO, RESCHEDULE MONTH	REASON FOR RESCHEDULING	APPROVED BY
			YES	**NO**			

ANNUAL MAINTAINANCE PLAN

SCHEDULED SHUT DOWN MAINTENANCE ACTIVITES

(TO BE MAINTAINED AT WHF)

REGION: WHF: FOR THE YEAR:

SL. NO.	NAME OF LINE	SCHEDULE MONTH	MAINTENANCE DONE		IF NO, RESCHEDULE MONTH	REASON FOR RESCHEDULING	APPROVED BY
			YES	**NO**			

SHUT DOWN MAINTENACE ACTIVITIES

(SCHEDULED PLANNED/UNSCHEDULED FORCED)

(FOR WHF PLANT)

WHF PLANT AMP FOR THE YEAR:

SL. NO	NAME OF LINE/EQUIPMENT	DETAIL ACTIVITY	FREQUENCY	DATE	DURATION	REQUIRED FORMATS FILLED UP	JOB COMPLETED	SIGNATURE (MAINT. ENGR.)	SIGNATURE (S/S OR T/L IN CHARGE)

TRANSFORMERS – MONTHLY MAINTENANCE RECORD

Monthly Maintenance –Without Shutdown Activity

MONTH_____

Sl.No.	Description of Activity	Tr-I	Tr-II	REMARKS & OBSERVATION
1	Date of Commissioning			
2	Make			
3	Rating			
4	Sl. No.			
5	Condition of Silica Gel			

Note: No. of columns to be adjusted as per the population of Transformers

TRANSFORMERS – YEARLY MAINTENANCE RECORD

Date Of Commissioning……. Make…… Rating…… Sl. No. …….. Bay Loc……

YEARLY MAINTENANCE-S/D Activity

SH MONTH…….. ACTUAL MONTH…….. PTW NO…… DATE……

(I) AUTORSTARTING OF FANS AND PUMPS: DONE/NOT DONE

(II) EXTERNAL CLEANING OF (I) RADIATORS (II) ALL BUSHINGS

(III) CHECKING OF REMOTE INDICATIONS OF WTIC REMOTE TAP INDICATION : OK/ NOT OK

(IV) ALARM TRIP TEST DATE…….

WTI	PRD	O/C TRIP

(V) MARSHALING BOXMAINTENANCE

Description	**Tightening of Terminations DONE/NOT DONE**	**Cleaning DONE/NOT DONE**	**Checking of contactors Space Heater & Illumination**
TB OF BUSHING CT			

Signature of Maintenance Engineer…… Signature of WHF Plant in charge……

TRANSFORMERS – 2 YEARLY MAINTENANCE RECORD

(I) WTI SETTINGS DATE…… TEMP……

WTI	SET FOR	TEST VALUE	
		Actual	Remarks
ALARM			
TRIP			
FANSTART			
PUMPSTART			

*Where pre-commissioning values are not available, comparision with previous year test results may be done

Signature of Maintenance Engineer……

Signature of WHF Plant in charge……

TRANSFORMERS – 4 YEARLY MAINTENANCE RECORD

Dt. Of Commissioning……. Make…… Rating…… Sl. No. ……..

S/D Activity PTW NO…… DATE……

(i) CHECKING AND CLEANING OF DIVERTER SWITCH CONTACTS (AFTER 50000 OPERATIONS OR SOS)

(ii) Tan delta and Capacitance Measurement of Windings

DATE OF MEASUREMENT - AMBIENT TEMP- Make of Tan delta & Capacitance Kit-

Test Modes	pre-commissioning		Actual Measurement		Remarks
	Capacitance	Tan delta	Capacitance	Tan delta	
HV-LV in UST Mode					Note: Please ensure that Jumpers are disconnected from all the Bushings before start of the Tests and all Bushings of a particular windings are shorted
HV-Ground in GSTg Mode					
LV-Tank in GSTg Mode					

(iii) WINDING RESISTANCE MEASUREMENT

Make of Winding Resistance measurement Kit

MEASUREMENT OF HV SIDE WDG RESISTANCE AT ALL TAPS (IN mOHM)									
TAP POSN.	**FACTORY TEST VALUES**			**MEASURED WDG. RESISTANCE(IN OHM)**			**WDG. RESISTANCE AT 75 DEG C**		
	R	**Y**	**B**	**IRI-2R1**	**1Y1-2Y1**	**1B1-2B1**	**R**	**Y**	**B**
MIN									
MAX									

