



TENDER DOCUMENT

(CONFIDENTIAL AND NON TRANSFERABLE)

IMPORTANT INSTRUCTION

1. Please fill in your percentage in figures as well as in words at appropriate place.
2. Please deposit earnest money separately and not kept in the cover containing tender. Earnest money should be so attached that it can be verified before opening tender form. Scan copy of earnest money should be uploaded on line .
3. Please seal the envelope with gum/paste and also by sealing wax.
4. The physical tender documents of EMD & TECH Bid should be submitted in the in office within well in time . Tender received after stipulated time will be returned unopened.
5. Please note that if financial proposal submitted manually bid will be rejected .
6. Please fill in your percentage in figures as well as in words at appropriate place.
7. Please deposit earnest money separately and not kept in the cover containing tender. Earnest money should be so attached that it can be verified before opening tender form. Scan copy of earnest money should be uploaded on line .
8. Please seal the envelope with gum/paste and also by sealing wax.
9. The tender should be put in the box well within time in the box kept in office. Tender received after stipulated time will be returned unopened.
10. Please note that if financial proposal submitted manually bid will be rejected.

M.P. AUDYOGIK KENDRA VIKASH NIGAM LTD.,INDORE

(A GOVT. OF MADHYA PRADESH UNDERTAKING – SUBSIDIARY OF MPSIDC LTD., BHOPAL)

NAME OF WORK - Construction of Administrative /IT/ITES complex adjoining crystal IT park, Khandwa road Indore i/c all allied works like HVAC, Electrical, Lift, Plumbing, Fire fighting, Landscape, STP, BMS, Outer development etc. including 3 yrs Integrated property management (operation and maintenance)

ISSUED TO :

TENDER NOTICE NO:- 17578 Dated – 11.02.16

DATE :- 11.02.16

Authorized Signatory

Authorized Signatory

MP Audyogik Kendra Vikas Nigam (I) Ltd.

Free press House , First Floor, 3/54 , Press Complex, Indore (MP)

Tender Document

For Percentage Rate only in works departments and other

Departments similar to work departments

Office of the Managing Director, MPAKVN(I) Ltd

Free press House , First & Second Floor, 3/54 , Press Complex, Indore (MP)

N.I.T.No. and Date: No. AKVN/IND/TECH/2016/17578 DATE 11.02.16

Agreement Number and Date: _____

Name of Work: Construction of Administrative /IT/ITES complex adjoining crystal IT park, Khandwa road Indore i/c all allied work like HVAC, Electrical, lift, Plumbing, Fire fighting, Landscape, STP, BMS, Outer development etc. including 3 yrs Integrated property management (operation and maintenance)

Name of Contractor: _____

Probable Amount of Contract: 44.34 Crores
(INR Fourty four Crores thirty four lacs)

Contract Amount

(Rs. In Figure) : _____

(Rs. In Words) : _____

Stipulated Period of Completion : 18 months i/c rainy season from date of issue
of work Order

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SECTION 1

Notice Inviting e-Tenders

MP Audyogik Kendra Vikas Nigam (I) Ltd.
Free press House , First & Second Floor, 3/54 , Press Complex,
Indore (MP)

N.I.T. No. AKVN/IND/TS/16/17578

Dated : 11.02.16

Online percentage rate bids for the following works are invited from registered contractors and Firms of repute fulfilling registration criteria:

Name of Work	Construction of Administrative /IT/ITES complex adjoining crystal IT park, Khandwa road Indore i/c all allied work like HVAC, Electrical, Lift, Plumbing, Fire fighting, Landscape, STP, BMS, Outer development etc. including 3 yrs Integrated property management (operation and maintenance)
District (s)	Indore
Probable Amount of Contract	INR 44.34 Crores
Earnest Money Deposit (EMD)	INR Rs 22,17000/-
Cost of Bid Document	INR Rs 30000/-
Category of Contractor	„A“ Class Registered in MPPWD under Centralized Registration system
Completion Period (In Months)	18 months including rainy season from date of issue of Work order.

1. Interested bidders can view and download the detailed NIT at the website <http://mpeproc.gov.in>.
2. The Bid Document can be purchased only online from 19.02.16 17:31 PM to 05.04.16 17:30 PM.
3. Amendments to NIT, if any, would be published on website only, and not in newspaper.
4. The contractor should have registration with Department of Employees Provident Fund and the copy of registration is to be submitted along with tender documents in Envelope B.

Signature and Designation

Notice Inviting e-Tenders

MP Audyogik Kendra Vikas Nigam (I) Ltd.

Free press House , First & Second Floor, 3/54 , Press Complex,
Indore (MP)

N.I.T. No. AKVN/IND/TS/16/17578

Dated : 11.02.16

Online percentage rate bids for the following works are invited from registered contractors and Firms of repute fulfilling registration criteria:

Online tenders are invited in percentage rate tender on key dates from the contractors registered with PWD under centralized e-registration system in the appropriate class.

Tender documents can be purchased from website <https://www.mpeproc.gov.in>
Help manual to the contractors can be seen on the portal of e-procurement system.

Name of Work	Construction of Administrative /IT/ITES complex adjoining crystal IT park, Khandwa road Indore i/c all allied work like HVAC, Electrical, Lift,Plumbing, Fire fighting, Landscape, STP, Outer development etc. including 3 yrs Integrated property management (operation and maintenance)
District (s)	Indore
Probable Amount of Contract	INR 44.34 Crores
Earnest Money Deposit (EMD)	INR Rs. 22,17000/-
Cost of Bid Document	INR Rs. 30000/-
Category of Contractor	„A“ Class Registered in MP PWD under Centralized Registration system
Period of Completion (In Months)	18 months including rainy season from date of issue of work order.

1. All details relating to bid document(s) can be viewed and downloaded from the website as per NIT.
2. Bid Document can be purchased after marking online payment of portal fees through Credit card / Debit card / Cash card / Internet Banking.
3. At the time of submission of the Bid the eligible bidder shall be required to:
 - a) pay the cost of Bid Document;
 - b) deposit the Earnest Money;
 - c) submit a check list; and
 - d) submit an affidavit.

Details can be seen in the Bid Data Sheet

4. ELIGIBILITY FOR BIDDERS:

- a) At the time of submission of the Bid the bidder should have valid registration with the Government of Madhya Pradesh, PWD in appropriate class. However, such bidders who are not registered with the Government of Madhya Pradesh and are eligible for registration can also submit their bids after having applied for registration with appropriate authority.
- b) Failure to sign the contract by the selected bidder, for whatsoever reason, shall result in forfeiture of the earnest money deposit.
- c) **Pre-qualification** – Prequalification conditions are attached as Annexure C1. Bidders shall have to fulfill the criteria set for the qualification.
- d) **Special Eligibility** – Special Eligibility Conditions, if any, are given in the Bid Data Sheet.
- e) The Bid Document can be purchased only online from 19.02.16 17:31 PM to 05.04.16 17:30 PM. Other key dates may be seen in bid data sheet.
- f) Schedule of rates for MPPWD, Bhopal, Building SOR w.e.f. 01.08.2014, Road & Bridge work w.e.f. 01.02.13, Electrical SOR w.e.f 01.08.14 with amendments upto closing date of tender.
- g) Amendments to NIT, if any would be published on website only, and not in newspaper

(Signature and Designation)

SECTION 2
INSTRUCTIONS TO BIDDERS (ITB)
A. GENERAL

1.0 SCOPE OF BID

The detailed description of work, hereinafter referred as „work□, is given in **the Bid Data Sheet**.

2.0 General Quality of Work

The work shall have to be executed in accordance with the technical specifications specified in the **Bid Data Sheet/Contract Data** and shall have to meet high standards of workmanship, safety and security of workmen and works.

3.0 PROCEDURE FOR PARTICIPATION IN E-TENDERING

The procedure for participation in e-tendering is given in the **Bid Data Sheet**.

4.0 ONE BID PER BIDDER

4.1 The bidder shall be as per shortlisted list prepared by MPAKVN LTD, INDORE after completing the pre-qualification process.

4.2 No bidder shall be entitled to submit more than one bid whether jointly or severally. If the bidder does so, all bids where in the bidder has participated shall stand disqualified.

5.0 Cost of Bidding

The bidder shall bear all costs associated with the preparation and submission of his bid, and no claim what so ever for the same shall lie on the Government.

6.0 Site Visit and examination of works

The bidder is advised to visit and inspect the Site of Works and its surroundings and obtain for itself on its own responsibility all information that may be necessary for preparing the bid and entering into a contract for construction of the work. All costs in this respect shall have to be borne by the bidder.

B. BID DOCUMENTS

7.0 CONTENT OF BID DOCUMENTS

The Bid Document comprises of the following documents:

1. NIT with all amendments.
2. Instructions to Bidders, bid data sheet with all Annexure
3. Conditions of Contract:
 - i. Part I - General Conditions of Contract and Contract Data with all Annexure
 - ii. Part II - Special Conditions of Contract
4. Specifications
5. Drawings
6. Bill of Quantities
7. Technical and Financial Bid
8. Letter of Acceptance
9. Agreement
10. Any other Document(s), as specified.

8.0 Bidder's responsibilities

8.1 The bidder is expected to examine carefully all instructions, conditions of contract, the contract data, forms, terms and specifications, bill of quantities, forms and drawings in the Bid Document. Bidder shall be solely responsible for his failure to do so.

9.0 Pre-Bid Meeting (where applicable)

Wherever the **Bid Data Sheet** provides for pre-bid meeting

9.1 Details of venue, date and time would be mentioned in the **Bid Data Sheet**. Any change in the schedule of pre-bid meeting would be communicated on the website only, and intimation to bidders would not be given separately.

9.2 Any prospective bidder may raise his queries and/or seek clarifications in writing before or during the pre-bid meeting. The purpose of such meeting is to clarify issues and answer questions on any matter that may be raised at that stage. The Employer may, at his / her option, give such clarifications as are felt necessary.

9.3 Minutes of the pre-bid meeting including the gist of the questions raised and the responses given together with any response prepared after the meeting will be hosted on the website.

9.4 Pursuant to the pre-bid meeting if the Employer deems it necessary to amend the Bid Document, it shall be done by issuing amendment to the online NIT.

10.0 Amendment of Bid Documents

10.1 Before the deadline for submission of bids, the Employer may amend or modify the Bid Documents by publication of the same on the website.

10.2 All amendments shall form part of the Bid Document.

10.3 The Employer may, at its discretion, extend the last date for submission of bids by publication of the same on the website.

C. PREPARATION OF BID

11.0 Online BID preparation

11.1 The bidders have to prepare their bids online, encrypt their Bid Data in the Bid Forms and submit Bid Seals (Hashes) of all the envelopes and documents related to the Bid required to be uploaded as per the time schedule mentioned in the key dates of the Notice Inviting e-Tenders after signing of the same by the Digital Signature of their authorized representative.

12.0 DOCUMENTS COMPRISING THE BID

The bid submitted online by the bidder shall be in the following parts:

Part 1 – This shall be known as **Envelope A** and would apply for the bid. Online **Envelop A** shall contain the following as per details given in the **Bid Data Sheet**:

- i) Copy of registration in MPPWD in appropriate class and organizational details in format given in the bid data sheet.
- ii) Receipt of Payment of the cost of Bid Document;
- iii) Earnest Money; and
- iv) An affidavit duly notarized.

Part 2 – This shall be known as online **Envelope B** and required to be submitted only in works where pre-qualification conditions and/or special eligibility conditions are stipulated in the **Bid Data Sheet**. Online **Envelop B** shall contain a **self-certified sheet** duly supported by documents to demonstrate fulfillment of pre-qualification conditions.

Part 3 – This shall be known as online **Envelope C** and would apply to all bids. **Envelope C** shall contain financial offer in the **format** prescribed format enclosed with the **Bid Data Sheet**.

13.0 Language

The bid as well as all correspondence and documents relating to the bid exchanged by the Bidder and the Employer shall be in English or Hindi. Supporting documents and printed literature that are part of the Bid may be in another language provided they are accompanied by an accurate translation of the relevant passages in English. In such case, for the purposes of interpretation of the bid, such translation shall govern.

14.0 TECHNICAL PROPOSAL

14.1 Only, in case of bids with pre-qualification conditions defined in the **Bid Data Sheet**, the Technical Proposal shall comprise of formats and requirements given in the **Bid Data Sheet**.

14.2 All the document/information enclosed with the technical proposal should be self-attested and certified by bidder. The bidder shall be liable for forfeiture of his earnest money deposit, if any document/information are found false/fake/untrue before acceptance of bid. If it is found after acceptance of the bid, the bid sanctioning authority may at his discretion forfeit his performance security/guarantee security deposit, enlistment deposit and take any other suitable action as per law

15.0 Financial BID

- i. The bidder shall have to quote Percentage of (%) in format referred in bid data sheet, in overall percentage, and not item wise. If the bid is in absolute amount, overall percentage would be arrived at in relation to the probable amount of contact given in NIT. The overall percentage rate would apply for all items of work.
- ii. Percentage shall be quoted in figures as well as in words. If any difference in figures and words is found, lower of the two shall be taken as valid and correct.
- iii. The bidder shall have to quote Percentage of (%) rates inclusive of all duties, taxes, royalties and other levies; and the Employer shall not be liable for the same.
- iv. The material along with the units and rates, which shall be issued, if any, by the department to the contractor, is mentioned in the Bid Data Sheet.

16.0 PERIOD OF VALIDITY OF BIDS

The bids shall remain valid for a period specified in **the Bid Data Sheet** after the date of “close for bidding” as prescribed by the Employer. The validity of the bid can be extended by mutual consent in writing.

17.0 EARNEST MONEY DEPOSIT (EMD)

17.1 The Bidder shall furnish, as part of the Bid, Earnest Money Deposit (EMD), for the amount specified in the **Bid Data Sheet**.

17.2 The EMD shall be in the form of Fixed Deposit Receipt of a scheduled commercial bank, issued in favour of the name given in the **Bid Data Sheet**. The Fixed Deposit Receipt shall be valid for six months or more after the last date of receipt of bids.

17.3 Bid not accompanied by EMD shall be liable for rejection as non-responsive.

17.4 EMD of bidders whose bids are not accepted will be returned within sixty working days of the decision on the bid.

- 17.5 EMD of the successful Bidder will be discharged when the Bidder has signed the Agreement after furnishing the required Performance Security.
- 17.6 Failure to sign the contract by the selected bidder, within the specified period, for whatsoever reason, shall result in forfeiture of the earnest money deposit.

D. SUBMISSION OF BID

- 18.0 The bidder is required to submit online bid duly signed digitally, and Envelope „A“ in physical form also at the place prescribed in the bid data sheet.

E. OPENING AND EVALUATION OF BID

19.0 PROCEDURE

- 19.1 Envelope „A“ shall be opened first online at the time and date notified and its contents shall be checked. In cases where Envelop „A“ does not contain all requisite documents, such bid shall be treated as non-responsive, and Envelop B and/or C of such bid shall not be opened.
- 19.2 Wherever Envelop „B“ (Technical Bid) is required to be submitted, the same shall be opened online at the time and date notified. The bidder shall have freedom to witness opening of the Envelop „B“. Envelop „C“ (Financial Bid) of bidders who are not qualified in Technical Bid (Envelop „B“) shall not be opened.
- 19.3 Envelope „C“ (Financial Bid) of bids shall be opened online at the time and date notified. The bidder shall have freedom to witness opening of the Envelop „C“.
- 19.4 After opening Envelop „C“ all responsive bids shall be compared to determine the lowest evaluated bid.
- 19.5 The Employer reserves the right to accept or reject any bid, and to annul the bidding process and reject all the bids at any time prior to contract award, without incurring any liability. In all such cases reasons shall be recorded.
- 19.6 The Employer reserves the right of accepting the bid for the whole work or for a distinct part of it.

20.0 CONFIDENTIALITY

- 20.1 Information relating to examination, evaluation, comparison and recommendation of contract award shall not be disclosed to bidders or any other person not officially concerned with such process until final decision on the bid.
- 20.2 Any attempt by a bidder to influence the Employer in the evaluation of the bids or contract award decisions may result in the rejection of its bid.

F. AWARD OF CONTRACT

21.0 AWARD OF CONTRACT

The Employer shall notify the successful bidder by issuing a „Letter of Acceptance“ (LOA) that his bid has been accepted.

22.0 PERFORMANCE SECURITY

- 22.1 Prior to signing of the Contract the bidder to whom LOA has been issued shall have to furnish performance security of the amount, in the form and for the duration, etc. as specified in the **Bid Data Sheet**.
- 22.2 Additional performance security, if applicable, is mentioned in the **Bid Data Sheet** and shall be in the form and for the duration, etc. similar to performance security.

23.0 SIGNING OF CONTRACT AGREEMENT

- 23.1 The successful bidder shall have to furnish Performance security and additional performance security, if any and sign the contract agreement within 15 days of issue of LOA.
- 23.2 The signing of contract agreement shall be reckoned as intimation to commencement of work. A separate work order shall be issued by the Employer to the contractor for commencement of work.
- 23.3 In the event of failure of the successful bidder to submit Performance Security and additional performance security, if any or sign the Contract Agreement, his EMD shall stand forfeited without prejudice to the right of the employer for taking action against the bidder.