Signature of Maintenance Engineer…… Signature of WHF Plant in charge……

YEARLY MAINTENANCE FORMAT FOR WHF PLANT ILLUMINATION SYSTEM

DATE OF MAINTENANCE: MTC.DONE BY MTC. DATE:

PTW NO. DATE:

S. NO	JOB DESCRIPTION	REMARKS & OBSERVATIONS	DATE	SIGNATURE
1	Check healthiness of light fittings in all circuits in the WHF Plant bldg and replace as required			
2	Check if all WHF Plant fittings are in working conditions (_____nos. as per list) Repair, replace as required			
3	Check Lighting panel, receptacle panel tightening o terminals.			
4	Check OUTPUT SUPPLY after fuse in receptacle panel			

Signature of Maintenance Engineer Signature of WHF Plant in charge

MAINTENANCE FORMAT FOR BATTERY SETS

WHF PLANT:
DATE OF INSPECTION:
BATTERY SET: I/II VOLTAGE: 24/48/110/220 VOLTS MONTH:
BATTERY VOLTAGE:_____VOLT

(A) MONTHLY MAINTENANCE FORMAT - A

-Checking of electrolyte level and topping up with DM water, if any
-Checking of emergency DC lighting to Control Room

(SWITCH OFF CHARGER TO NOTE TOTAL BATTERY VOLTAGE EXCEPT 24V BATTERY OF HVDC STATION)

The cell voltage should be less than 2.16 V and Specific Gravity 1195+/-10 at 27 deg C

CELL NO	BATTERY VOLTAGE	SP. GRAVITY	CELL TEMP (DEG C)	CELL NO	BATTERY VOLTAGE	SP. GRAVITY	CELL TEMP (DEG C)
1				9			
2				10			
3				11			
4				12			
5				13			
6				14			
7				15			
8				16			

Checking of any Earth fault in D.C. System Wherever E/F relays are not provided

Signature: **Signature:**
Name: **Name:**

BATTERY BANK/BATTERY CHARGER MAINTENANCE RECORD

Dt. Of Commissioning…….. Make…… Type…….
DC DB No. ……. Battery Bank No…….. Charger No…… PTW No…… Date……..

(B) HALF YEARLY MAINTENANCE- S/D Activity

(I) Checking of Charger Panel/ DCDB for Electrical Connection tightness and cleanliness

(C) YEARLY MAINTENANCE RECORD- S/D Activity

(I) Checking of Control Cards of charger measurement of Test point voltages values

Test Pt. No.	1	2	3	4	5	6	7
Value as per Drg.							
Value actual							

(II) Testing of D.C. E/F & U/V Relays
(III) IR Measurement of Charger Transformers…….M Ohm
(IV) Battery Impedance Test……
(V) Checking & Cleaning of Battery cell terminal and application of petroleum gelly, if required

(D) YEARLY MAINTENANCE RECORD- S/D Activity

DISCHARGE TEST OF BATTERY SET

(I) Connect the load to battery, Start the timing and continue to maintain the discharge rate AT 10 % Battery capacity for 2 hours.

(II) Record hourly the temp, current, voltage and Sp. Gravity of individual cell as well as Battery terminal voltage.

(III) Charge the battery (in boost mode) to full capacity and measure the temperature, voltage and specific gravity of individual cell.

DATE/HRS	CELL NO.	SP.GRAVITY	CELL VOLTS	CELL TEMP	BATTERY DISCHARGE CURRENT	BATTERY TERMINAL VOLTAGE

Note: Above test to be carried out after ascertaining of battery capacity (during commissioning or during any o AMP activity)

Signature of Maintenance Engineer

YEARLY MAINTENANCE FORMAT FOR FIRE EXTINGUISHERS

WHF PLANT: DATE OF MAINTENANCE: MTC DONE BY:

PTW NO.: DATE:

01. Check for fully charged Cartridge & change if necessary.
02. Check for quality of charge & refill if required.
03. Check if ready for operation.
04. Check for cleanliness.
05. Seal using lead seal.