24.0 CORRUPT PRACTICES

The Employer requires that bidders observe the highest standard of ethics during the procurement and execution of contracts. In pursuance of this policy, the Employer:

- i. may reject the bid for award if it determines that the bidder recommended for award has, directly or through an agent, engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract; and
- ii. may debar the bidder declaring ineligible, either indefinitely or for a stated period of time, to participate in bids, if it at any time determines that the bidder has, directly or through an agent, engaged in corrupt, fraudulent, collusive, or coercive practices in competing for, or in executing, a contract.

For the purposes of this provision, the terms set forth above are defined as follows:

- a. "corrupt practice" means the offering, giving, receiving, or soliciting, directly or indirectly, anything of value to influence improperly the actions of another party;
- b. "fraudulent practice" means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation;
- c. "coercive practice" means impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence improperly the actions of a party;
- d. "collusive practice" means an arrangement between two or more parties designed to achieve an improper purpose, including influencing improperly the actions of another party.

[End of ITB]

BID DATA SHEET

GENERAL

S.No.	Particulars	Data
1	Office Inviting Tender	MP Audyogik Kendra Vikas Nigam (I) Ltd.
2	NIT No.	AKVN/IND/TS/16/17578 dt. 11.02.16
3	Date of NIT	11.02.16
4	Bid document download available from date & time	from 19.02.16 17:31 PM
5	Website link	http://www.mpeproc.gov.in

For Section 1 – NIT

Nit Clause	Particulars	Data
2	Portal Fees (also known as processing fee)	As notified in E-Tendering Website
3	Cost of Bid Document	Rs. 30,000/- (Rupees thirty thousand only)
	Cost of Bid Document Payable at	Online
	Cost of Bid Document In favor of	Managing Director, MPAKVN(I)Ltd, Indore
4	Affidavit Format	As per 'Annexure- B'
5	Pre-qualifications required	Yes
	If Yes, details	As per Annexure C 1
6	Special Eligibility (if yes, prior permission of E-in-C required)	NO
	If Yes, details	As per 'Annexure -D'
7	Key dates	As per 'Annexure -A'

For Section 2 – ITB

ITB Cla use	Particulars	Data
1	Name of the „Work“	Construction of Administrative /IT/ITES complex adjoining crystal IT park, Khandwa road Indore i/c all allied work like HVAC, Electrical, lift, Plumbing, Fire fighting, Landscape, STP, BMS, Outer development, 3yrs O & M etc. including 3 yrs Integrated property management (Operation and Maintenance)
2	Specifications	As per 'Annexure – E in addition to as below: In case of Roads and Bridge works: 'SPECIFICATION FOR ROAD AND BRIDGE WORK (fifth Revision) By MORTH In case of Building works: SPECIFICATION FOR BUILDING WORKS , Electrical, plumbing by CPWD, NBC Stipulation by SOR of MP PWD in Force from 01/08/2014, relevant Codes etc
3	Procedure for participation in e-tendering	As per 'Annexure – F'
4	Whether Joint Venture is allowed.	NO
4	If yes, requirement for Joint Venture	Not Applicable
9	Pre bid meeting to be held	YES
9	If Yes, Date, Time & Place	Date : 10.03.16 Time from: 3:00 pm Place: Office of Managing Director MPAKVN (I) Ltd. Indore

Annexure – A

(See clause 1, 7 of Section 1 – NIT)

KEY DATES

S. No.	Works Department Stage	Bidder's Stage	Start		Expiry		Envelopes
			Date	Time	Date	Time	
1		Purchase of Tender – Online	19.02.16	17.31	05.04.16	17.30	
2		Bid Submission – Online	19.02.16	17.31	06.04.16	17.30	
3	Mandatory submission Open (Envelope-A)		06.04.16	17.31	11.04.16	11.30	Envelope-A
4	Technical Proposal open (PQ Envelope-B)		06.04.16	17.31	11.04.16	11.30	Envelope-B
5	Financial Bid open (Envelope-C)		11.04.16	11.31	21.04.16	15.30	Envelope-C

The last date for submission of physical Envelop A and B is 07.04.16 upto 17.30. No price bid should be submitted manually otherwise Bid will be rejected.

Annexure – B

(see Clause-3 of Section 1 – NIT)

|| AFFIDAVIT ||

(to be Contained in Envelope-A)
(On Non Judicial Stamp of Rs. 100)

I/we _____ who is/ are _____ (status in the firm/ company) and competent for submission of the affidavit on behalf of M/S _____ (contractor) do solemnly affirm an oath and state that:

I/we am/are fully satisfied for the correctness of the certificates/records submitted in support of the following information in bid documents which are being submitted in response to notice inviting e-tender No. _____ for _____ (name of work) dated _____ issued by the _____ (name of the department).

I/we am/are fully responsible for the correctness of following self certified information/ documents and certificates:

1. That the self certified information given in the bid document is fully true and authentic.
2. That:
 - a. Term deposit receipt deposited as earnest money, demand draft for cost of bid document and other relevant documents provided by the Bank are authentic.
 - b. Information regarding financial qualification and annual turn-over is correct.
 - c. Information regarding various Technical qualifications is correct.
3. No close relative of the undersigned and our firm/company is working in the department.

OR

Following close relatives are working in the department:

Name _____ Post _____ Present Posting _____

Signature with Seal of the Deponent (bidder)

I/ We, _____ above deponent do hereby certify that the facts mentioned in above paras 1 to 4 are correct to the best of my knowledge and belief.

Verified today _____ (dated) at _____ (place).

Signature with Seal of the Deponent (bidder)

Note: Affidavit duly notarized in original shall reach at least one Calendar day before opening of the bid.

PRE-QUALIFICATIONS CRITERIA

Attached as Annexure – C 1

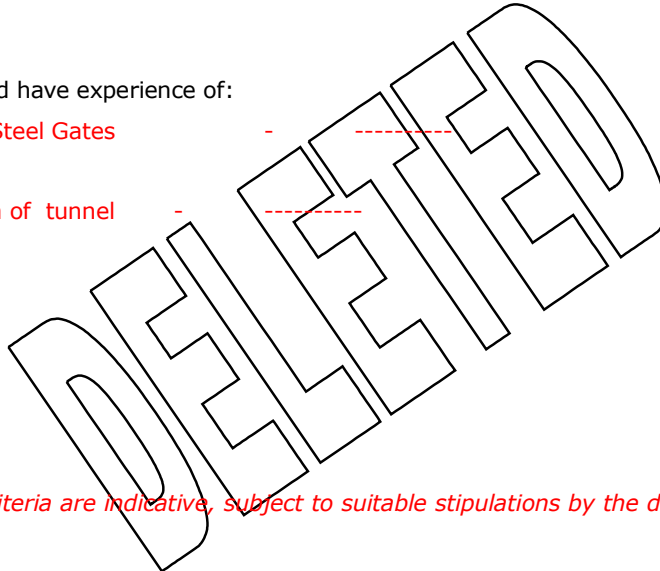
SPECIAL ELIGIBILITY CRITERIA

The bidder should have experience of:

A. Erection of Steel Gates

B. Construction of tunnel

C.



Note: Above criteria are indicative, subject to suitable stipulations by the departments and specific bid.

Specifications

1. MP Public Works Department Specifications and specifications as mentioned in MP PWD SOR applicable as on 01/08/2014, with upto date amendments till closing of tender.
2. CPWD Specifications
3. MORTH specification for road work (latest revision)
4. As per Annexure- E (E1 to E7)
5. NBC for building (latest revision)

The provisions of general / special conditions of contract, those specified elsewhere in the bid document, as well as execution drawings and notes, or other specifications issued in writing by the Employer shall form part of the technical specifications of this work.

PROCEDURE FOR PARTICIPATION IN E-TENDERING

1. Registration of Bidders on E-Tendering System:

All the PWD Registered Bidders who are already registered on the new e-Procurement portal <http://mpeproc.gov.in> the user ID will be the contractor ID provided to them from MP online. The password for the new portal has been sent to the bidders registered e-mail ID. For more details may contact M/s Tata Consultancy Services, Corporate Block, 5th Floor, DB City, Bhopal-462011 email ID: eproc_helpdesk@mpsdc.gov.in helpdesk phone numbers are available on website.

2. **Digital Certificates:**

The Bids submitted online should be signed electronically with a Class III Digital Certificate to establish the identity of the Bidder submitting the Bid online. The Bidders may obtain Class III Digital Certificates issued by an approved Certifying Authority authorized by the Controller of Certifying Authorities, Government of India. A Class III Digital Certificate is issued upon receipt of mandatory identity proofs along with an Application. Only upon the receipt of the required documents, a Digital Certificate can be issued. For details please visit cca.gov.in

Note:

- i. It may take upto 7 working days for issuance of Class III Digital Certificate, hence the bidders are advised to obtain the certificate at the earliest. Those bidder who already have valid class III Digital certificate need not obtain another Digital Certificate for the same.
The bidders may obtain more information and the application form required to be submitted for the issuance of Digital Certificate form cca.gov.in.
- ii. Bid can be submitted during the ONLINE BID SUBMISSION stage only using the Digital Certificate that is used to encrypt the data and sign the hash during the ONLINE BID PREPARATION AND HASH SUBMISSION stage. In case, during the process of a particular bid, the bidder loses his Digital Certificate because of any problem (such as misplacement, virus attack, hardware problem, operating system problem, etc.); he may not be able to submit his bid online. Hence, the bidders are advised to keep their Digital Certificate in a safe place under proper security to be used whenever required.

The digital certificate issued to the Authorized User of a Partnership firm / Private Limited Company / Public Limited Company and used for online bidding will be considered as equivalent to a no-objection certificate / power of attorney to that user.

In case of Partnership Firm, majority of the Partners have to authorize a specific individual through Authority Letter signed by majority of the Partners of the firm.

In case of Private Limited Company, Public Limited Company, the Managing Director has to authorized a specific individual through authority letter. Unless the certificate is revoked, it will be assumed to represent adequate authority of the specific individual to bid on behalf of the Organization for online bids as per Information Technology Act 2000. This Authorized User will be required to obtain a Digital Certificate. The Digital Signature executed through the use of Digital Certificate of this Authorized User will be binding on the firm. It shall be the responsibility of Management / Partners of the concerned firm to inform the Certifying Authority, if the Authorized User changes, and apply for a fresh digital certificate for the new Authorized User.

3. Set Up of Bidders' Computer System:

In order for a Bidder to operate on the e-tendering System, the Computer System of the Bidder is required to be set up for Operating System, Internet Connectivity, Utilities, Fonts, etc. the details are available at <http://www.mpeproc.gov.in>

4. Key Dates:

The Bidders are strictly advised to follow the time schedule (Key Dates) of the bid on their side for tasks and responsibilities to participate in the bid, as all the stages of each bid are locked before the start time and date and after the end time and date for the relevant stage of the bid as set by the Department.

5. Preparation and Submission of Bids:

The Bidders have to prepare their Bids online, encrypt their Bid Data in the Bid Forms and submit Bid of all the envelopes and documents required to be uploaded related to the Tender as per the time schedule mentioned in the key dates of the Notice Inviting Tenders after signing of the same by the Digital Signature of their authorized representative.

6. Purchase of bid Documents:

For purchasing of the bid document bidders have to pay service charge online only. Which is Rs. (as per bid data sheet) cost of bid document is separately maintained in the detail NIT. The bid document shall be available for purchase to concerned eligible bidder immediately after online release of the bid and upto scheduled date and time as set in the key dates.

9.1 Generation of Super – Hash

After the time of submission of Bid Seal (Hash) by the bidders has lapsed, the bid round will be closed and the Employer shall generate a Bid Super-Hash which shall be digitally signed by the Employer.

9.2 De-cryption and re-encryption of Bid Data

Bidder have to decrypt the Bid Data with Their Digital Certificate and re-encrypt the Bid Data and also upload the relevant documents using Online Briefcase feature for which they had generated the bid Seals (Hashes) during the Bid Preparation and Hash Submission stage within the specified time as stated in the Key Dates.

The encrypted data of only those bidders, who have submitted their Bid Seals (Hashes) within the stipulated time pas per the Key Dates, will be accepted by the system. A Bidder who has not submitted Bid Seals (Hashes) within the stipulated time will not be allowed to decrypt and re-encrypt his Bid Data or upload the relevant documents.

The Bidder shall submit the following in three separate envelopes online:

- | | |
|--|--------------|
| a. Cost of Bid Document, Earnest Money deposit and Affidavit | Envelope „A“ |
| b. Technical Proposal | Envelope „B“ |
| c. Financial Bid | Envelope „C“ |

Note: Bidders are required to submit the Original Term Deposit Receipt of Earnest Money Deposit demand Draft being the cost of Bid Document and Affidavit in Envelope-„A“ physically,. The envelope should be sealed and shall bear the name of work, address of the Employer and name and address of the bidder. The envelope should reach at the Employer’s address at least one calendar day before the start time and date fixed for opening of technical proposal as mentioned in the Key Dates. Scanned copies of the same are to be uploaded online. In the Technical Proposal the bidders are required to submit the documents described therein. The Financial Bids are also to be submitted online only and shall not be considered by any other mode.

WITHDRAWAL, SUBSTITUTION AND MODIFICATION OF BIDS

Bidder cannot withdraw, substitute or modify the bid after generating the Bid Seal (Hash) by the Bidder. However, if a bidder does not want to submit the bid after generating the Bid Seal (Hash), it can be done by not re-encrypting the bid.

The payments for the cost of bid document shall be made online through Debit/Credit Card / Net-Banking or NEFT Challan Through the payment gateway provided on the portal.

Withdrawal Substitution and Modification of Bids:

Bidder can withdraw and modify the bid till bid submission end date.

Annexure – G

(See Clause-4 of Section 2 – ITB)

JOINT VENTURE (J.V.) is not allowed

DETAILS OF PARTICIPATION IN THE JOINT VENTURE (NOT ALLOWED)

PARTICIPATION DETAILS	FIRM "A" (lead Partner)	FIRM "B"	FIRM "C"
Financial			
Name of the Banker(s)			
Planning			
Construction Equipment			
Key personnel			
Execution of Work (give details on contribution of each)			

DECLARATION

Annexure – H

(See Clause-12 of Section 2 – ITB & Clause 4 of GCC)

ORGANIZATIONAL DETAILS

(To be contained in Envelope-A)

S. No.	Particulars	Details
1	Registration number issued by Centralized Registration System of Govt. of M.P. or Proof of application for registration.	(if applicable scanned copy of proof of application for registration to the uploaded)
2	Valid Registration of bidder in appropriate class through Centralized Registration of Govt. of MP	Registration No _____ Date _____ (Scanned copy of Registration to be uploaded)
3	Name of Organization/Individual/ Proprietary Firm/ Partnership Firm	
4	Entity of Organization Individual/ Proprietary Firm/ Partnership Firm Registered under Partnership Act)/ Limited Company, (Registered under the Companies Act-1956)/ Corporation/ Joint Venture	
5	Address of Communication	
6	Telephone Number with STD Code	
7	Fax Number with STD Code	
8	Mobile Number of Directors	
9	E-mail Address for all communications	
	Details of Authorized Representative	
10	Name	
11	Designation	
12	Postal Address	
13	Telephone Number with STD Code	
14	Fax Number with STD Code	
15	Mobile Number	
16	E-mail Address	

Note: In case of partnership firm and limited company certified copy of partnership deed/ Articles of Association and Memorandum of Association along with registration certificate of the company shall have to be enclosed.

Signature of Bidder with Seal

Date: _____

Annexure -I

(See Clause-14 of Section 2 – ITB)

Envelope - B, Technical Proposal

AS PER ANNEXURE C 1

FINANCIAL & PHYSICAL EXPERIENCE DETAILS (AS PER ANNEXURE C1)

A. Financial Requirement:

The bidder should have completed either of the below:

- a) three similar works each costing not less than the amount equal to 40% of the probable amount of contract during the last 3 financial years; or
- b) two similar works each costing not less than the amount equal to 60% of the probable amount of contract during the last 3 financial years; or
- c) one similar work of aggregate cost not less than the amount equal to 80% of the probable amount of contract in anyone financial year during the last 3 financial years;

To be filled in by the contractor:

- i. Details of successfully completed similar works shall be furnished in the following format.
- ii. Certificate duly signed by the employer shall also be enclosed for each completed similar work.

Agreement Number & Year	Name of Work	Date of Work Order	Date of Completion	Amount of Contract	Employer's Name and Address

Existing commitments - (Value of 'C' for Bid Capacity formula)

Agreement Number & Year	Name of Work	Date of Work Order	Date of Completion	Amount of Contract	Amount of balance work	Employer's Name and Address

B. Physical Requirement:

Similar items of work in anyone financial year during the last 3 financial years

should not be less than the minimum physical requirement fixed for the work

S. No.	Particulars	Actual Quantity Executed (To be filled in by the contractor)		
		Year – 1	Year – 2	Year – 3
1	Physical qualification required			
2	Earthwork			

3	Concrete work			
---	---------------	--	--	--

- Note:** 1. Certificate duly signed by the employer shall be enclosed for the actual quantity executed in any one year during the last 3 financial years.
2. Similar works: The similarity shall be based on the physical size, complexity, methods technology or. Other characteristics of main items of work viz. earth work, cement concrete, Reinforced cement concrete, brick masonry, stone masonry etc.

ANNUAL TURN OVER (AS PER ANNEXURE C1)

Requirement:

Average annual construction turnover on the construction works not less than 50% of the probable amount of contract during the last 5 financial years;

To be filled in by the contractor:

Financial Year	Payments received for contracts in progress or completed

Note:

- i. Annual turnover of construction should be certified by the Chartered Accountant.*
- ii. Audited balance sheet including all related notes, and income statements for the above financial years to be enclosed.*

Bid Capacity

Applicants who meet the minimum qualifying criteria in the evaluation as stated above are to be evaluated further for bid capacity as under:

Bid Capacity = (1.5 A X B) - C

Where

- A= Maximum value of civil engineering works executed in anyone year during the last five year (10% weight age per year shall be given to bring the value of work executed at present price level)
- B= Proposed contract period in years.
- C= Amount of work in hand at present.

Annexure – I (Format: I-4)

(See Clause-14 of Section 2 – ITB)

Guidelines of Key Equipment/Machines for Quality Control Labs

As mentioned in Annexure C1 at Annexure I

Annexure – I (Format: I-5)
(See Clause-14 of Section 2 – ITB)

Guidelines of Key Equipment / Machines / formwork for Construction Work

As mentioned in Annexure C1 at Annexure J

FINANCIAL BID

NAME OF WORK: Construction of Administrative /IT/ITES complex adjoining crystal IT park, Khandwa road Indore i/c all allied work like HVAC, Electrical, Plumbing, Fire fighting, Landscape, STP, BMS, Outer development etc. including 3 yrs Integrated property management (operation and maintenance)

I/We hereby bid for the execution of the above work within the time specified at the rate(in figures)..... (in words) percent below/ above or at par based on the Bill of Quantities and item/package wise rates given therein in all respects and in accordance with the specifications, designs, drawings and instructions in writing in all respects in accordance with such conditions so far as applicable. I/We have visited the site of work and I am are fully aware of all the difficulties and conditions likely to affect carrying out the work. I/We have fully acquainted myself/ourselves about the conditions in regard to accessibility of site and quarries/kilns, nature and the extent of ground, working conditions including stacking of materials, installation of tools and plant conditions effecting accommodation and movement of labour etc. required for the satisfactory execution of contract.

Should this bid be accepted, I/We hereby agree to abide by and fulfill all the terms and provisions of the said conditions of contract annexed hereto so far as applicable, or in default thereof to forfeit and pay to the Governor of Madhya Pradesh or his successors in office the sums of money mentioned in the said conditions.

Note:

- i. Only one rate of percentage above or below or at par based on the Bill of Quantities and item / package wise rates given therein shall be quoted.*
- ii. Percentage shall be quoted in figures as well as in words. If any difference in figures and words is found lower of the two shall be taken as valid and correct rate. If the bidder is not ready to accept such valid and correct rate and declines to furnish performance security and sign the agreement his earnest money deposit shall be forfeited.*
- iii. In case the percentage "above" ar "below" is not given by a bidder, his bid shall be treated as non-responsive.*
- iv. All duties, taxes, and other levies payable by the bidder shall be included in the percentage quoted by the bidder.*

Signature of Bidder

Name of Bidder

The above bid is hereby accepted by me on behalf of the Managing Director , MPAKVN(I)ltd , Indore dated the..... day of 20

Signature of Officer by whom accepted

Annexure – K (To Be Deleted)
(See Clause-15 of Section 2 – ITB)

MATERIALS TO BE ISSUED BY THE DEPARTMENT

S.no	Name of material	Rate (Issue rate)	Unit	Remarks

DELETED

LETTER OF ACCEPTANCE

No. _____ Dated

To,

M/s.....

(Name and address of the contractor)

Subject: Construction of Administrative /IT/ITES complex adjoining crystal IT park, Khandwa road Indore i/c all allied work like HVAC, Electrical, Plumbing, Fire fighting, Landscape, STP, BMS, Outer development etc. including 3 yrs Integrated property management (operation and maintenance)
(Name of the work as appearing in the bid for the work)

Dear Sir (s),

Your bid for the work mentioned above has been accepted on behalf of the M.D., MPAKVN (I) Ltd., Indore M.P. at your bided percentagebelow/ above or at par the Bill of Quantities and item / package wise rates given therein.

You are requested to submit within 15 (Fifteen) days from the date of issue of this letter:

- a. The performance security/ performance guarantee of Rs. (in figures) (Rupeesin words only). The performance security shall be in the shape of term deposit receipt / bank guarantee of any nationalized bank valid up to six months after the expiry of defects liability period.
- b. Sign the contract agreement.

Please note that the time allowed for carrying out the work as entered in the bid is 30 months including rainy season, shall be reckoned from the date and time of signing the contract agreement.

Signing the contract agreement shall be reckoned as intimation to commencement of work and no separate letter for commencement of work is required. Therefore, after signing of the agreement, you are directed to contact the Engineer-in-charge for taking the possession of site and necessary instructions to start the work.

Yours Faithfully

Chief General Manager

PERFORMANCE SECURITY

To

..... [name of Employer]
..... [address of Employer]
.....

WHEREAS[name and address of Contractor] (Hereinafter called "the Contractor") has undertaken, in pursuance of Letter of Acceptance No.dated to execute[name of Contract and brief description of Works] (hereinafter called "the Contract").

AND WHEREAS it has been stipulated by you in the said Contract that the Contractor shall furnish you with a Bank Guarantee by a recognized bank for the sum specified therein as security for compliance with his obligation in accordance with the Contract;

AND WHEREAS we have agreed to give the Contractor such a Bank Guarantee:

NOW THEREFORE we hereby affirm that we are the Guarantor and responsible to you on behalf of the Contractor, up to a total of[amount of guarantee]*(in words), such sum being payable in the types and proportions of currencies in which the Contract Price is payable, and we undertake to pay you, upon your first written demand and without cavil or argument, any sum or sums within the limits of [Amount of guarantee] as aforesaid without your needing to prove or to show grounds or reasons for your demand for the sum specified therein.

We hereby waive the necessity of your demanding the said debt from the contractor before presenting us with the demand.

We further agree that no change or addition to or other modification of the terms of the Contract of the Works to be performed there under or of any of the Contract documents which may be made between you and the Contractor shall in any way release us from any liability under this guarantee, and we hereby waive notice of any such change, addition or modification.

Our liability under this Bank Guarantee shall not exceed Rs. (Rs. only) & we further declare that this Bank Guarantee will be valid fromto and we declare that this Bank Guarantee will be renewed automatically; (Only upto actual work completion period + 12 months defect liability period + 36 months operation and maintenance + 6 months) we undertake to renew this Bank Guarantee on our own till the matter is settled & fully discharged by the MD,MPAKVN Indore. The liability of the importer shall not be discharged in any account without the consent of the MD MPAKVN Indore in writing.

This guarantee shall be valid until 6 (six) months from the date of completion of Operation and maintenance period .

Signature, Name and Seal of the guarantor

Name of Bank

Address

Phone No., Fax No., E-mail Address, of Signing Authority

Date

* An amount shall be inserted by the Guarantor, representing the percentage the Contract Price specified in the Contract including additional security for unbalanced Bids, if any and denominated in Indian Rupees.

SECTION 3
CONDITIONS OF CONTRACT
Part – I General Conditions of Contract

Table of Clauses

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20	Extra Items	42	Jurisdiction

A. General

1.0 Definitions

- 1.1. Bill of Quantities: means the priced and completed Bill of Quantities forming part of the Bid.
- 1.2. Chief Engineer: means Chief Engineer of the zone/ basin concerned. (Superintending Engineer in Capital Project Administration)
- 1.3. Completion: means completion of the work as certified by the Engineer-in-Charge, in accordance with provisions of agreement.
- 1.4. Contract: means the Contract between the Employer and the Contractor to execute, complete and/or maintain the work. Agreement is synonym of Contract and carries the same meaning wherever used.
- 1.5. Contract Data: means the documents and other information which comprise the Contract.
- 1.6 Contractor: means a person or legal entity whose bid to carry out the work has been accepted by the Employer.
- 1.7. Contractor's bid: means the completed bid document submitted by the Contractor to the Employer.
- 1.8. Contract amount: means the amount of contract worked out on the basis of accepted bid.
- 1.9. Completion of work: means completion of the entire contracted work. Exhaustion of quantity of any particular item mentioned in the bid document shall not imply completion of work or any component thereof.
- 1.10. Day: means the calendar day.
- 1.11. Defect: means any part of the work not completed in accordance with the specifications included in the contract.
- 1.12. Department: means Department of the State Government viz. Capital Project Administration, Water Resources Department, Public Works Department, Public Health Engineering Department, Rural Engineering Service and any other organisation which adopts this document.
- 1.13. Drawings: means drawing including calculations and other information provided or approved by the Engineer-in-Charge. For the carried out the work

- 1.14. Employer: means the party as defined in the Contract Data, who employs the Contractor to carry out the work. The Employer may delegate any or all functions to a person or body nominated by him for specified functions. The word Employer / Government / Department wherever used denote the Employer.
- 1.15 Engineer: means the person named in the contract Data.or Authorized firm/entity appointed by the employer
- 1.16 Engineer in charge: means the person named in the contract Data.
- 1.17 Equipment: means the Contractor's machinery and vehicles brought temporarily to the Site for execution of work.
- 1.18 Government: means Government of Madhya Pradesh.
- 1.19 In Writing: means communicated in written form and delivered against receipt.
- 1.20 Material: means all supplies (Procurements) including consumables, used by the Contractor for incorporation in the work.
- 1.21. Superintending Engineer: means Superintending Engineer-in-Charge of the Circle concerned.
- 1.22. Stipulated period of completion: means the period in which the Contractor is required to complete the work. The stipulated period is specified in the Contract Data.
- 1.23. Specification: Means the specification of the work included in the contract and any modification or addition made or approved by the Engineer-in-Charge(Description of items to carried out work approved by Engineer-In-Charge)
- 1.24. Start Date: means the date of signing of agreement for the work.
- 1.25. Sub-Contractor: means a person or corporate body who has a Contract with the Contractor, duly authorized to carry out a part of the construction work under the Contract. (Only after approval from competent authority in special condition)
- 1.26. Temporary Work: means work designed, constructed, installed, and removed by the Contractor that are needed for construction or installation of the work.
- 1.27. Tender / Bid, Tendered / Bidder: are the synonyms and carry the same meaning where ever used.
- 1.28. Variation: means any change in the work which is instructed or approved as variation under this contract.

1.29. Work: The expression "work" or "works" where used in these conditions shall unless there be something either in the subject or context repugnant to such construction, be constructed and taken to mean the work by virtue of contract, contracted to be executed, whether temporary or permanent and whether original, altered, substituted or additional.

2.0 Interpretations and Documents

2.1 Interpretations: In the contract, except where the context requires otherwise:

- a. words indicating one gender include all genders;
- b. words indicating the singular also include the plural and vice versa.
- c. provisions including the word "agree", "agreed" or "agreement" require the agreement to be recorded in writing;
- d. written" or "in writing" means hand-written, type-written, printed or electronically made, and-resulting in a permanent record;

2.2 Documents Forming Part of Contract:

- a. NIT with all amendments.
- b. Instructions to Bidders (ITB, Bid Data Sheet with all Annexure)
- c. Conditions of Contract:
 - i. Part I General Conditions of Contract and the Contract Data; with all Annexure
 - ii. Part II Special Conditions of Contract.
- d. Specifications
- e. Drawings
- f. Bill of Quantities
- g. Technical and Financial Bid'
- h. Agreement, and
- i. Any other documents, as specified.

3.0 Language and Law

The language of the Contract and the law governing the Contract are stated in the **Contract Data Sheet**.

4.0 Communications

All certificates, notice or instruction to be given to the Contractor by Employer/Engineer shall be sent to the address or contact details given by the

Contractor in [Annexure H of ITB]. The address and contact details for communication with the Employer/Engineer shall be as per the details given in the Contract Data. Communication between parties that are referred to in the conditions shall be in writing. The notice sent by facsimile (fax) or other electronic means (email) shall also be effective on confirmation of the transmission. The notice sent by registered post or speed post shall be effective on delivery or at the expiry of the normal delivery period as undertaken by the postal service. In case of any change in address for communication, the same shall be kept in advance & immediately notified to Engineer-in- Charge.

5.0 Subcontracting :-

Subcontracting shall be permitted for contract value more than amount specified in the contract Data with following condition:-

Is the specialized agency to carry out work in special condition with the approval of competent authority

- a. The Contractor may subcontract up to 25 percent of the contract price with the approval of the Employer in writing, but will not assign the Contract. Subcontracting shall not alter the Contractor's obligations.
- b. Following shall not form part of subcontracting:
 - i. Hiring of labour through a labour contractor.
 - ii. The purchase of Materials to be incorporated in the works.
 - iii. Hiring of plant & machinery
- c. The sub-contractor will have to be registered in the appropriate category in the centralized registration system for contractors of the Govt.MP.

6.0 Personnel

- 6.1 The Contractor shall employ for the construction work and routine maintenance the technical personnel as provided in the Annexure 1-3 of Bid Data Sheet, if applicable. If the Contractor fails to deploy required number of technical staff, recovery as specified in the Contract Data will be made from the Contractor.
- 6.2 If the Engineer asks the Contractor to remove a person who is a member of the Contractor's staff or work force, stating the reasons, the Contractor shall ensure that the person leaves the Site within 24 hours and has no further connection with the Works in the Contract.

7.0 Force Majeure

7.1 The term "Force Majeure" means an exceptional event or circumstance:

- a. which is beyond a Party's control,
- b. which such Party could not reasonably have provided against before entering into the Contract,
- c. Which, having arisen, such Party could not reasonably have avoided or overcome,
and
- d. which is not substantially attributable to the other Party.

Force Majeure may include, but is not limited to, exceptional events or circumstances of the kind listed below, so long as conditions (a) to (d) above are satisfied:

- e. War, hostilities (whether war be declared or not), invasion, act of foreign enemies,
- f. Rebellion, terrorism, sabotage by persons other than the Contractor's Personnel, revolution, insurrection, military or usurped power, or civil war, Riot, commotion, disorder, strike or lockout by persons other than the Contractor's Personnel,
- g. Munitions of war, explosive materials, ionizing radiation or contamination by radio-activity, except as may be attributable to the Contractor's use of such munitions, explosives, radiation or radio-activity, and
- h. Natural catastrophes such as earthquake, hurricane, typhoon or volcanic activity.

7.2 In the event of either party being rendered unable by force majeure to perform any duty or discharge any responsibility arising out of the contract, the relative obligation of the party affected by such force majeure shall upon notification to the other party be suspended for the period during which force majeure event lasts. The cost and loss sustained by either party shall be borne by respective parties.

7.3 For the period of extension granted to the Contractor due to Force Majeure the price adjustment clause shall apply but the penalty clause shall not apply. It is clarified that this sub clause shall not give eligibility for price adjustment to

contracts which are otherwise not subject to the benefit of price adjustment clause.

- 7.4 The time for performance of the relative obligation suspended by the force majeure shall stand extended by the period for which such cause lasts. Should the delay caused by force majeure exceed twelve months, the parties to the contract shall be at liberty to foreclose the contract after holding mutual discussions.

8.0 Contractor's Risks

- 8.1 All risks of loss or damage to physical property and of personal injury and death which arise during and in consequence of the performance of the Contract are the responsibility of the Contractor.

- 8.2 All risks and consequences arising from the inaccuracies or falseness of the documents and/or information submitted by the contractor shall be the responsibility of the Contractor alone.

9.0 Liability for Accidents to Person

The contractor shall be deemed to have indemnified and saved harmless the Government / Employer against all action, suits, claims, demands, costs etc. arising in connection with injuries suffered by any persons employed by the contractor or his subcontractor for the works whether under the General law or under workman's compensation Act, or any other statute in force at the time of dealing with the question of the liability of employees for the injuries suffered by employees and to have taken steps properly to ensure against any claim there under.

10.0 Contractor to Construct the Works

- 10.1 The Contractor shall construct, install and maintain the Works in accordance with the Specifications and Drawings as specified in the Contract Data.
- 10.2 In the case of any class of work for which there is no such specification as is mentioned in Contract Data, such work shall be carried out in accordance with the instructions and requirement of the Engineer-in-charge.
- 10.3 The contractor shall supply and take upon himself the entire responsibility of the sufficiency of the scaffolding, timbering, machinery, tools and implements,

and generally of all means used for the fulfillment of this contract whether such means may or may not be approved or recommended by the Engineer.

11.0 Discoveries

Anything of historical or other interest or of significant value unexpectedly discovered on the Site shall be the property of the Employer. The Contractor shall notify the Engineer of such discoveries and carry out the Engineer's instructions for dealing with them.

12.0 Dispute Resolution System

12.1 No dispute can be raised except before the Competent Authority as defined in Contract Data in writing giving full description and grounds of dispute. It is clarified that merely recording protest while accepting measurement and/or payment shall not be taken as raising a dispute.

12.2 No dispute can be raised after 45 days of its first occurrence. Any dispute raised after expiry of 45 days of its first occurrence shall not be entertained and the Employer shall not be liable for claims arising out of such dispute.