S.NO	TYPE	LOCATION	QUANTITY	REMARKS & OBERVATIONS	DATE	SIGNATURE

Signature of Maintenance Engineer…… Signature of Plant in charge……

YEARLY MAINTENANCE FORMAT FOR FIRE ALARM SYSTEM

WHF PLANT: DATE OF MAINTENANCE: MTC DONE BY:
PTW NO.: DATE:

01. Check for operation of fire alarm system installed at various locations by Agarbatti or some smoke device.
02. Check for alarm in the control panel
03. Check the condition of battery
04. Check for cleanliness.

S.NO	TYPE	LOCATION	QUANTITY	REMARKS & OBERVATIONS	DATE	SIGNATURE

Signature of Maintenance Engineer…… Signature of Plant in charge……

LT SWITCHGEAR MAINTENANCE RECORD

Dt. Of Commissioning……. Make…… Type…….

1. Section-I/II/Bus Coupler 2. L.T.TRF No…….

(A) YEARLY MAINTENANCE- S/D Activity

PTW NO…… Date……..

LT PANELS

(I) Cleaning of Panels, Bus Bars Insulators etc.

(II) Relay Checking and TRIP TEST

	MAKE/TYPE SR.NO.	Set Values		Operate Values	
		Volt/Current	Time delay	Volt/Current	Time delay
(a)O/C Relay					
(b) E/C Relay					
(c)U/V Relay					

LT SWITCHGEAR

(III) Tightness of all electrical Power & Control Cable connection

(IV) Cleaning of insulators of CT/PT/Isolators/ MV CBs

(V) Checking of alignment of isolators

(VI) Functional Checks (Trip/Close) and Operating Time measurement (every 3 years) of MV CBs

GENERAL

Check operation (normal/protection trip), spring charging motor and condition of finger contacts/arcing contacts of all air LT circuit breakers (Where ever provided)

Check correct operation of change over facility (if provided)

Signature of Maintenance Engineer…… Signature of WHF Plant in charge……

PREVENTIVE MAINTENANCE RECORD FOR PROTECTION SYSTEM

MONTHLY PREVENTIVE MAINTENANCE RECORD-GENERAL

SN	ACTIVITY	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR
1.	Testing of Disturbance Recorder for test prints Feeder ---												
2.	Testing of Event Logger (Min two events to be checked)												

Signature of Maintenance Engineer…… Signature of Plant in charge……

EQUIPMENT FAILURE REPORT

Equipment Failure Report (EFR) shall report any type of failure in equipments and is the first information of failure. Whenever there is failure of any main equipments or part of any equipment during operation and maintenance which leads to outage of said equipment, EFR is to be filled up.

Report No.

Each EFR to be given a specific Report no., first abbreviated name of plant as circulated, then Sr.no. of failure and then year.

Date

Date of reporting of Failure

Reporting Region

Concerned region (where failure of equipment has occurred) to be noted down.

Plant

Name of Plant (where equipment failure occurred)

Date and time of occurrence/discovery

Date and time of occurrence of equipment failure or discovery of failed equipment to be written.

Fault discovered during

Appropriate option to be marked X, during which fault was discovered.

___ TESTING __ OPERATION

___ COMMISSIONING __ MAINTENANCE

Subsystem (WHF)

Appropriate option to be marked X, in which subsystem, fault has occurred/discovered. Specify the name of the equipment in others, if not covered by names given.

___ A/C & VENTILATION __ DC SYSTEM __ LT SWITCHGEAR

___ AUX. POWER __ FIRE PROTECTION __ PLANT EQUIPMENT

___ CONTROL RELAY __ ILLUMINATION __ TELEPHONE EXCHANGE

___ OTHERS

Main equipment type

Put a X mark in appropriate base, representing main equipment, If not covered, then, specify in others.

___ ARRESTER __ CURRENT TRANSFORMER __ EVENT LOGGER

___ BREAKER __ FAULT LOCATOR __ PACKAGE SUBSTATION

___BATTERY ___CHARGER __ PT

___BUS BAR __ DIST.RECORDER __ METERING EQUIPMENT

___ CABLING __ OTHERS

Manufacturer/Supplier

Name of the manufacturer of equipment to be specified along with sub vendor/sub supplier if any.

Faulty Unit

Type of faulty unit/equipment as given by manufacturer to be specified

- Item designation is bay name in which faulty equipment was located/ erected.
- Sr.No. & Batch No. as given on equipment name plate to be given.

Faulty Component in unit

Appropriate option to be marked X.