12.3 The Competent Authority , Chairman , MPAKVN(I)Ltd , Indore shall decide the matter within 45 days.

12.4 Appeal against the order of the Competent Authority can be referred within 30 days to the Appellate Authority as defined in the Contract Data. The Appellate Authority shall decide the dispute within 45 days.

12.5 Appeal against the order of the Appellate Authority can be referred before the Madhya Pradesh Arbitration Tribunal constituted under Madhya Pradesh Madhyastham Adhikaran Adhiniyam, 1983.

12.6 The Contractor shall have to continue execution of the Works with due diligence notwithstanding pendency of a dispute before any authority or forum.

B. Time Control

13.0 Program

13.1 Within the time stated in the Contract Data, the Contractor shall submit to the Engineer for approval a Program showing the general methods, arrangements, order and timing for all the activities for the construction of works.

- 13.2 The program shall be supported with all the details regarding key personnel, equipment, tools and machinery proposed to be deployed on the works for its execution. The contractor shall submit the list of equipment and machinery being brought to site, the list of key personnel being deployed, the list of machinery/equipment being placed in field laboratory and the location of field laboratory along with the Program.
- 13.3 An update of the Program shall be a program showing the actual progress achieved on each activity and the effect of the progress achieved on the timing of the remaining Works, including any changes to the sequence of the activities.
- 13.4 The Contractor shall submit to the Engineer for approval an updated Program at intervals no longer than the period stated in the Contract Data. If the Contractor does not submit an updated Program within this period, the Engineer may withhold the amount stated in the Contract Data from the next payment certificate and continue to withhold this amount until the next payment after the date on which the overdue Program has been submitted.
- 13.5 The Engineer's approval of the Program shall not alter the Contractor's obligations.

14.0 Extension of Time

- 14.1 If the Contractor desires an extension of time for completion of the work on the ground of his having been unavoidably hindered in its execution or on any other grounds, he shall apply, in writing, to the Engineer-in-charge, on account of which he desires such extension. Engineer-in-Charge shall forward the aforesaid application to the Competent Authority as prescribed in contract data sheet.
- 14.2 The competent authority shall grant such extension at each such occasion within a period of 30 days of receipt of application from contractor and shall not wait for finality of work. Such extensions shall be granted in accordance with provisions under clause- 15 of this agreement.
- 14.3 In case the work is already in progress, the Contractor shall proceed with the execution of the works, including maintenance thereof, pending receipt of the decision of the competent authority as aforesaid with all due diligence.

15.0 Compensation for delay

- 15.1 The time allowed for carrying out the work, as entered in the agreement, shall be strictly observed by the Contractor.
- 15.2 The time allowed for execution of the contract shall commence from the date of signing of the agreement. It is clarified that the need for issue of work order is dispensed with.
- 15.3 In the event milestones are laid down in the Contract Data for execution of the works, the contractor shall have to ensure strict adherence to the same.
- 15.4 Failure of the Contractor to adhere to the timelines and/or milestones shall attract such liquidated damages as is laid down in the Contract Data.
- 15.5 In the event of delay in execution of the Works as per the timelines mentioned in the Contract Data the Engineer-in-charge shall retain from the bills of the Contractor amount equal to the liquidated damages livable until the Contractor makes such delays good. However, the Engineer-in-charge shall accept bankable security in lieu of retaining such amount.
- 15.6 If the Contractor is given extension of time after liquidated damages have been paid, the Engineer in Charge shall correct any over payment of liquidated damages by the Contractor in the next payment certificate.
- 15.7 In the event the Contractor fails to make good the delay until completion of the stipulated contract period (including extension of time) the sum so retained shall be adjusted against the liquidated damages levied.

16.0 Contractor's quoted percentage

The Contractor's quoted percentage rate referred to in the "Bid for works" will be deducted/ added from/to the net amount of the bill after deducting the cost of material-supplied by the department, if any.

17.0 Tests

- 17.1 The Contractor shall be responsible for carrying out the tests prescribed in specifications and for the correctness of the test results, whether preformed in his laboratory or elsewhere.
- 17.2 The contractor shall have to establish field laboratory within the time specified and having such equipments as are specified in the Contract Data.

17.3 Failure of the Contractor to establish laboratory shall attract such penalty as is specified in the Contract Data.

18.0 Correction of Defects noticed during the Defect Liability Period and operation & maintenance period:

18.1 The Defect Liability Period and operation & maintenance period of work in the contract shall be as per the Contract Data and bid document.

18.2 The Contractor shall promptly rectify all defects pointed out by the Engineer well before the end of the Defect Liability Period and operation & maintenance period. The Defect Liability Period and operation & maintenance period shall automatically stand extended until the defect is rectified.

18.3 If the Contractor has not corrected a Defect pertaining to the Defect Liability Period and operation & maintenance period to the satisfaction of the Engineer, within the time specified by the Engineer, the Engineer will assess the cost of having the Defect corrected, and the cost of correction of the Defect shall be recovered from the Performance Security or any amount due or that may become due to the contractor and other available securities. Or work may be carried out by other agency with in the satisfactory manner which is approved by AKVN and cost of work shall be deducted from the bill of contractors

D. Cost Control

19.0 Variations - Change in original Specifications, Designs, and Drawings etc.

19.1 The Engineer-in-charge shall have power to make any alterations, omissions or additions to or substitutions in the original specifications, drawings, designs and instructions, that may appear to him to be necessary during the progress of the work and the contractor shall carry out the work in accordance with any instructions which may be given to him in writing signed by the Engineer-in-charge, and such alterations, omission, additions or substitutions shall not invalidate the contract and any altered, additional or substituted work, which the contractor may be directed to do in the manner above specified, as part of the work, shall be carried out by the contractor on the same conditions in all respects on which he agrees to do the main work

19.2 The time for the completion of the work shall be extended in the proportion that the altered, additional or substituted work bears to the original contract work and the certificate of the Employer shall be conclusive as to such proportion.

20.0 Extra items (not Applicable)

20.1 All such items which are not included in priced BOQ shall be treated as extra item .

21.0 Payments for Variations and / or Extra Quantities (not Applicable)

21.1 The rates for such additional (Extra quantity), altered or substituted work / extra items under this clause shall be worked out in accordance with the following provisions in their respective order:-

- a. The contractor is bound to carry out the additional (Extra quantity) work at the same rates as are specified in the contract for the work.
- b. If the item is not in the priced BOQ and is included in the SOR of MPPWD and as adopted in MPAKVN Ltd., Indore & technical specification of the department, the rate shall be arrived at by applying the quoted tender percentage on the SOR rate as applicable in MP PWD and as adopted in MPAKVN Ltd., Indore for building works w.e.f. 01/08/14 and for road works w.e.f. 21/02/13 with its all upto date amendments till the closing date of NIT.
- c. If the rates for the altered or substituted work are not provided in applicable SOR - such rates will be derived from the rates for a similar class (type) of work as is provided in the contract (priced BOQ) for the work.
- d. If the rates for the altered, substituted work cannot be determined in the manner specified in the sub clause (c) above - then the rates for such composite work item shall be worked out on the basis of the concerned Schedule of Rates minus /plus/at par the percentage quoted by the contractor.
- e. If rates for a particular part or parts of the item is not in the Schedule of Rates and the rates for the altered, or substituted work item cannot be determined in the manner specified in sub clause (b) to (d) above, the rate for such part or parts will be determined by the Competent Authority as defined in the Contract Data on the basis of the rate analysis derived out of prevailing market rates when the work was done.

f. But under no circumstances, the contractor shall suspend the work on the plea of non-acceptability of rates on items falling under sub clause (a) to (d). In case the contractor does not accept the rate approved by the Engineer in Charge for a particular item, the contractor shall continue to carry out the item at the rates determined by the Competent Authority. The decision on the final rates payable shall be arrived at through the dispute settlement procedure.

22.0 No compensation for alterations in or restriction of work to be carried out.

22.1 If at any time after the commencement of the work, the Engineer-in-charge, for any reason whatsoever, not require the whole or any part of the work as specified in the bid to be carried out; the Engineer-in-charge shall give notice in writing of the fact to the Contractor and withdraw that whole or any part of the work.

22.2 The Contractor shall have no claim to any payments or compensation whatsoever, on account of any profit or advantage which he might have derived from the execution of work in full or on account of any loss incurred for idle men and machinery due to any alteration or restriction of work for whatsoever reason.

22.3 The Engineer-in-charge may supplement the work by engaging another agency to execute such portion of the work, without prejudice to his rights.

23.0 No Interest Payable

No interest shall be payable to the Contractor on any payment due / awarded by any authority / against any security deposits.

24.0 Recovery from Contractors

Whenever any claim against the Contractor for the payment arises under the contract, the Department may be entitled to recover such sum by:

- a. Appropriating, in part or whole of the Performance Security and Additional Performance Security, if any; and/or Security Deposit and / or any sums payable under the contract to the contractor.
- b. If the amount recovered in accordance with (a) above is not sufficient, the balance sum may be recovered from any payment due to the contractor under

any other contract of the department, including the securities which become due for release.

- c. The department shall, further have an additional right to effect recoveries as arrears of land revenue under the M.P. Land Revenue Code.

25.0 Tax

- 25.1 The rates quoted by the Contractor shall be deemed to be inclusive of the commercial tax and other levies, duties, cess, toll, taxes of Central and State Governments, local bodies and authorities.
- 25.2 The liability, if any, on account of quarry fees, royalties, octroi and any other taxes and duties in respect of materials actually consumed on public work, shall be borne by the Contractor. The amount of royalty shall be deducted by the deptt. until the N.O.C. from mining deptt / dist. Authority is not produced by the contractor.
- 25.3 Any changes in the taxes due to change in legislation or for any other reason shall not be payable to the contractor.

26.0 Check Measurements

- 26.1 The department reserves to itself the right to prescribe a scale of check measurement of work in general or specific scale for specific works or by other special orders.
- 26.2 Checking of measurement by superior officer shall supersede measurements by subordinate officer(s), and the former will become the basis of the payment.
- 26.3 Any over/excess payments detected, as a result of such check measurement or otherwise at any stage up to the date of completion of the defect liability period specified in this contract, shall be recoverable from the Contractor, as per clause 24 above.

27.0 Termination by Engineer in Charge

- 27.1 If the Contractor fails to carry out any obligation under the Contract, the Engineer in Charge may by notice require the Contractor to make good the failure and to remedy it within a specified reasonable time.
- 27.2 The Engineer in Charge shall be entitled to terminate the Contract if the Contractor

Abandons the Works or otherwise plainly demonstrates the intention not to continue performance of his obligations under the Contract;

- a. abandons the Works or otherwise plainly demonstrates the intention not to continue performance of his obligations under the contract;
- b. the Contractor is declared as bankrupt or goes into liquidation other than for approved reconstruction or amalgamation;
- c. without reasonable excuse fails to comply with the notice to correct a particular defect within a reasonable period of time;
- d. the Contractor does not maintain a valid instrument of financial security as prescribed;
- e. the Contractor has delayed the completion of the Works by such duration for which the maximum amount of liquidated damages is recoverable;
- f. If the Contractor fails to deploy machinery and equipment or personnel or set up a field laboratory as specified in the Contract Data;
- g. If the contractor, in the judgment of the Engineer in charge has engaged in corrupt or fraudulent practices in competing for or in executing the contract;
- h. Any other fundamental breaches as specified in the Contract Data.

27.3 In any of these events or circumstances, the Engineer in Charge may, upon giving 14 days' notice to the Contractor, terminate the Contract and expel the Contractor from the Site. However, in the case of sub-paragraph (b) or (g) of clause 27.2, the Engineer in Charge may terminate the Contract immediately.

27.4 Notwithstanding the above, the Engineer-in-Charge may terminate the Contract for convenience by giving notice to the Contractor

28.0 Payment upon Termination

28.1 If the contract is terminated under clause 27.3, the engineer shall issue a certificate for value of the work accepted on final measurements, less Advance Payments and Penalty as indicated in the Contract Data. The amount so arrived at shall be determined by the Engineer-in-Charge and shall be final and binding on both the parties.

28.2 Payment on termination under clause 27.4 above-

If the Contract is terminated under clause 27.4 above, the Engineer shall issue a certificate for the value of the work done, the reasonable cost of removal of Equipment, repatriation of the Contractor's personnel employed solely on the

Works, and the Contractor's costs of protecting and securing the Works and less advance payments received up to the date of the certificate, less other recoveries due in terms of the contract and less taxes due to be deducted at source as per applicable law.

- 28.3 If the total amount due to the Employer exceeds any payment due to the Contractor, the difference shall be recovered as per clause 24 above.

29.0 Performance Security

The Contractor shall have to submit performance security and additional performance security, if any, as specified in the Bid Data Sheet at the time of signing of the contract. The contractor shall have to ensure that such performance security and additional performance security, if any, remains valid for the period as specified in the Contract Data.

30.0 Security Deposit

- 30.1 Security Deposit shall be deducted from each running bill at the rate as specified in the Contract Data. The total amount of Security Deposit so deducted shall not exceed the percentage of Contract Price specified in the Contract Data.

- 30.2 If deduction of security deposit from running bills exceeds Rs.50 lacs, security deposit may be replaced, during execution, at any time on demand of the bidder by equivalent amount of bank guarantee assigned to the Employer, with validity up to 6 (six) months beyond the completion of operation maintenance period.

- 30.3 The Security Deposit shall be refunded on completion of 6 months beyond Operation and maintenance period.

31.0 Price Adjustment

31.1 Applicability

- a. Price adjustment shall be applicable only if provided for in the Contract Data.
- b. The price adjustment clause shall apply only for the works executed from the date of signing of the agreement until the end of the initial intended completion date or extensions granted for reasons attributed to the Employer by the Engineer. (**Applicable as per contract data sheet**)

- c. The Contractor shall not be entitled to any benefit arising from the price adjustment clause for extension in the contract period for reasons attributed to the Contractor.
- d. In the Force Majeure event the price escalation clause shall apply.

31.2 Procedure

- a. Contract price shall be adjusted for increase or decrease in rates and price of, cement, Steel, POL in accordance with following principles and procedures and as per formula given in the contract data.
- b. The price adjustable shall be determined during each quarter from the formula given in the contract data.
- c. Following expression and meaning are assigned to the work done during each quarter:

R = Total value of work during the quarter. It would include the amount of secured advance granted, if any, during the quarter, less the amount of secured advance recovered, if any during the quarter, less value of material issued by the department, if any, during the quarter.
- d. Weight ages of various components of the work shall be as per the Contract Data.

31.3 To the extent that full compensation for any rise or fall in costs to the contractor is not covered by the provisions of this or other clauses in the contract, the unit rates and prices included in the contract shall be deemed to include amounts to cover the contingency of such other rise or fall in costs.

31.4 The index relevant to any quarter, for which such compensation is paid, shall be the arithmetical average of the indices relevant of the calendar month.

31.5 For the purpose of clarity it is pointed out that the price adjustment may be either positive or negative, i.e. if the price adjustment is in favour of the Employer, the same shall be recovered from the sums payable to the Contractor.

32.0 Mobilization and Construction Machinery Advance

32.1 Payment of advances shall be applicable if provided in the Contract Data.

32.2 If applicable, the Engineer in Charge shall make interest bearing advance payment to the contractor of the amounts stated in the Contract Data, against provision by the contractor of an unconditional Bank Guarantee in a form and by

a nationalized/ scheduled banks, in the name as stated in the Contract Data, in amounts equal to the advance payment. The guarantee shall remain effective until the advance payment has been repaid, but the amount of the guarantee shall be progressively reduced by the amounts repaid by the contractor.

- 32.3 The rate of interest chargeable shall be as per Contract Data.
- 32.4 The construction machinery advance, if applicable, shall be limited to 80% of the cost of construction machinery and admissible only for new construction machinery.
- 32.5 The advance payment shall be recovered as stated in the Contract Data by deducting proportionate amounts from payment otherwise due to the Contractor. No account shall be taken of the advance payment or its recovery in assessing valuations of work done, variations, price adjustments, compensation events, or liquidated damages.

33.0 Secured Advance

- 33.1 Payment of Secured Advance shall be applicable if provided in the Contract Data.
- 33.2 If applicable, the Engineer shall make advance payment against steel intended for but not yet incorporated in the Works and against provision by the contractor of an unconditional Bank Guarantee in a form and by a nationalized/ scheduled bank, in the name as stated in the Contract Data, in amounts equal to the advance payment. The guarantee shall remain effective until the advance payment has been adjusted, but the amount of the guarantee shall be progressively reduced by the amounts adjusted by the contractor.
- 33.3 The amount of secured advance and conditions to be fulfilled shall be as stipulated in the Contract Data.
- 33.4 The Secured Advance paid shall be recovered as stated in the Contract Data.

34.0 Payment Certificates

The payment to the contractor will be as follows for construction work:

- a. The Contractor shall submit to the Engineer monthly statements of the value of the work executed less the cumulative amount certified previously, supported with detailed measurement of the items of work executed.

- b. The Engineer shall check the Contractor's monthly statement and certify the amount to be paid to the Contractor.
- c. The value of work executed shall be determined, based on the measurements approved by the Engineer/ Engineer-in-charge.
- d. The value of work executed shall comprise the value of the quantities of the items in the Bill of Quantities completed.
- e. The value of work executed shall also include the valuation of Variations and Compensation Events.
- f. All payments shall be adjusted for deductions for advance payment, security deposit, other recoveries in terms of contract and taxes at source as applicable under the law.
- g. The Engineer may exclude any item certified in a previous certificate or reduce the proportion of any item previously certified in any certificate in the light of later information.
- h. Payment of intermediate certificate shall be regarded as payments by way of advance against the final payment and not as payments for work actually done and completed.
- i. Intermediate payment shall not preclude the requiring of bad, unsound and imperfect or unskilled work to be removed and taken away and reconstructed or be considered as an admission of the due performance of the contractor any part thereof, in any respect or the occurring of any claim.
- j. The payment of final bill shall be governed by the provisions of clause 36 of GCe.

E. Finishing the Contract

35.0 Completion Certificate

35.1 A Completion Certificate in the prescribed format in Contract Data shall be issued by the Engineer-in-Charge after physical completion of the Work.

35.2 After final payment to the Contractor, a Final Completion Certificate in the prescribed format in the Contract Data shall be issued by the Engineer-in-Charge.

36.0 Final Account

- 36.1 The Contractor shall supply the Engineer with a detailed account of the total amount that the Contractor considers payable for works under the Contract within 21 days of issue of certificate of physical completion of works. The Engineer shall issue a Defects Liability Certificate and certify any payment that is due to the Contractor within 45 days of receiving the Contractor's account if it is correct and complete. If the account is not correct or complete, the Engineer shall issue within 45 days a schedule that states the scope of the corrections or additions that are necessary. If the Account is still unsatisfactory after it has been resubmitted, the matter shall be referred to the Competent Authority as defined in the Contract Data, who shall decide on the amount payable to the Contractor after hearing the Contractor and the Engineer in Charge.
- 36.2 In case the account is not received within 21 days of issue of Certificate of Completion as provided in clause 32.1 above, the Engineer shall proceed to finalize the account and issue a payment certificate within 28 days.

F. Other Conditions of Contract

37.0 Currencies

All payments will be made in Indian Rupees.

38.0 Labour

- 38.1 The Contractor shall, unless otherwise provided in the Contract, make his own arrangements for the engagement of all staff and labour, local or other, and for their payment, housing, feeding and transport.
- 38.2 The Contractor shall, if required by the Engineer, deliver to the Engineer a return in detail, in such form and at such intervals as the Engineer may prescribe, showing the staff and the numbers of the several classes of labour from time to time employed by the Contractor on the Site and such other information as the Engineer may require.

39.0 Compliance with Labour Regulations

- 39.1 During continuance of the Contract, the Contractor and his sub-Contractors shall abide at all times by all existing labour enactments and rules made there under, regulations, notifications and bye laws of the State or Central Government or local authority and any other labour law (including rules), regulations, bye laws

that may be passed or notification that may be issued under any labour law in future either by the State or the Central Government or the local authority. Salient features of some of the major labour laws that are applicable to construction industry are given in the Contract Data. The Contractor shall keep the Employer indemnified in case any action is taken against the Employer by the competent authority on account of contravention of any of the provisions of any Act or rules made thereunder, regulations or notifications including amendments. If the Employer is caused to pay or reimburse, such amounts as may be necessary to cause or observe, or for non-observance of the provisions stipulated in the notifications/ byelaws/ Acts/ Rules/ regulations including amendments, if any, on the part of the Contractor, the Engineer/Employer shall have the right to deduct from any money due to the Contractor including his amount of performance security. The Employer/Engineer shall also have right to recover from the Contractor any sum required or estimated to be required for making good the loss or damage suffered by the Employer. The employees of the Contractor and the Sub-Contractor in no case shall be treated as the employees of the Employer at any point of time.

40.0 Audit and Technical Examination

40.1 MP Audyogik Kendra Vikas Nigam (I) Ltd. (Indore) shall have the right to cause an audit and technical examination of the works and the final bill of the contract 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 and found not to, have been overpaid in respect of any work done by the contractor under the contract or any work claimed by him to have been done under the contract and found not to, have been executed , the Contractor shall be liable to refund the amount of overpayment and it shall be lawful for MP Audyogik Kendra Vikas Nigam (I) Ltd. (Indore), to recover the same from him in the manner prescribed in clause 24 above 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 MP Audyogik Kendra Vikas Nigam (I) Ltd. (Indore) to the Contractor.

41.0 Death or Permanent Invalidity of Contractor

If the Contractor being an individual or a proprietary concern, partnership concern, dies during the period of the contract or becomes permanently incapacitated, where the surviving partners are only minors, the contract shall be closed without levying any damages/ compensation as provided for in clause 28.2 of the contract agreement. However, if the competent authority is satisfied about the competence of the survivors, then the competent authority shall enter into a fresh agreement for the remaining work strictly on the same terms and conditions under which the contract was awarded.

42.0 Jurisdiction

This contract has been entered into the State of Madhya Pradesh and its validity, construction, interpretation and legal effect shall be subjected to the courts at the place where this agreement is entered into. No other jurisdiction shall be applicable.

Contract Data Sheet

Clause Reference	Particulars	Data
1.14	Employer	MPAKVN(I)Ltd, Indore (MP)
1.15	Engineer	Junior Engineer, Assistant Engineer,
1.16	Engineer in Charge	Executive Engineer
1.22	Stipulated Date of Completion	18 months including rainy season after one month mobilization period from the date of issue of work order
3	Language & Law of Contract	English & Indian contract Act 1872
4	Address & contact details of the Contractor	As per 'Annexure-H'
	Address & contact details of the Employer/ Engineer – phone, Fax, E-mail.	Executive Engineer, Free press house, first floor, 3/54, Press Complex, A B road , Indore. Phone – 0731 – 4070976, 2572623 Fax – 0731 - 2572629 E-mail – indoreakvn@gmail.com
5	Subcontracting permitted for the Contract Value	Not Permitted
6	Technical Personnel to be provided by the contractor Requirement &	As per 'Annexure-I' (Format I-3)
	Penalty, if required Technical Personnel not employed	Rs 20,000/- per month for each Diploma Holder Rs. 35,000/- per month for each Graduate Engineer and Rs 10,000/- per month for each Subordinate Technical Supervisory Staff to be employed as per Format I-3
10	Specifications	As per 'Annexure - E'
	Drawings	As per 'Annexure - N'
12	Competent Authority for deciding dispute under Dispute Resolution System	Managing Director, MPAKVN(I)Ltd, Indore
	Appellate Authority for deciding dispute under Dispute Resolution System	Chairman, MPAKVN(I)Ltd, Indore (Managing Director, MPTRIFAC, Bhopal)

13	Period for submission of updated construction program	Monthly
	Amount to be withheld for not submitting construction program in the prescribed period	@ 1 % (one) percent of contract amount
14	Competent Authority for granting Time Extension	Managing Director, MPAKVN(I)Ltd, Indore
15	Milestones laid down for the contract	YES. Refer Annexure – „0□
	If Yes, details of Milestones	As per 'Annexure - O' or as below, if not mentioned in Annexure -O: Mile Stone 1:- 1/8th of the whole work before 1/4th of the whole time allowed has elapsed, Mile Stone 2:- 3/8th of the whole work before 1/2th of the whole time allowed has elapsed Mile Stone 3:- 3/4th of the whole work before 3/4th of the whole time allowed has elapsed Mile Stone 4:- complete work within the stipulated time
	Liquidated damage	As per 'Annexure - P'
17	List of equipment for lab	As per 'Annexure - Q'
	Time to establish lab	30 days from date of signing of the Agreement
	Penalty for not establishing field Laboratory	Rs. 50,000/- each month□s delay

Clauses reference	Particulars	Data
18	Defect Liability Period.	<p style="text-align: right;">6 3</p> <p>4 years as mentioned below:</p> <p>Defect Liability Period: Initial 1 year from the physical completion of the work including operation and maintenance without any payment .</p> <p>Operation and maintenance period : further 3 years Defect Liability Period after expiry of initial 1 year defect liability period . Payment shall be made for 3 yrs based on quoted rates.</p> <p>after execute, complete and maintain works in accordance with agreement and special conditions of contract (SCC) after issue of physical completion certificate as per "Annexure-U"</p> <p>Note: in accordance with clause 18.3 (GCC), the Engineer in Charge shall intimate the contractor about the cost assessed, for making good the defects, and If the contractor has not corrected defects, action for correction of defects shall be taken by the Engineer in Charge as below at the contractor's risk and cost:</p> <ul style="list-style-type: none"> deploy departmental labour and material or engage a contractor by issuing a work order at contract rate/SOR rate or sanction supplementary work in an existing agreement to a contractor for zonal works or similar other work or invite open tender or combination of above
21	Competent Authority for determining the rate	Managing Director, MPAKVN(I)Ltd, Indore
27	Any other condition for breach of contract	<p>Yes as below:</p> <p>If the contractor fails to achieve 50% financial progress in any milestone and /or</p> <p>fails to achieve 75% financial progress in two consecutive mile stones</p>

28	Penalty	Penalty Shall include : 6 a) Security deposit as per clause 30 of General 4 Conditions of Contract, and b) Liquidated Damages imposed as per clause 15 or Performance Security (Guarantee) including Additional Performance Security (Guarantee) , if any, as per clause 29 of General Conditions of Contract, whichever is higher
29	Performance guarantee (Security) shall be valid up to	Performance guarantee for construction work : 5% of agreed cost. This guarantee shall be valid until 6 (six) months from the date of successful completion of construction work including operation and maintenance. (i.e. actual construction period +12 months defect liability period + 36 months operation & maintenance+ 6 month) and shall be released after 6 months of successful completion of the work including operation & maintenance..
30	Security Deposit to be deducted from each running bill	At the rate of 5% of Gross Amount of Running Bills of construction and O&M. If during execution , deduction of security deposit from running bill exceeds Rs.50 lacs, security deposit may be replaced, at any time, on demand of the bidder by equivalent amount of bank guarantee assigned to the Employer, with validity up to 6 (six) months beyond the completion of operation maintenance period.
	Maximum limit of deduction of Security Deposit	Up to 5% of Final Contract Amount.
31	Clause 31.1(1)Price adjustment shall be applicable	As per Annexure R and as below: (a) The price Adjustment shall apply in respect of Cement, Steel, and POL components after 12 months of opening of the bid. (b) if time extension is given with or without penalty, no price variation shall be payable in extended time. (c) Price Adjustment shall be applicable only in case

		of Probable Amount of Contract (PAC) in NIT is 6 more than Rs ten Cr. This clause shall not have any bearing with the Contract Amount.			
	Clause 31.2.4 Weightages of Component in the work	Component	Percentage of Component in the work		
			Road work	Bridge Work	Building work
		Cement – Pc	-	-	5%
		Steel- Ps	-	-	11%
		POL - Pf	-	-	5%
32	Clause 32.1 Mobilization and Construction Machinery Advance Applicable	5% Mobilization Advance on request of the contractor			
	Clause 32.2 If yes, Unconditional Bank Guarantee	Unconditional bank guarantee bond from scheduled Bank for the amount equal to 112% of the amount of advance and valid for the contract period.			
	Clause 32.3 If yes, Unconditional Bank Guarantee	The advance bears a simple interest of 12% per annum and shall be calculated from the date of payment to the date of recovery both days inclusive, on the outstanding amount of advance			
	Clause 32.4 If yes, Type & Amount of Advance payment that can be paid	Not applicable			
	Clause 32.5 If yes, Recovery of advance payment	The advance bears a simple interest of 12% per annum and shall be calculated from the date of payment to the date of recovery both days inclusive, on the outstanding amount of advance. Recovery of such sums advanced shall be made by the deduction from the contractors bills commencing after first ten per cent of the gross value of the work is executed and paid, on prorata percentage basis to the gross value of the work billed beyond 10% in such a way that the entire advance is recovered 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 upto the date of recovery of the installment			
33	Clause 33.1 Secured Advance Applicable	Applicable for Steel only			

	Clause 33.2 if yes, Unconditional Bank Guarantee	Bank Guarantee issued by any Nationalized Bank till full recovery of advance
	Clause 33.2 if yes, Amount of Secured Advance	75% of purchased voucher value
	Clause 33.3 if yes, Conditions for secured advance	On execution of indenture bond in prescribed format
	Clause 33.4 if yes, Recovery of Secured advance	From each running bill as per actual consumption
35	Completion Certificate – after physical completion of the Work	As per 'Annexure- U'
	Final Completion Certificate – after final payment on completion of the Work	As per 'Annexure- V' 6 6
36	Competent Authority	MD , MPAKVN(I)LTD,.INDORE
39	Salient features of some of the major labour laws that are applicable	As per 'Annexure-W'
41	Competent Authority	MD , MPAKVN(I)LTD,.INDORE

Annexure – N

(See Clause-10 of Section 3 – GCC)

DRAWINGS & DRAWING LIST ATTACHED

(See Clause-15 of Section 3 – GCC)

DETAILS OF MILESTONES (for construction work)

No.	Description of Milestone (Financial)	Time allowed in days (from date of start)	Amount to be withheld in case of non achievement of milestone
1	1/8 th of the whole work	1/4 th of the Stipulated period of contract	As per Annexure 'P'
2	3/8 th of the whole work	1/2 of the Stipulated period of contract	
3	3/4 th of the whole work	3/4 th of the Stipulated period of contract	
4	Completion of Work	Stipulated period of contract	

No.	Description of Milestone (Financial: construction work e/x O&M)	Time allowed in days (from date of start) Construction period	Amount to be withheld in case of non achievement of milestone
1	5.17 cr	4.5 months from the start of the work	As per Annexure 'P'
2	15.50 cr	9 months from the start of the work	
3	31.01cr	13.5 months from the start of the work	
4	41.35 cr	18 months from the start of the work	

(See Clause-15 of Section 3 – GCC)

Compensation for Delay

If the contractor fails to achieve the milestones, and the delay in execution of work is attributable to the contractor, the Employer shall retain an amount from the sums payable and due to the contractor as per following scale -

- i. Slippage up to 25% in financial target during the milestone under consideration - 2.5% of the work remained unexecuted in the related time span.
- ii. Slippage exceeding 25% but Up to 50% in financial target during the milestone under consideration 5% of the work remained unexecuted in the related time span.
- iii. Slippage exceeding 50% but Up to 75% in financial target during the milestone under consideration -7.5% of the work remained unexecuted in the related time span.
- iv. Slippage exceeding 75% in financial target during the milestone under consideration -10% of the work remained unexecuted in the related time span.

Note: For arriving at the dates of completion of time span related to different milestones, delays which are not attributable to the Contractor shall be considered. The slippage on any milestone is if made good in subsequent milestones or at the time of stipulated period of completion, the amount retained as above shall be refunded. In case the work is not completed within the stipulated period of completion along with all such extensions which are granted to the Contractor for either Employer's default or Force Majeure, the compensation shall be levied on the contractor at the rate of 0.05% per day of delay limited to a maximum of 10% of contract price. The decision of Managing Director shall be final and binding upon both the parties.

Annexure – Q

(See Clause-17 of Section 3 – GCC)

Guidelines for EQUIPMENT FOR QUALITY CONTROL LAB

As per Annexure C1 at Annexue I

PRICE ADJUSTMENT

The formulas for adjustment of price are as follow:

R = Value of work as defined in Clause 31.2(3) of General Conditions of Contract

Weightages* of component in the work

S.No	Component	Percentage of component in the work
1	Cement - P _c	
2	Steel - P _s	
3	POL - P _f	

Weightages of various components of the work shall be as determined by the competent technical sanction authority.

Adjustment for Labour component

- (i) Price adjustment for increase or decrease in the cost of labour shall be paid in accordance with the following formula:

$$V_L = 0.85 \times P_1 / 100 \times R \times (L_1 - L_0) / L_0$$

V_L = increase or decrease in the cost of work during the month under Consideration due to changes in rates for local Labour.

L₀ = The Consumer price index for industrial workers for the State nearest city from the site on the date of opening of Bids as published by Labour Bureau, Ministry of Labour, Government of India.

L₁ = The Consumer price index for industrial workers for the State nearest city from the site for the month under consideration as published by Labour Bureau, Ministry of Labour, Government of India.

P₁ = Percentage of Labour component of the work

Adjustment for cement component

- (ii) Price adjustment for increase or decrease in the cost of cement procured by the contractor shall be paid in accordance with the following formula:

$$V_C = 0.85 \times P_C / 100 \times R \times (C_1 - C_0) / C_0$$

V_C = increase or decrease in the cost of work during the month under Consideration due to changes in rates for cement.

C₀ = The all India wholesale price index for Grey cement on the date of opening of Bids as published by the Ministry of Industrial Development, Government of India, New Delhi. (www.eaindustry.nic.in)

C₁= The all India average wholesale price index for Grey cement for the month under consideration as published by Ministry of Industrial Development, Government of India New Delhi. (www.eaindustry.nic.in)

P_c= Percentage of cement component of the work

Note: For the application of this clause, index of Grey Cement has been chosen to represent Cement group.

Adjustment of steel component

(iii) Price adjustment for increase or decrease in the cost of steel procured by the Contractor shall be paid in accordance with the following formula:

$$V_s = 0.85 \times P_s \times /100 \times R \times (S_1 - S_0) / S_0$$

V_s= Increase or decrease in the cost of work during the month under consideration due to changes in the rates for steel.