___ ACCUMULATOR __ FUSE __ WINDING

___ BUSHING __ GAS __ RELAY

___ CABLE ___ EARTHING SYSTEM ___ CONTACT

__ MOTOR __ CLAMPS & CONNECT __ SWITCH

___ OTHERS

Part No. as per part list. O&M manual of manufacturer to be given and name of faulty item to be described in brief.

Type of failure

Appropriate option to be marked X. Specify in others, if not covered by type of failure given.

___ BURNED __ MAL OPERATION __OPERATOR ERROR

___ FLASH OVER __ MECHANICAL FAULT __ SETTING

___LEAKAGE __ OPEN CIRCUIT __ SHORT CIRCUIT

___OTHERS __ UNKNOWN

Action taken

Appropriate option to be marked X

___ RESET ___ REPLACED ___ REPAIR

___ PENDING ___ DEFFERED MAINTENANCE ___ DESIGN CHANGE

Description of fault

Short/ Brief description of occurrence of fault and cause thereof may be given.

Ref to documents

Reference of documents from which Part No. or fault diagnosis has been done to be specified so that it may help in analysis of fault. It could be manufacturer part list manual, O&M manual or P Manual, as the case may be.

Tripping/Outrage report No.

Equipment failure may occur during tripping due to suspected fault/malfunctioning of some other equipment. Report No. thereof to be specified.

General Remarks

(i) The document should be signed by Maintenance Engineer and countersigned by WHF Plant in charge.

(ii) Distribution of EFR to be done as per list on the format.

APPENDIX G

CONTRACTORS OPERATION & MAINTENANCE LABOUR REGULATIONS

1. Working Hours

(i) Number of hours of work which shall constitute a normal working day:

The number of hours which shall constitute a normal working day for an adult shall be EIGHT hours. The working day of an adult worker shall be so arranged that inclusive of intervals, if any, for rest, it shall not spread over more than twelve hours on any day; when an adult worker is made to work for more than EIGHT hours on any day or for more than FORTY EIGHT hours in any week, he shall, in respect of overtime work, be paid wages at double at ordinary rate of wages.

(ii) Weekly day or rest:

Every worker shall be given a weekly day of rest which shall be fixed and notified at least TEN days in advance. A worker shall not be required or allowed to work on the weekly rest day unless he has or will have a substituted rest day, on one of the five day immediately before or after the rest day. Provided that no substitution shall be made which will result in the worker working for more than ten days consecutively without a rest day for a whole day.

Where in accordance with the foregoing provisions a worker works on the rest day and has been given a substituted rest day he shall be paid wages for the work done on the weekly rest day at the overtime rate of wages.

NOTE: The expression "ordinary rate of wages" means the fair wage the worker is entitled to.

2. Display of notice regarding Wages, Weekly Day of Rest etc.

The Contractor shall, before he commences his work on Contract, display and correctly maintain and continue to display and correctly maintain in a clean and legible condition in conspicuous places on the works, notice in English and in the local Indian Language spoken by majority of workers, giving the rate of fair wages, the hours of work for which such wages are payable, the weekly rest days workers are entitled to and name and address of the Inspecting Officer. The Contractor shall send a copy each of such notices to the Inspecting Officers.

3. Fixation of Wage Periods

The Contractor shall fix wage periods in respect of which wages shall be payable. No wage period shall normally exceed one week.

4. Payment of Wages

(i) Wages due to every worker shall be paid to him direct. All wages shall be paid in current coins or currency or in both.

(ii) Wages of every worker employed on the Contract shall be paid where the wage period is one week, within THREE days from the end of the Wage period; and in any other case before the expiry of the 7th day from the end of the wage period

(iii) When employment of any worker is terminated by or on behalf of the Contractor, the wages earned by him shall be paid before expiry of the day succeeding the one on which his employment is terminated.

Payment of wages shall be made at the work site on a working day except when the work is completed before expiry of the wage period, in which case final payment shall be made at the work site within 48 hours of the last working day and during normal time.

NOTE: The term "working day" means a day on which the work on which labour is employed, is in progress.

5. Register of Workmen

A register of workmen shall be maintained in the Form appended to these regulations and kept at the work site or as near to it as possible, and relevant particulars of every workman shall be entered therein within THREE days of his employment. (Ref. Form 4)

6. Employment Card

The Contractor shall issue an employment card in the Form appended to these regulations to each worker on the day of work or entry into his employment. If a worker already has any such card with him issued by the previous employer, the contractor shall merely endorse that Employment Card with relevant entries. On termination of employment the Employment Card shall again be endorsed by the Contractor and returned to the worker. (Form 5)

7. Register of Wages etc.

(i) A Register of Wages-Cum-Muster Roll in the Form appended to these regulations shall be maintained and kept at the work site or as near to it as possible.(Form 6)

(ii) A wage slip in the Form appended to these regulations shall be issued to every worker employed by the Contractor at least a day prior to disbursement of wages.

8. Fines and deductions which may be made from Wages

(i) Wages of a worker shall be paid to him without any deduction of any kind except the following:

c) fines;

d) deductions for absence from duty; i.e. from the place of his employment he is required to work. The amount of deduction shall be in proportion to the period for which he was absent;

e) deduction for damage to or loss of goods expressly entrusted to the employed person for custody, or for loss of money which he is required to account for, where such damage or loss is directly attributable to his neglect or default;

f) deductions for recovery of advances or for adjustment or overpayment of wages, Advance granted shall be entered in a register; and

g) any other deduction which the Institute may from time to time allows.

(ii) No fines shall be imposed on any worker say in respect of such acts and omissions on his part as has been approved by the Chief Labour Commissioner.

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

(iv) The total amount of fines which may be imposed in anyone wage period on a worker shall not exceed an amount equal to three paise in a rupee of the wages payable to him in respect of that wage period.

(v) No fine imposed on a worker shall be recovered from him in installments, or after expiry of sixty days from the date on which it was imposed. Every fine shall be deemed to have been imposed on the day of the act or omission in respect of which it was imposed.

(vi) The contractor shall maintain both in English &the local Indian language a list, approved by the Chief Labour Commissioner, clearly stating the acts and omissions for which penalty or fine may be imposed on a workman and display it in a good condition in a conspicuous place on the work site.

(vii) The Contractor shall maintain a register of fines and the register of deductions for damage or loss in the Forms appended to these regulations which should be kept at the place of work.

9. Register of Accidents:

The Contractor shall maintain a register of accidents in such form as may be convenient at the work place.

10. Preservation of Registers

The Register of workmen and the Register of Wages – cum - Muster Roll required to be maintained under these Regulations shall be preserved for 3 years after the date on which the last entry is made therein.

11. Enforcement

The Inspecting Officer small either on his own motion or on a complaint received by him carry out investigations, and send a report to the Engineer-In-Charge specifying the amounts representing Workers' dues and amount of penalty to be imposed on the Contractor for breach of these Regulations, that have to be recovered from the Contractor, indicating full details of the recoveries proposed and the reasons therefore. It shall be obligatory on the part of the Engineer-In-Charge on receipt of such a report to deduct such amounts from payment due to the Contractor.

12. Disposal of amounts recovered from the Contractor

The Engineer-In-Charge shall arrange payment to workers concerned within FORTY FIVE days from receipt of a report from the Inspecting Officer except in cases where the Contractor had made an appeal under Regulation 16 of these Regulations. In cases where there is an appeal, payment of workers dues would be arranged by the Engineer-In-Charge, wherever such payments arise, within THIRTY days from the date of receipt of the decision of the Regional Labour Commissioner (RLC).

13. Welfare Fund

All moneys that are recovered by the Engineer-In-Charge by way of workers dues, which could not be disbursed to workers within the time limit prescribed above, due to reasons such as whereabouts of workers not being known, death of workers, etc. and also amounts recovered as penalty, shall be credited to a Fund to be kept under the custody of GIFT for such benefit and welfare of workmen employed by Contractors.

14. Appeal against decision of Inspecting Officer

Any person aggrieved by a decision of the Inspecting Officer may appeal against such decision to the Regional Labour Commissioner concerned within THIRTY days from the date of the decision, forwarding simultaneously a copy of his appeal to the Engineer-in-Charge. The decision of the Regional Labour Commissioner shall be final and binding upon the Contractor and the workmen.

15. Representation of parties

A workman shall be entitled to be represented in any investigation or enquiry under these Regulations by an officer of a registered trade union of which he is a member or by an officer of a Federation of Trade Unions to which the said trade union is affiliated or where the workman is not a member of any registered trade union, by an official of a registered trade union, connected with, or by any other workman employed in, the industry in which the worker is employed.