S₀= The all India wholesale price index for steel (Bars and Rods) on the date of opening of Bids as published by the Ministry of Industrial Development, Government of India, New Delhi. (www.eaindustry.nic.in)

S₁ = The all India average wholesale price index for steel (Bars and Rods) for the month under consideration as published by Ministry of Industrial Development, New Delhi. (www.eaindustry.nic.in)

P_s= Percentage of steel component of the work.

Note: For the application of this clause, index of Bars and Rods has been chosen to represent steel group.

Adjustment of bitumen component

(iv) Price adjustment for increase or decrease in the cost of bitumen shall be paid in accordance with the following formula:

$$V_b = 0.85 \times P_b / 100 \times R \times (B_i - B_0) / B_0$$

V_b= Increase or decrease in the cost of work during the month under consideration due to changes in rates for bitumen.

B₀= The official retail price of bitumen at the IOC depot at nearest center on the date of opening of Bids.

B_i= The official retail price of bitumen of IOC depot at nearest center for the 15th day of the month under consideration.

P_b = Percentage of bitumen component of the work.

Adjustment of POL (fuel and lubricant) component

(v) Price adjustment for increase or decrease in cost of POL (fuel and lubricant) shall be paid in accordance with the following formula:

$$V_f = 0.85 \times P_f / 100 \times R \times (F_i - F_0) / F_0$$

- V_f = Increase or decrease in the cost of work during the month under consideration due to changes in rates for fuel and lubricants.
- F_0 = The official retail price of High Speed Diesel (HSD) at the existing consumer pumps of IOC at nearest center on the date of opening of Bids.
- F_i = The official retail price of HSD at the existing consumer pumps of IOC at nearest center for the 15th day of month of the under consideration.
- P_f = Percentage of fuel and lubricants component of the work.

Note:For the application of this clause, the price of High Speed Diesel has been chosen to represent fuel and lubricants group

Adjustment of Other materials component

- (vii) Price adjustment for increase or decrease in cost of local materials other than Cement, Steel, Bitumen and POL procured by the contractor shall be paid in accordance with the following formula:

$$V_m = 0.85 \times P_m / 100 \times R \times (M_i - M_0) / M_0$$

V_m = Increase or decrease in the cost of work during the month under consideration due to changes in rates for local materials other than Cement, Steel, Bitumen and POL.

M_0 = The all India wholesale price index (all commodities) on the date of opening of bids, as published by the Ministry of Industrial Development government of India, New Delhi.

M_i = The all India average wholesale price index (all commodities) for the month under consideration as published by ministry of Industrial development, Government of India, New Delhi.

P_m = Percentage of local material component (other than Cement, Steel, bitumen and POL) of the work plant and machinery spares component of the work.

**Bank Guarantee Form for Mobilization and Construction Machinery
Advance**

To,

_____ [name of Employer]

_____ [address of Employer]

_____ [name of Contractor]

In accordance with the provisions of the General Conditions of Contract, clause 31 ("Mobilization and Construction Machinery Advance") of the above-mentioned Contract _____ [name and address of Contractor] (hereinafter called "the Contractor") shall deposit with _____ [name of Employer] a bank guarantee to guarantee his proper and faithful performance under the said Clause of the Contract in an amount of _____ [amount of Guarantee] _____ [in words).

We, the _____ [bank of financial institution], as instructed by the Contractor, agree unconditionally and irrevocably to guarantee as primary obligator and not as surety merely, the payment to _____ [name of Employer] on his first demand without whatsoever right of obligation on our part and without his first claim to the Contractor, in the amount not exceeding _____ [amount of guarantee] _____ [in words).

We further agree that no change or addition to or other modification of the terms of the Contractor or Works to be performed there under or of any of the Contract documents which may be made between _____ [name of Employer] and the Contractor, shall in any way release us from any liability under this guarantee, and we hereby waive notice of any such change, addition or modification.

This guarantee shall remain valid and in full effect from the date of the advance payment under the Contract until _____ [name of Employer] receives full repayment of the same amount from the Contractor.

Yours truly,

Signature and Seal: _____

Name of Bank/Financial Institution: _____

Address: _____

Date: _____

*An amount shall be inserted by the Bank or Financial Institution representing the amount of the Advance Payment, and denominated in Indian Rupees.

Bank Guarantee Form for Secured Advance

INDENTURE FOR SECURED ADVANCES

This indenture made the _____day of 20__ BETWEEN _____ (hereinafter called the contractor which expression shall where the context so admits or implies be deemed to include his executors, administrators and assigns) or the one part and the Employer of the other part.

Whereas by an agreement dated (hereinafter called the said agreement) the contractor has agreed.

AND WHEREAS the contractor has applied to the Employer that he may be allowed advanced on the security of materials absolutely belonging to him and brought by him to the site of the works the subject of the said agreement for use in the construction of such of the works as he has undertaken to execute at rates fixed for the finished work (inclusive of the cost of materials and labour and other charges)

AND WHEREAS the Employer has agreed to advance to the Contractor the sum of Rupees _____ on the security of materials the quantities and other particulars of which are detailed in Accounts of Secured Advance attached to the Running account Bill for the said works signed by the Contractor on and the Employer has reserved to himself the option of making any further advance or advances on the security of other materials brought by the Contractor to the site of the said works.

Now THIS INDENTURE WITNESSETH that in pursuance of the said agreement and in consideration of the sum of Rupees _____ on or before the execution of these presents paid to the Contractor by the Employer (the receipt where of the Contractor doth hereby acknowledge) and of such further advances (if any) as may be made to him as aforesaid the Contractor doth hereby covenant and agree with the President and declare as follows:

That the said sum of Rupees _____so advanced by the Employer to :

- (1) the Contractor as aforesaid and all or any further sum of sums advanced as aforesaid shall be employed by the Contractor in or towards expending the execution of the said works and for no other purpose whatsoever.
- (2) That the materials details in the said Account of Secured Advances which have been offered to and accepted by the Employer as security are absolutely the Contractor's own propriety and free from encumbrances of any kind and the contractor will not make any application for or receive a further advance on the security of materials which are not absolutely his own property and free from encumbrances of any kind and the Contractor indemnified the Employer against all claims to any materials in respect of which an advance has been made to him as aforesaid.
- (3) That the materials detailed in the said account of Secured Advances and all other materials on the security of which any further advance or advances may hereafter be made as aforesaid (hereafter called the said materials) shall be used by the Contractor solely in the execution of the said works in accordance with the directions of the Engineer.
- (4) That the Contractor shall make at his own cost all necessary and adequate arrangements for the proper watch, safe custody and protection against all risks of the said materials and that until used in construction as aforesaid the said materials shall remain at the site of the said

works in the Contractor's custody and on his own responsibility and shall at all times be open to inspection by the Engineer or any officer authorized by him. In the event of the said materials or any part thereof being stolen, destroyed or damaged or becoming deteriorated in a greater degree than is due to reasonable use and wear thereof the Contractor will forthwith replace the same with other materials of like quality or repair and make good the same required by the Engineer.

- (5) That the said materials shall not be removed from the site of the said works except with the written permission of the Engineer or an officer authorized by him on that behalf.
- (6) That the advances shall be repayable in full when or before the Contract receives payment from the Employer of the price payable to him for the said works under the terms and provisions of the said agreement. Provided that if any intermediate payments are made to the Contractor on account of work done than on the occasion of each such payment the Employer will be at liberty to make a recovery from the Contractor's bill for such payment by deducting there from the value of the said materials than actually used in the construction and in respect of which recovery has not been made previously, the value for this purpose being determined in respect of each description of materials at the rates at which the amounts of the advances made under these presents were calculated.
- (7) That if the Contractor shall at any time make any default in the performance or observance in any respect of any of the terms and provisions of the said agreement or of these presents the total amount of the advance or advances that may still be owing of the Employer shall immediately on the happening of such default be re-payable by the Contractor to be the Employer together with interest thereon at twelve percent per annum from the date or' respective dates of such advance or advances to the date of repayment and with all costs, charges, damages and expenses incurred by the Employer in or for the recovery thereof or the enforcement of this security or otherwise by reason of the default of the Contractor and the Contractor hereby covenants and agrees with the Employer to reply and pay the same respectively to him accordingly.
- (8) That the Contractor hereby charges all the said materials with the repayment to the Employer of the said sum of Rupees _____ and any further sum of sums advanced as aforesaid and all costs, charges, damages and expenses payable under these presents PROVIDED ALWAYS and it is hereby agreed and declared that notwithstanding anything in the said agreement and without prejudice to the power contained therein if and whenever the covenant for payment and repayment here-in-before contained shall become enforceable and the money owing shall not be paid in accordance there with the Employer may at any time thereafter adopt all or any of the following courses as he may deem best:
 - (a) Seize and utilise the said materials or any part thereof in the completion of the said works on behalf of the contractor in accordance with the provision in that behalf contained in the said agreement debiting the contractor with the actual cost of effecting such completion and the amount due to the contractor with the value of work done as if he had carried it out in accordance with the said agreement and at the rates thereby provided. If the balance is against the contractor, he is to pay same to the Employer on demand.

- (b) Remove and sell by public auction the seized materials or any part thereof and out of the moneys arising from the sale retain all the sums aforesaid repayable or payable to the Employer under these presents and pay over the surplus (if any) to the Contractor.
 - (c) Deduct all or any part of the moneys owing out of the security deposit or any sum due to the Contractor under the said agreement.
- (9) That except in the event of such default on the part of the contractor as aforesaid interest on the said advance shall not be payable.
- (10) That in the event of any conflict between the provisions of these presents and the said agreement the provisions 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 here-in-before expressly provided for the same shall be referred to the Employer whose decision shall be final and the provision of the Indian Arbitration Act for the time being in force shall apply to any such reference.

This guarantee shall remain valid and in full effect from the date of the advance payment under the Contract until _____ [name of Employer] receives full repayment of the same amount from the Contractor.

Yours truly,

Signature and Seal: _____
Name of Bank/Financial Institution: _____
Address: _____
Date: _____

*An amount shall be inserted by the Bank or Financial Institution representing the amount of the Advance Payment, and denominated in Indian Rupees.

Physical Completion Certificate

Name of Work:.. Construction of Administrative /IT/ITES complex adjoining crystal IT park, Khandwa road Indore i/c all allied works like HVAC, Electrical, Lift, Plumbing, Fire fighting, Landscape, STP, BMS, Outer development etc

Agreement No. **Date**

Amount of Contract Rs

Name of Agency:.....

MB No.....

Last measurement recorded on date

Certified that the above mentioned work was physically completed on (date) and taken over on (date) and that I have satisfied myself to best of my ability that the work has been done properly.

Date of issue

Executive Engineer
MPAKVN (I) Ltd., Indore

Annexure-V

(See clause 34 of Section 3 -GCC)

Final Completion Certificate

Name of Work: Construction of Administrative /IT/ITES complex adjoining crystal IT park, Khandwa road Indore i/c all allied works like HVAC, Electrical, Lift, Plumbing, Fire fighting, Landscape, STP, BMS, Outer development etc. including 3 yrs Integrated property management (operation and maintenance)

Agreement No. **Date**

Name of Agency:.....

MB No.....

Last measurement recorded on Date

Certified that the above mentioned work was physically completed on (date) and taken over on (date).

Agreed amount Rs

Final Amount paid to contractor Rs.....

Incumbency of officers for the work

I have satisfied myself to best of my ability that the work has been done properly.

Date of issue

Executive Engineer
MPAKVN (I) Ltd.,Indore

Salient Features of Some Major Labour Laws Applicable

- a) **Workmen Compensation Act 1923:** - The Act provides for compensation in case of injury by accident arising out of and during the course of employment.
- b) **Payment of Gratuity Act 1972:** - Gratuity is payable to an employee under the Act on satisfaction of certain conditions on separation if an employee has completed the prescribed minimum years (say, five years) of service or more or on death the rate of prescribed minimum days (say, 15 days) wages for every completed year of service. The Act is applicable to all establishments employing the prescribed minimum number (say, 10) or more employees.
- c) **Employees P.F. and Miscellaneous Provision Act 1952:** The Act Provides for monthly contributions by the Employer plus workers at the rate prescribed (say, 10% or 8.33%). The benefits payable under the Act are:
 - i) Pension or family pension on retirement or death as the case may be.
 - ii) Deposit linked insurance on the death in harness of the worker.
 - iii) Payment of P.F. accumulation on retirement/death etc.
- d) **Maternity Benefit Act 1951:** - The Act provides for leave and some other benefits to women employees in case of confinement or miscarriage etc.
- e) **Contract labour (Regulation & Abolition) Act 1970:** - The Act provides for certain welfare measures to be provided by the Contractor to contract labour and in case the Contractor fails to provide, the same are required to be provided, by the Principal Employer by Law. The principal Employer is required to take Certificate of Registration and the Contractor is required to take license from the designated Officer. The Act is applicable to the establishments or Contractor of Principal Employer if they employ prescribed minimum (say 20) or more contract labour.
- f) **Minimum Wages Act 1948:** - The Employer is to pay not less than the Minimum Wages fixed by appropriate Government as per provisions of the Act if the employment is a scheduled employment. Construction of buildings, roads, runways is scheduled employment.
- g) **Payment of Wages Act 1936:** - It lays down as to by what date the wages are to be paid, when it will be paid and what deductions can be made from the wages of the workers.
- h) **Equal Remuneration Act 1979:** - The Act provides for payment of equal wages for work of equal nature to male and female workers and for not making discrimination against female employees in the matters of transfers, training and promotions etc.
- i) **Payment of Bonus Act 1965:** - The Act is applicable to all establishments employing prescribed minimum (say, 20) or more workmen. The Act provides for payments of annual bonus within the prescribed range of percentage of wages to employees drawing up to the prescribed amount of wages, calculated in the prescribed manner. The Act does not apply to certain establishments. The newly set-up establishments are exempted for five years in certain circumstances. States may have different number of employment size.
- j) **Industrial Disputes Act 1947:** - The Act lays down the machinery and procedure for resolution of industrial disputes, in what situations a strike or lock-out becomes

illegal and what are the requirements for laying off or retrenching the employees or closing down the establishment.

- k) **Industrial Employment (Standing Orders) Act 1946:** - It is applicable to all establishments employing prescribed minimum (say, 100, or 50). The Act provides for laying down rules governing the conditions of employment by the Employer on matters provided in the Act and gets these certified by the designated Authority.
- l) **Trade Unions Act 1926:** - The Act lays down the procedure for registration of trade unions of workmen and Employers. The Trade Unions registered under the Act have been given certain immunities from civil and criminal liabilities.
- m) **Child labour (Prohibition & Regulation) Act 1986:** - The Act prohibits employment of children below 14 years of age in certain occupations and processes and provides for regulations of employment of children in all other occupations and processes. Employment of child labour is prohibited in building and construction industry .
- n) **Inter-State Migrant Workmen's (Regulation of Employment & Conditions of Service) Act 1979:** - The Act is applicable to an establishment which employs prescribed minimum (say, five) or more inter-state migrant workmen through an intermediary (who has recruited workmen in one state for employment in the establishment situated in another state). The Inter-State migrant workmen, in an establishment to which this Act becomes applicable, are required to be provided certain facilities such as Housing, Medical-Aid, Travelling expenses from home up to the establishment and back etc.
- o) **The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 and the Cess Act of 1996:** - All the establishments who carry on any building or other construction work and employs the prescribed minimum (say, 10) or more workers are, covered under this Act. All such establishments are required to pay cess at the rate not exceeding 2% of the cost of construction as may be modified by the Government. The Employer of the establishment is required to provide safety measures at the building or construction work and other welfare measures, such as canteens, first-aid facilities, ambulance, housing accommodations for workers near the work place etc. The Employer to whom the Act applies has to obtain a registration certificate from the Registering Officer appointed by the Government.
- p) **Factories Act 1948:** - The Act lays down the procedure for approval of plans before setting up a factory, health and safety provisions, welfare provisions, working hours, annual earned leave and rendering information regarding accidents or dangerous occurrences to designated authorities. It is applicable to premises employing the prescribed minimum (say, 10) persons or more with aid of power or another prescribed minimum (say, 20) or more persons without the aid of power engaged in manufacturing process.

SCHEDULE 'X'

**INFORMATION REGARDING LITIGATION, DEBARRING/EXPELLING AND ABANDONMENT
DURING LAST THREE YEARS**

1. (a) Is the bidder currently involved in any litigation related to the contract works. YES/NO
(b) If yes, give details

2. (a) Has the bidder or any of its constituent partners been debarred/expelled by any department during the last three years. YES/NO
(b) If yes, give details

3. (a) Has the bidder or any of its constituent partners Failed to perform any contract work during the last three years. YES/NO

NOTE: - If any information in this schedule is found to be incorrect or concealed, application/tender will be rejected.