A contractor shall be entitled to be represented in any investigation enquiry under these Regulations by an officer of an association of Contractors of which he is a member or by an officer of a Federation associations of contractors to which the said association is affiliated where the contractor is not a member of any association of contractors, by an officer of association of employers, connected with, or by any other employer engaged in, the industry in which the contractor is engaged.

No party shall be entitled to be represented by a legal practitioner in investigation or enquiry under these Regulations.

16. Inspection of Books and other Documents

The Contractor shall allow inspection of the Registers and other documents prescribed under these Regulations by Inspecting Officers and the Engineer-in-charge or his authorised representative at any time and by the worker or his agent on receipt of due notice at convenient time.

17. Interpretation etc.

On any question as to the application interpretation or effect of these Regulations, the decision of the Chief Labour Commissioner or Deputy Chief Labour Commissioner (Central) shall be final and binding.

18. Amendments

Central Government may from time to time, add to or amend these Regulations and issue such directions as it may consider necessary for the proper implementation of these Regulations or for the purpose of removing any difficulty which may arise in the administration thereof.

LIST OF DOCUMENTS AND SUBMITTAL

S. No.	Items
1.	4-Sets of Technical Literature
2.	Performance Guarantee
3.	All Permits/ Licenses
4.	Technical Data
5.	Manufacturer's Certificates, Drawings, Catalogues & Pamphlets & Other Documents
6.	Material safety data sheets
7.	Operating Instructions & Maintenance Manual
8.	Guarantee
9.	Quality Assurance Plan
10.	List of subcontractors, supplier and superintendents
11.	Project Schedule
12.	Construction Methodology
13.	Total Estimated Power & Water Requirement

Note :

1. Soft copies of the above shall also be provided on CD or media as approved by Engineer-in-Charge. All drawings shall be in AutoCAD format.

2. The above list is only for guide line of the contractor. The contractor shall thoroughly check all the documents and submittals required as per the tender documents and submit them in time as per the requirement.

SECTION-8

DRAWINGS

(ATTACHED SAPARATELY)

SECTION-9

BILL OF QUANTITIES

(ATTACHED SAPARATELY)

SECTION-10

ENVIRONMENT HEALTHAND SAFETY REQUIREMENTS (EHS POLICY)

ENVIRONMENT, HEALTH& SAFETY POLICY

SPECIFICATIONFORENVIRONMENT, HEALTH &SAFETYPOLICY(EHS) MANAGEMENT

CONTENTS

1.0 SCOPE: This specification established the Environment, Health and Safety (EHS) management requirement to be complied with by the Contractors during construction. Requirements stipulated in this specification shall supplement the requirements of EHS Management given in relevant Act (s) / legislations. General Conditions of Contract (GCC), Special Conditions of Contract (SCC) and Job Specifications. Where different documents stipulate different requirements, the most stringent shall be adopted.

2.0 REFERENCES: This document should be read in conjunction with following:

General Conditions of Contract (GCC)

Special Conditions of Contract (SCC)

Job pecifications

3.0 REQUIREMENTS OF ENVIRONMENT, HEALTH & SAFETY (EHS)MANAGEMENT SYSTEM TO BE COMPLIED BY BIDDERS

3.1MANAGEMENT RESPONSIBILITY

3.1.1The Contractor should have a documented EHS policy to cover commitment of their organization to ensure health, safety and environment aspects in their line of operations.

3.1.2The EHS management system of the Contractor shall cover the EHS requirements including but not limited to what is specified under Para 1.0 and para 2.0 above.

3.1.3Contractor shall be fully responsible for planning and implementing EHS requirements. Contractor as a minimum requirement shall designate / deploy the following to co-ordinate the above :

No. of workers deployed

Up to 250 - Designate one safety supervisor

Above 250 & up to 500 - Deploy one qualified and experienced safety Engineer /officer

Above 500-One additional safety (for every 500 or less) engineer/officer as above.

Contractor shall indemnify & hold harmless Owner / BSCDCL & either representatives free from any and all liabilities arising out of non – fulfillments of EHS requirements.

3.1.4 The Contractor shall ensure that the Environment, Health & Safety (EHS) requirements are clearly understood & faithfully implemented at all levels at site.