Signature of Bidder

PART – II- SPECIAL CONDITION OF CONTRACT

The specifications and contents laid down in the tender are for the “**Proposed Administrative / IT/ ITES Office complex by MP AKVN Indore, Near Crystal IT Park, Indore**” the Facility is to be developed for state of the art Office Complex Building Project, it is being constructed with most modern technology adopting the advanced energy efficient system. Green Building Features incorporated in this Building are-

- Energy efficient glass
- Use of Energy efficient fixtures
- Use of water efficient fixtures
- Sewage treatment plant
- Rain water harvesting system
- Energy efficient air conditioning system
- Indoor air quality (IAQ) to meet ASHRAE 62.1-2007 standards
- Roof insulation material with R values better than ASHRAE 90.1-2007
- Use of Low VOC paints, coatings, adhesives and sealants

The entire construction Work shall be based on MP PWD SOR, NBC ,MORTH specifications, relevant IS codes etc and GRIHA/IE/ISHREA/ASHREA and the local norms.

The system will be catering to a most modern building accordingly the system offered shall be suitable for continuous trouble free operation to meet with any unforeseen and unwanted emergency. The project has been designed with the aim of demonstrating superior envelope design to minimize the heat gain and reducing consumption of energy by using energy efficient systems.

The special conditions shall be read in conjunction with General conditions of contract.

1. ENGINEER, ENGINEER'S REPRESENTATIVE

Architect/ PMC/ SQC consultant shall be appointed and be responsible to the Engineer-in-charge and shall carry out such duties and exercise such authority as may be delegated to him by the Engineer-in-charge.

2. References

Applicable Local Codes as approved by Government of M.P. and National Building Code as applicable including all amendments up to tender closing date. In case of conflict, the more stringent requirement will apply unless ruled otherwise by the Engineer-in-charge.

3. Codes

Applicable Local Codes as approved by Indian standards(IS) and in the absence of definite provision on particular issue in the specification/codes, reference may be made to relevant latest International Codes recommended to be used and good engineering practices duly approved by Engineer-in-charge.

- 4. Though the drawings for tender purpose has been uploaded along with tender document. In case of any problem in downloading the drawings, the CD of the tender drawings can be collected from AKVN office after providing receipt of cost of tender document for online purchase of document.**

5. Contractor's Mandatory Obligation:

1. At the time of quoting bid price , bidder shall ascertain the design criteria and calculation included in the Bid Document and satisfy itself regarding their accuracy and adequacy. Contractor shall meet the design and sizing requirements specified in the Bid Documents and prevailing codes. Further if Contractor believes that the design and sizing requirements specified are not adequate to meet the performance requirements specified/ mentioned in prevalent codes and practices, then Contractor shall make whatever upward adjustments to the design and sizing it deems necessary to meet the performance requirements and include these in the bid price. Contractor assumes full responsibility for meeting the specified performance requirements and ensuring the adequacy of the work for this purpose." No extra payment shall be made on account of any upgradation or revision".
The Contractor shall submit the design and drawing for final approval to consultant there on approved by PMC/ Engineer In-charge.
2. Any item /component which is left out in calculation / design drawings but an integral part of building system , it is to be executed at the quoted rates & no extra payment shall be made .
3. With in 3 months from the award of the work, bidder shall submit all required designs/ shop drawings/revisions, if any etc for approval to the Consultant /PMC / engineer in charge.
4. If any item mentioned in the BOQ is revised on demand of AKVN, then extra payment for difference in cost shall be adjusted (addition or deduction) as per percentage rate quoted by the bidder in case of SOR item or based on rate analysis approved by PMC/AKNV.
5. If any new item which is not mentioned in the BOQ is to be executed on demand of AKVN, then extra payment shall be made as per percentage rate quoted by the bidder in case of SOR item or based on rate analysis approved by PMC/AKNV.
6. The work includes four year defect liability period after successful physical completion of the work. Initial one year defect liability period will include all cost of operation & maintenance of the system in the quoted rates including all consumables, repairs , replacement, manpower etc to run the system smoothly except cost of water , electricity & Govt duties. For further 3 years defect liability period, the agency shall have to quote the rates for 1st, 2nd & 3rd year for operation and maintenance as per BOQ . Quoted rates shall include all cost of operation & maintenance of the system including all cost of consumables, repairs ,spares, replacement, manpower etc to run the system smoothly except cost of water , electricity & Govt duties.
7. Testing of all equipments like HVAC, electrical , Fire etc shall be done according to prevailing codes and specifications and shall be got approved by concerning Electrical / Fire Inspector before commissioning.
8. The agency shall have to handover the building after 3 years of O&M with all civil, mechanical, electrical etc equipments in running and good conditions.
9. AKVN may employ separate agency for housekeeping & security services after physical completion of the work . Though , housekeeping & Security of the system in scope of work of the bidder shall be responsibility of the bidder only.
10. No lead and lift , at any floor, shall be payable for any supply and installation of any item /work/equipment/ system/manpower etc unless specified. All taxes and duties, transportation, or any other charges shall be inclusive in quoted rates and no extra payment shall be given on this account.
11. Drawings and General guidelines for package wise quantities are provided along with tender document and payments shall be made to the contractor on the basis of the package wise mode of payment mentioned in tender document based on general guidelines for quantities

and drawings provided with tender document. Any variation in quantities from general guidelines +/- 2% of finished work (actual work done) shall be paid/ deducted accordingly.

12. If there is any difference between rates quoted in words and in figures in the tender form by the contractor, the lesser amount will be treated as valid. If the contractor is not ready to accept the amount so fixed in the above manner and declines to do work, earnest money deposited by the contractor shall be forfeited.

6. Bar Bending Schedule

The contractor shall prepare bar bending schedule from the detailed RCC working drawings supplied by Architects for execution of work and nothing extra shall be paid on this account. Three copies of such bar bending schedule shall be made available to the Engineer for his approval before casting of concrete and effecting payment of reinforcement. Engineer has power to withheld the payment for reinforcement and concrete laid without approval of bar bending schedule.

7. Safety Measures

It shall be the sole responsibility of the Contractor to ensure all safety measures giving proper prior notices etc. and obtaining prior permission from concerned local authorities as per bye-laws or directions issued by them all at his own cost. No claim of the contractor in this regard shall be entertained. Contractor should have given Three days training program on Personal Protective Equipment (PPE) for labours before execution on site to avoid violence of safety measure at site. Contractors should provide reflective jackets to labours along with valid entry pass. Which is duly sign by contractors safety officer.

8. Statutory Approvals

Contractor is responsible for obtaining all statutory approvals required for successful completion & operation & maintenance of the project including Diesel and Petrol storage explosive approval, Sewage Treatment, during construction and thereafter .Necessary liaisoning to be undertaken wherever required with no extra claim. All the approvals shall be taken before the scheduled completion period /O&M and in any case before the work can be taken over.

9. Design Mix

Contractor is required to submit his design mix for various grades of concrete for approval of Engineer-in-charge keeping in view the requirement stipulated in the technical specification and relevant codes.

10. Sub-Standard Materials

Any material/item/fitting/fixtures rejected by the Engineer shall be removed from the site within 24 hours of issue of instructions to this effect by the Engineer-in-charge. Failing this, the Engineer-in-charge shall have the rights to get these so removed and the Contractor shall have no claim whatsoever in this regard. He will be not charged for this work.

11. Sign Board

Contractor will arrange to fabricate and erect sign board at his own cost showing name of work, name of Owner, name of Architect/Consultants, date of commencement& Target date of completion in front of work site. contractor should display the scrap yard, go downs,

storage yards etc. size of board shall be 8' x 12' or as approved by Engineer-in-charge. Location will be decided on approved plan submitted by the contractor.

12. Responsibility For Procurement

Sole responsibility rests with contractor for procurement of all materials required for completion of work within the stipulated time. Any delay in the procurement may attract the penalty as Decided by Engineer-In-Charge. Storage of materials in such a manner as to facilitate rapid and easy execution, checking and control

13. Removal of Plant and, Equipment from Site

All materials, tools, tackles plant and equipment brought to the site by the contractor, shall not be removed from the work site without written permission of the Engineer-in-charge.

14. Covering up of Contract Works

- I) No part of the contract works shall be covered up without the approval of the Engineer-in-charge and the contractor shall make arrangement for examination and inspection by the Engineer-in-charge.
- II) The Contractor shall give due notice to the engineer-in-charge about the works to be covered up for their measurement and examination. The engineer-in-charge shall within a reasonable time attend for the purpose of examining such work.

15. Inspection and Testing

- I As and when required by Engineer-in-charge, the contractor shall provide all facilities for inspection of contract works and materials at his own cost.
- II All materials shall be of highest standard, quality and kind. All requisite Tests as per Tender stipulations are to be carried out by the contractor at his own cost and results submitted to the engineer-in-charge. 10 % test should be carried from govt engineering collage / well established NABL approved labs. All test are to be carried out under electronic Surveillance & records of test to be submitted by the contractor in the form of CD's also.
This, however, does not absolve the contractor from his responsibility for the overall quality, kind, strength and stability of the structures.

16. Site Order Book

The contractor shall maintain a site order book at site of the work. Any special orders and instructions to be issued to the contractor at site will be recorded in this book which will be numbered and initialled by the PMC/Engineer/Engineer-in-charge. The contractor will however sign all the orders as a token of information received by him and take action accordingly.

17. Specifications

Those items for which detailed specifications have not been included in the contract document shall be executed as per relevant Local Specification approved by Govt, I.S. or as mentioned in the respective specification of respective utility services like air-conditioning, fire-fighting, mechanical purpose etc. covered under the scope of this contract or as per the Standard Construction practices and/or as per the instructions/ suggestions of the PMC/ Engineer-in-charge

18. RELATIONSHIP :

The contractor shall not be permitted to tender for work in the AKVN, if his near relative is posted in the Nigam. He shall intimate the names of persons who are working in any capacity or subsequently employed by him and who are near relative to any staff/officer in the AKVN. Any breach of this condition, by the contractor would render his tender/contract void.

Note: By the term near relative is meant wife, husband, parents and grandparents, brothers and sisters, children, uncles and their corresponding in laws.

19. Taxes: All duties and taxes including Commercial Tax, VAT, Works Contract Tax, Service Tax, TDS, Octroi, Duties, Royalties and any other direct or indirect taxes and duties levied or to be levied by the Central Government, State Government, Local Bodies and any other Government agency or private individuals on the contractor's work are inclusive in the contract/tender price of this tender and such taxes and duties will borne and paid by the contractor. If the obligation to pay such tax to the exchequer is on the authority, such taxes and duties shall be deducted from the contract/tender price and deposited/paid by the. It is clarified that the burden/incidence of all such taxes and duties are on the contractor. The list given in the clause is an illustrative list and not the exhaustive list.

a) The contractor has to get himself registered regarding the service tax with the Commissioner, customs central excise & service tax, Govt. of India as per rules applicable.

b) Service Tax :

Civil construction work is taxable under Service Tax Rules, service tax rates at present are 14.5 % on the value of service charges portion where material cost and service charges shown separately in the bill, if consolidated amount so raised in bills shall be chargeable @5.6% over bill amount.

If service provider is Individual, HUF, Proprietor or Partner, as per reverse charge mechanism 50% of service tax shall be payable by the AKVN and 50% shall be payable by the service provider, in such case Service Tax liability arises over AKVN (@2.8% of total amount) shall be taken in calculation of financial proposal comparisons.

If service provider is other than Individual, HUF, Proprietor or Partner, all service tax liabilities shall be discharged by the service provider, and service tax shall deemed to be inclusive in bidders rate.

Above provisions are subjected to amendment in current service tax rules and may be amend accordingly.

20. Fair wages: The contractor shall pay not less than fair wages to labourers engaged by him on the work

21. Removal of undesirable persons: The contractor shall on receipt of the requisition from the Engineer-in-Charge, at once remove any person employed by him on the work who in the opinion of the Engineer-in-Charge is unsuitable or undesirable.

22. Amount due from contractor: Any amount due from the contractor on any account concerning work may be recovered from him as arrears of land revenue.

23. The contractor shall be exclusively liable for payments relating to or arising out of any law relating to PROVIDENT FUND or any other law requiring deductions of any amount from the wages of any employee of the making of any/ contributing by any employer and the contractor shall promptly and punctually comply with all the legal requirements including registration with the concerned

authority and submit to M.P. Audyogik Kendra Vikas Nigam (I) Limited a certificate/receipt from the concerned authority to show that a full payment of the liability has been made by the contractor as required by the law.

24. Gatekeepers & Watchmen

The Contractor shall provide, maintain at his own expense gatekeepers and watchmen to ensure at all times effective protection of the works, materials and workmen, until completion of the project including operation and maintenance, at his own risk and cost, at all Entry & Exit points. Once building become operational after physical completion of the work, AKVN may appoint the separate housekeeping and security agency, however, for housekeeping and security of the whole system under scope of work of construction agency shall be responsibility of the bidder i.e. construction agency

25. Vehicle Entry systems

Contractor should have valid Entry pass for incoming & outgoing vehicle signed by the safety officer of Contractors duly signed by Engineer's representative. Driver should have valid license from competent authority, No Unauthorized Vehicle should enter into the premises.

26. Deployment of labours

- a. The Contractor shall keep complete and accurate records of the employment of labour at the Site. The records shall include the names, ages, genders, Permanent address. These records shall be summarized on a monthly basis and submitted to the Engineer-in-charge.
- b. Contactor can deploy only those labour which have gone through safety Induction & Police verification process & should have valid I.D. proof issued by Contractor.
- c. Contactor should have made proper hutments for the labour at out side the high security zone .No Hutment or any type of temporary construction shall be allowed with in premises

27. Project Meetings

- I Attend project meetings at times and locations approved by Engineer.
- II Notify participants of meetings.
- III PMC/Engineer's representative shall record minutes of meetings and distribute to participants within 3 Days.

28. Setting Out of Work

- I Assume full responsibility for and execute complete layout of work to locations, lines and elevations indicated.
- II Provide devices needed to layout and construct work.
- III Supply stakes and other survey markers required for laying out work.

29. Location of Equipment and Fixtures

- I Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.

- II Locate equipment, fixtures and distribution systems to provide minimum interference and maximum useable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
- III Inform Engineer of impending installation and obtain his approval for actual location.
- IV Submit field drawings to indicate relative position of various services and equipment when required by Engineer-in-charge.

30. Billing Documents

- I Following documents shall be enclosed by contractor along with submission of each bill otherwise the same shall not be accepted by Engineer-in-charge for checking a certification of payment:
 - a) Monthly progress reports in the format as approved by Engineer-in-charge.
 - b) Cube test etc reports in Quality Assurance plan.
 - c) All the information/documents contained in Quality control plan
 - e) Copies of bills and royalty for the materials procured at site.
 - f) Any other document / Reports as required by engineer-in-charge in approved format

31. Brand Name

The specific reference in the Specifications and documents to any material by trade name, make or catalogue number shall be construed as establishing standard or quality and performance and not as limited competition.

32. Co-ordination Between Agencies

It shall be the Contractors responsibility to ensure complete co-ordination between works of various agencies such as Civil, Electrical, HVAC, Utilities, Plumbing with GRIHA consultants etc. Contractor shall be deemed to have considered this aspect carefully.

33. Site Meetings

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

34. Operation & Maintenance Manual

Maintenance manuals, product catalogues, all warranties and guarantees against each section of work shall be submitted hardbound in Triplicate As well as in soft on completion as directed by engineer-in-charge. It is the responsibility of the contractor to operate & maintain the following systems for 3 years O&M after 1 year defect liability period-

- 1) Building
- 2) H.T/L.T. Substation
- 3) D.G.Sets
- 4) HVAC System
- 5) Fire fighting system
- 6) C C TV

- 7) Electrical
- 8) Plumbing
- 9) BMS
- 10) Landscape etc as mentioned in scope of work..

35. TEMPORARY FACILITIES TO BE PROVIDED BY THE CONTRACTOR.

Site office :

Construct and maintain site offices covering approx. 1,200 sq .feet of plinth area, with general specifications. This area shall cater for Employer's officials / Consultants / Conference Rooms / Toilets / Pantry etc.

36. HOUSE KEEPING

General

1. Conduct cleaning and disposal operations to comply with local guidelines and anti-pollution laws.
2. Store volatile waste in covered metal containers and remove from premises at the end of each working day.
3. Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.

Materials

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

Cleaning During

1. Provide on-site containers for collection of waste materials and debris.
2. Dispose of waste materials and debris off site.
3. Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

Final Cleaning

1. Remove grease, dust, dirt, stains, labels, fingerprints and other foreign materials, from interior and exterior finished surfaces including glass and other polished surfaces.
2. Clean lighting reflectors, lenses and other lighting surfaces.
3. Broom clean paved surfaces: rake clean other surfaces of grounds.
4. Remove debris and surplus materials from crawl areas and other accessible concealed spaces.

37. CONSTRUCTION PHOTOGRAPHS

1. General:

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

2. Progress Photographs:

- I. Sizes: 200x300mm.
- II. Type: Gloss and colour.

- III. Paper: Single weight, unmounted.
- IV. Number of prints required: 2 sets.
- V. Identification: Typewritten name and number of project and date of exposure on 25x50mm white patch in upper right hand corner.
- VI. Viewpoints: Interior and exterior location: viewpoints determined by Engineer.
- VII. Frequency: Monthly with progress statement.

3. **Final Photographs**

- I. Sizes: 200x300mm.
- II. Type: Gloss and colour.
- III. Paper: Single weight, unmounted.
- IV. Number of prints required: 3 sets.
- V. Identification: Typewritten name and number of project and date of exposure on reverse side.
- VI. Number of viewpoints:
 - a Each side of buildings for total of 4 for each building.
 - b Interior of rooms and finishes for total of 8 for each building.
 - c Locations of viewpoints determined by Engineer.