3.1.5 The Contractor shall promote and develop consciousness for Safety , Health and Environment among all personnel working for the Contractor. Regular awareness, program site meetings shall be arranged on EHS activities to cover hazards involved in various operations during construction.

3.1.6 Arrange suitable first aid measures such as First Aid Box, trained personnel to give First Aid, Stand by Ambulance or Vehicle and install fire protection measures such as : adequate number of steel buckets with sand and adequate fire extinguishers to the satisfaction of BSCDCL/Owner.

3.1.7 The Contractor shall evolve a comprehensive planned and documented system for implementation and monitoring of the EHS requirements. This shall be submitted to BSCDCL/Owner for approval. The monitoring for implementation shall be done by regular inspections and compliance to the observations thereof. The Contractor shall get similar EHS requirements implemented at his sub-contractor(s) work site/office. However, compliance of EHS requirements shall be the sole responsibility of the Contractor. Any review / approval by BSCDCL/Owner shall not absolve contractor of his responsibility / liability in relation to all HSE requirements.

3.1.8Non-Conformance on EHS by Contractor (including his Sub-contractors) as brought out during review/audit by BSCDCL/Owner representatives shall be resolved forthwith by Contractor. Compliance report shall be provided to BSCDCL/Owner.

3.1.9The Contractor shall ensure participation of his Resident Engineer / Site-in- Charge in the Safety Committee / EHS Committees meetings arranged by BSCDCL/Owner. The compliance of any observations shall be arranged urgently. He shall assist BSCDCL/Owner to achieve the targets set by them on EHS during the project implementation.

3.1.10 The Contractor shall adhere consistently to all provisions of EHS requirements. In case of non-compliance or continuous failure in implementation of any of EHS provisions; BSCDCL/Owner may impose stoppage of work without any Cost & Time implication to Owner and/or impose a suitable penalty for non-compliance with a notice of suitable period, up to a cumulative limit of 1.0% (one percent) of Contract Value with a maximum limit of Rs. 10 lakhs. This penalty shall be in addition to all other penalties specified else where in the contract. The decision of imposing stoppage work, its extent & monitory penalty shall rest with BSCDCL/Owner & binding on the Contractor.

3.1.11 All fatal accidents and other personnel accidents shall be investigated by a team of Contractor‟s senior personnel for root cause & recommend corrective and preventive actions. Findings shall be documented and suitable actions taken to avoid recurrences shall be communicated to BSCDCL/Owner. Owner / BSCDCL shall have the liberty to independently investigate such occurrences and Contractor shall extend all necessary help and co-operation in this regard.

3.2 HOUSE KEEPING

3.2.1Contractor shall ensure that a high degree of house keeping is maintained and shall ensure inter alia the followings wherever applicable:

a. All surplus earth and debris are removed/disposed off from the working areas to identified location(s).

b. Unused/Surplus Cables, Steel items and steel scrap lying scattered at different places within the working areas are removed to identified location(s).

c All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from work place to identified location(s).

d. Roads shall be kept clear and materials like: pipes, steel, sand boulders, concrete, chips and bricks etc. shall not be allowed on the roads to obstruct free movement of men & machineries.

e. Fabricated steel structural, pipes & piping materials shall be stacked properly for erection.

f. Water logging on roads shall not be allowed.

g. No parking of trucks / trolleys, cranes and trailers etc. shall be allowed on roads which may obstruct the traffic movement.

h. Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas.

i. Trucks carrying sand, earth and pulverised materials etc. shall be covered while moving within the premises.

j. Only properly designed steel scaffolding materials to be used for working at heights more than 3.0M . Double scaffolding using wooden ballis may be allowed for working at height less than 3.0M

3.3 ENVIRONMENT, HEALTH AND SAFETY

3.3.1 The Contractor shall provide safe means of access to any working place including provisions of suitable and sufficient scaffolding at various stages during all operations of the work for the safety of his workmen, and, BSCDCL/Owner. Contractor shall ensure deployment of appropriate equipment and appliances for adequate safety and health of the workmen and protection of surrounding areas.

3.3.2 The Contractor shall ensure that all their staff and workers including their sub-contractor(s) shall wear Safety Helmet and Safety shoes. Contractor shall also ensure use of safety belt, protective goggles, gloves etc. by the personnel as per job requirements. All these gadgets shall conform to relevant IS specifications or equivalent.

3.3.3 Contractor shall ensure that a proper Safety Net System shall be used at appropriate locations. The safety net shall be located not more than 30 feet (9.0 metres) below the working surface at site to arrest or to reduce the consequences of a possible fall of persons working at different heights.

3.3.4 Contractor shall ensure that flash back arrester shall be used while using

Gas Cylinders at site. Cylinders shall be mounted on trolleys.

3.3.5 The Contractor shall assign to his workmen, tasks commensurate with their qualification, experience and state of health for driving of vehicles, handling and erection of materials and equipments. All lifting equipments shall be tested certified for its capacity before use. Adequate and suitable lighting at every work place and approach there to, shall be provided by the Contractor before starting the actual operations at night.

3.3.6 Hazardous and/or toxic materials such as solvent coating, or thinners shall be stored in appropriate containers.

3.3.7 All hazardous materials shall be labelled with the name of the materials, the hazards associated with its use and necessary precautions to be taken.

3.3.8 Contractor shall ensure that during the performance of the work, all hazards to be health of personnel, have been identified, assessed and eliminated.

3.3.9 Chemical spills shall be contained & cleaned up immediately to prevent further contamination.

3.3.10All personnel exposed to physical agents such as ionizing radiation, ultraviolet rays or similar other physical agents shall be provided with adequate shielding or protection commensurate with the type of exposure involved.

3.3.11 Where contact or exposure of hazardous materials could exceed limits or could otherwise have harmful affects, appropriate personal protective equipments such as gloves, goggles, aprons, chemical resistant clothing and respirator shall be used.

A Crèche where 10 or more female workers are having children below the age of 6 years.

Reasonable Canteen facilities are made available at appropriate location depending upon site conditions.

3.3.13 Suitable facilities for toilet, drinking water, proper lighting shall be provided at site and labour camps, commensurate with applicable Laws / Legislation.

3.3.14 Contractor shall ensure storage and utilization methodology of materials that are not detrimental to the environment. Where required Contractor shall ensure that only the environment friendly materials are selected.

3.3.15All persons deployed at site shall be knowledgeable of and comply with the environmental laws, rules & regulations relating to the hazardous materials substances and wastes. Contractor shall not dump, release or otherwise discharge or dispose off any such materials without the express authorization of BSCDCL/Owner.

4.0 DETAILS OF EHS MANAGEMENT SYSTEM BY CONTRACTOR

4.1 On Award of Contract

The Contractor shall prior to start of work submit his Safety Health and

Environment Manual or procedure and EHS Plans for approval by BSCDCL/Owner. The Contractor shall participate in the pre-start meeting with BSCDCL/Owner to finalise EHS Plans including the following :

Job procedure to be followed by Contractor for activities covering. Handling of equipment, Scaffolding, Electric Installation, describing the risks involved, actions to be taken and methodology for monitoring each activity.

BSCDCL/Owner review / audit requirement.

Organization structure along with responsibility and authority records / reports etc. on

EHS activities.

4.2 During job execution

4.2.1 Implement approved Environment, Health & Safety management procedure including but not limited to as brought out under para 3.0. Contractor shall also ensure to:

Arrange workmen compensation insurance, registration under ESI Act, third party liability insurance etc., as applicable.

Arrange all HSE permits before start of activities (as applicable) like hot work, confined space, work at heights, storage of chemical / explosive materials and its use and implement all precautions mentioned therein.

Submit timely the completed checklist on EHS activities, Monthly EHS report, accident reports, investigation reports etc. as per BSCDCL/Owner requirements. Compliance of instructions on EHS shall be done by Contractor and informed urgently to BSCDCL/Owner.

Ensure that Resident Engineer / Site-in-Charge of the Contractor shall attend all the Safety Committee / EHS meetings arranged by BSCDCL/Owner. Only in case of his absence from site that a second senior most person shall be nominated by him in advance and communicated to BSCDCL/Owner.

Display at site office and work locations caution boards, list of hospitals, emergency services available.

Provide posters, banners for safe working to promote safety consciousness.

Carryout audits / inspection at sub contractor works as per approved EHS

Document and submit the reports for BSCDCL/Owner review.

Assist in EHS audits by BSCDCL/Owner, and submit compliance report.

Generate & submit HSE records / report as per EHS Plan

1. Appraise BSCDCL/Owner on EHS activity