38. SPECIAL CONDITIONS OF CONTRACT FOR MEP-

- 1) Plumbing, Sanitary, Electrification & water proofing work shall be conducted by only specialized agency after approved by PMC/Engineer-in-Charge. Electrification work will be conducted by only License holder Agency.

For Water Proofing & Termite treatment the contractor shall get the material verified by the authorities, and use the same for execution at site, stage-wise, all such material release dates needs to be recorded, as the product shall give Ten Years performance Guaranty.

- 2) The location of the MEP drawings, indicated in the drawing is only indicative. The actual route of MEP Pipe line, duct, Cable tray, wire, and lighting may differ from the plans according to the details of the building construction and the conditions of executions of the installations.

The contractor shall supply and install at his expense all secondary materials and special fittings found necessary to overcome the interference and to supply the modifications on the route of MEP Pipe line & duct that are found necessary during the work, to the complete satisfaction of the EIC/Consultants.

3) SHOP DRAWINGS –

- a) The contractor shall prepare and submit to the EIC/Consultants for his approval five (5) sets of GA drawings/detailed layout drawings of all MEP equipment's and piping, ducting, Cable tray, Point Wiring layouts.
- b) He shall prepare shop drawings incorporating the details given by manufacturers for the items included in the contract and any other items which need to be coordinated for interfacing.
- c) Before starting the work, the contractor shall submit to the EIC/Consultants for his approval in the prescribed manner, the shop/execution drawings for the entire installation.

- d) The EIC/Consultants, reserves the right to alter or modify these drawings if they are found to be insufficient or not complying with the established technical standards or if they do not offer the most satisfactory performance or accessibility for maintenance. Contractor shall supply in four (4) sets of all approved shop drawings for execution.

Shop drawings shall be submitted under the following conditions:-

- Large scale drawings showing fixing detail of fixtures, equipment and showing co-ordination with other services.
- Showing any change in layout in the MEP drawings.
- MEP layout, piping and ducting layout.
- Manufacturer's or Contractor's fabrication drawings for any materials or equipment supplied by him.
- The contractor shall submit four copies of catalogues, manufacturer's drawings , equipment characteristics data or performance chart as required by the Engineer-in-Charge.

- 4) Shop Drawings to be provided by the Contractor-

List of Shop Drawings			
Sr. No.	Description	Number of set	Paper size
A	Electrical + IBMS		
1.0	Point Wiring + Circuit Wiring	5	A-2 or A-1
1.1	Load Schedule + Wire Size Details		
1.2	Conduiting Drawings		
1.3	Typical section details for Conduiting + Wiring		
1.4	Switch Board Schedule + Details		
2.0	Cable Tray & Cabling Work	5	A-2 or A-1
2.1	Cable tray layout with Level & supports details		
2.2	Cable Schematic with sizes & Shaft Location		
3.0	Earthing	5	A-2 or A-1
3.1	Earthing layout with pits location & Installation details		
3.2	Earthing Strips Routing Layout, Size & Schedule		
3.3	Earthing Schematic Layout		
4.0	Lighting arrester & aviation Light Mounting Details	5	A-2 or A-1
5.0	Mounting Details or DG, Transformer, HT Breaker, Main LT Panel & Pedestal , Trench & Sectional Details of All Equipments Room	5	A-2 or A-1
6.0	LT Panel GA Drawing, Control wiring details, Logic Details	5	A-2 or A-1
7.0	Floor Layout, Schematic Layout, Looping drawing, Cable Tray & Cabling of FAS, CCTV, PA, BMS	5	A-2 or A-1
8.0	Data, Telephone layout	5	A-2 or A-1
9.0	GA drawing of All Equipments	5	A-2 or A-1
B	HVAC		
1.0	Each Floors Ducting, Chilled Water, Condenser Water, Drain Piping, Valves, Grills/Diffuser, Damper, Insulation Routing, sizing, Location & Typical Sectional Layout with typical supporting details & Levels	5	A-2 or A-1

2.0	Mounting with Pedestal Details of Equipments:-Chillers, Pumps, AHUs, Ventilation Fans, Cooling Towers, Stair & Lift Pressurization fans	5	A-2 or A-1
h3.0	High side & Low side Schematic Details of Chilled Water & Condenser Water	5	A-2 or A-1
4.0	Schematic Drawing of vertical Riser of Toilet Exhaust & Stair case pressurization Ducting with supporting details & Sizing	5	A-2 or A-1
5.0	GA drawing of All Equipments	5	A-2 or A-1
C Plumbing			
1.0	All Floor toilet details layout with invert level (Piping routing, sizing, sectional details)	5	A-2 or A-1
2.0	Rain Water Piping routing with Slope, level & Khurra Mounting details	5	A-2 or A-1
3.0	Schematic Drawing of Water supply (Domestic & flushing) & Drainage (Soil & West)	5	A-2 or A-1
4.0	Mounting with Pedestal Details of Equipments:- Pumps, Filter	5	A-2 or A-1
5.0	Pumps Room Arrangement with sectional Details	5	A-2 or A-1
6.0	External drainage, rain water Channel / Piping routing , invert level with respective existing Level	5	A-2 or A-1
7.0	GA drawing of All Equipments	5	A-2 or A-1
D Fire fighting			
1.0	All Floor sprinkler Location , Piping routing , Valve location layout with level	5	A-2 or A-1
2.0	FHC Details & Sectional Details	5	A-2 or A-1
3.0	Mounting with Pedestal Details of Equipments:- Pumps	5	A-2 or A-1
4.0	Pumps Room Arrangement with sectional Details	5	A-2 or A-1
5.0	External Hydrant Piping Routing with mounting details drawing	5	A-2 or A-1
6.0	Schematic Drawing	5	A-2 or A-1
7.0	GA drawing of All Equipments	5	A-2 or A-1

do all drilling and cutting of walls or other elements of the

building for the complete and proper installation of the pipe lines and other equipments by using electrically operated tools. Manual drilling or chiseling shall be permitted on special request only.

Beams, girders and other principal structural members shall not be cut or drilled unless prior permission has been granted by the EIC/Consultants. If such drilling and cutting are made on finished surfaces, any marring of the surfaces shall be made good by repair at the Contractor's expense.

All chases and openings made by the contractor for his pipe lines/fixtures shall be filled /covered over with cement plaster and finished in reasonable manner.

Before rough plastering on the pipe surfaces the concealed pipes shall be secured to the wall by using proper supports/clamps/chicken mesh. No extra payment shall be made for these.

5) REJECTION OF DEFECTIVE EQUIPMENT

- a) If the completed system or any portion thereof before it is taken over is found defective or fails to fulfill the intent of the specifications, the Contractor shall on receipt of notice from the PMC/ AKVN forthwith make defective system good. Should he fail to do so within a time considered reasonable by the AKVN, the AKVN may reject and replace at risk, and expense to the Contractor, the whole or any portion of the system, which is defective or fails to fulfill the requirement of the contract.
- b) The AKVN shall have the right to operate all equipment, if in operating condition, whether or not such equipment has been accepted as complete and satisfactory.

6) ERECTION

This specification provides for the complete erection including minor civil works like wall cutouts for pipes/duct etc. The Contractor shall make good and repair all damages to the building, property, equipments and articles, what so ever arising from the erection of the equipment. The Contractor shall indemnify and hold harmless the AKVN against all claims in respect of injury to any person how so ever arising out of the erection of the equipment in the course of such installation.

7) INSPECTION DURING ERECTION

The AKVN is at liberty to inspect the work during installation & the Contractor free of cost shall remedy defects found. The Contractor shall furnish all instruments & services needed for the tests. Any defects and deficiencies that are noticed during this inspection will have to be attended by the Contractor from time to time.

- 8) The PMC/ EIC reserves the right to request inspection and testing at manufacturer's works at all reasonable times during manufacture of items for this contract. Tests on site of completed works shall demonstrate, among other things:

That the equipment installed complies with specification in all particulars and is of the correct rating for the duty and site conditions.

That all items operate efficiently and meet the specified requirements.

The contractor shall provide all necessary instruments and labour for testing, shall make adequate records of test procedures and readings, shall repeat any tests requested by the EIC/Consultants and shall provide test certificates signed by a properly authorized person. Such test shall be conducted on all materials and equipments and on completed work as called for by the EIC/Consultants.

If it is proved that the installation or part there of is not satisfactorily carried out then the contractor shall be liable for the rectification and retesting of the same as called for by the EIC/ Consultants at the cost of the contractor. The EIC/ Consultants decision as to what constitutes a satisfactory test shall be final.

The above general requirements as to testing shall be read in conjunction with any particular requirements specified elsewhere. All tests shall be carried out by a test house approved by the EIC/Consultants.

Rating of all items shall be appropriate for the conditions on the particular site on which the item will be used. All the equipment shall be fit for continuous work under the most severe conditions of site.

9) TRAINING OF PERSONNEL-

The tenderer shall undertake to extend free training in operation and maintenance of system offered by them to two technical persons of AKVN at their works for a period of 15 days at the site of AKVN. The choice of dates for training is to be decided in consultation with the AKVN.

- 10) After completion of the entire work, test report should be submitted to the Competent Authorities of M.P.P.K.V.V. Co. Ltd. and M.P. Licensing Board and also to the PMC/ Engineer in Charge and NOC is to be obtained from M.P. Licensing Board and submitted to the Competent Authorities of M.P.P.K.V.V. Co. Ltd. and AKVN.
- 11) The contractor shall prepare and produce instruction, operation and maintenance manuals with warranties and guarantees in English for the use, operation and the maintenance of the supplied equipment and installations, and submit to the Engineer in-charge in (8) copies at the time of handing over. Generally these consist of the following:
- a. Description of the project
 - b. Operating instructions
 - c. Maintenance instructions including procedures for preventive maintenance
 - d. Manufacturer's catalogues
 - e. Spare parts list
 - f. Trouble shooting charts
 - g. Drawings
 - h. Type and routine test certificates for major items
 - i. One (1) set of reproducible 'as built' drawings on polyester film
 - j. Warranties and guarantees of Installed Plant and Equipment and other work like waterproofing, Anti Termite treatment of the soil
- 12) All electrical installation shall be properly earthed and grounded. Good quality cable shall be used and as far as possible avoid joints in the cable. Water shall not be allowed to accumulate near electrical installations.
- 13) At the time of construction, cables shall not run on floor. Cables shall be routed through sufficient height to avoid any obstruction. Any joints in the cable shall be properly insulated. Electrical cables shall not run or placed on metal body or pipe scaffolding.
- 14) Only PVC body drill machine shall be used on site. Switch boxes or switch boards shall be properly fitted and should not lie on floor. Do not overload switch. Provide switches of required capacity.
- 15) Welding Activity
- The welding machine and its accessories should be in good working condition.
 - Proper earthing shall be provided to the welding machine and the job.
 - The work area and its surrounding shall be made free from any flammable or combustible materials.

- The welder shall use helmet, leather hand gloves, shoes, welding screen, welding goggles and safety belt when working at height.
- The area of work and its surrounding shall be cordoned off or free from any other activities.
- Fire extinguishing medium like fire extinguishers, water or sand must be available at the working place.
- The electrode buds should be collected at one place and disposed off.
- After completion of the job switch off the power of the welding machine and inspect the area to ascertain the area is safe. The welding cable and the earthing cable should be removed, rolled and should be kept in proper place along with welding machine.

16) Gas Cutting Activity

- The gas cylinder shall be carried in a trolley.
- The rubber hose fitted to the gas cylinder shall be of good quality and sufficiently long.
- The gas cylinder shall be fitted with gas regulator and pressure gauges which must be in good working condition. Non return valve shall be provided on the gas cylinder to prevent back fire.
- All the joints on gas cylinder, gas cylinder valves, gas holder connection, gas rubber hose joints etc shall be free from any type of leakage.
- The operator shall wear helmet, hand gloves, safety goggles, shoes etc while carrying out the activity. While working at height safety belt shall be used. The operator shall use gas lighter to light the gas.
- The work place and its surrounding areas shall be free from any flammable or combustible materials.
- The gas cylinder shall be kept away from any hot object.
- The gas hose shall be kept away to prevent any contact with the hot falling material.
- The area below and its surrounding shall be free from any other activity or cordoned off.
- Fire extinguishing medium like fire extinguishers, water or sand shall be available at the work place.
- After completion of the job close the valve of the gas cylinder and discharge the gas from the gas hose. Keep the gas cylinder and gas pipe in a proper place.

17) Lifting / Erection of Heavy Equipment

- The contractor shall produce test certificates approved by certifying authorities for all its lifting gear and hoists (slings, chains, hooks, D-shackles, chain pulley, winches, hoist, ropes, crane, hydra etc) to the PMC/AKVN engineer before being brought to site or before putting into use. A copy of the test certificates shall be submitted to the PMC/ Engineer.
- Proper capacity lifting gears shall be used to for lifting the equipment.
- Only trained operator shall operate the lifting machine and shall take signal from authorized signal man.

- No equipment shall be kept suspended at a height on lifting machine without providing proper supports and fasteners.
- The people on site shall be alerted while lifting activity is carried out or cordon off the area.
- Lifting and lowering of load shall be carried out without any jerks.
- While carrying the load from one place to another ensure that load does not swing.
- The load to be lifted shall be properly tied to avoid any fall of load.
- Proper access shall be provided to the people to reach the working the working place.
- No load shall be lifted beyond its safe working load.
- Lifting or erection activity shall be carried out under proper supervision.
- Workers engaged in the work activity shall wear hand gloves, shoes to prevent any injury to hands and foot.

18) Notes for Fire Safety

- Before carrying out any hot jobs the contractor shall clear any flammable or combustibles materials in the surrounding areas of the work.
- Oil spillage or drips shall be cleaned immediately.
- Oil soaked cotton rags or waste shall be disposed off in a safe manner.
- Flammable materials shall be stored in an isolated place in a well ventilated area.
- Smoking is prohibited in fire prone areas.
- Proper earthing shall be provided to all electrical installation and grounded.
- Gas cylinders shall be stored in a proper place.
- Fire extinguishers of various types and in sufficient numbers shall be kept at appropriate place to deal with any fire. Also water storage arrangement shall be made at site.
- Trained persons to operate the fire extinguishers shall be available at site. Access to fire extinguishers and electrical installations shall be free from any obstructions. Carbon dioxide type fire extinguishers shall be kept near electrical installation.

- 19) All precautions shall be taken to identify and pre-empt any and all situations that can cause accidents, with a particular attention to major or main causes like Gravity, Electricity, Compressed air etc. peculiar to the nature of work in progress including of other contractors in the vicinity.

41. INSURANCE CONTRACT CONDITIONS CONTRACTOR'S LIABILITY & INSURANCE-

From commencement to completion of works, the Contractor shall take full responsibility for the care of the work & for taking precautions to prevent loss or damage to the work to the maximum extent possible & shall be liable for any damage or loss that may arise to the works or any part thereof from any cause whatsoever including causes of lighting **explosion, earthquake**, storm, hurricane, floods, tempest, fire, inundation, subsidence, landslides, rock slides, riots (excluding civil war, rebellion, revolution & insurrection) but further including the failure of the design, the failure or omission to recognize properly & accurately the substrata of the design or any latent defect & shall at his own cost repair & make good the

same so that at all times the work shall be in good order & condition & in conformity in every respect with the requirements of the Contract. The original insurance will be handed over to the AKVN.

For the purpose of this condition, the expression 'from the commencement of the work' shall mean the time commencing from the issue of the acceptance letter to the Contractor and ending with the expiry of defects liability period provided in the Agreement.

- a) Without limiting the obligations and responsibilities under this condition, the Contractor shall insure and keep insured the works from commencement to completion, as aforesaid, as increased by 25% against the risk of loss or damage from any cause whatsoever including the causes enumerated in the foregoing Clause (a), in the event of there being a variation in the nature and extent of the works, the Contractor shall from time to time increase or decrease the value of the insurance correspondingly.
- b) If the Contractor has a blanket insurance policy for all the works to be executed by him, and if the policy covers all the items to be insured under the condition, the said policy shall be assigned by the Contractor in favour of the AKVN provided however that if any amount is payable under the policy by the insurers in respect of the works other than the work under the Contract, the same may be recovered by the Contractors directly from the insurers.
- c) The Contractor shall at all times indemnify and keep indemnified the AKVN against all losses, claims, damages or compensation under the provisions of the payment of the Wages Act 1936, Minimum Wages Act 1948, Employer Liability Act 1938, Workman's Compensation Act 1923, the Maternity Benefit Act 1961, the Bombay Shops and Establishment Act 1947, Industrial Disputes Act 1947, & Contract Labour (Regulation & Abolition) Act 1970 and Employees State Insurance Act 1948 or any modification thereof or any other law relating thereto and rules made there under from time to time or as a consequence of any accident or injury including death to any workman or other person in or about the work and also against all costs, charges and expenses of any suit, action or proceedings whatsoever out of such accident or injury or combination of any such claims.
- d) Before commencing the work, the Contractor shall without limiting his obligations and responsibilities under this condition, insure against any loss of life or injury to any personnel in the employment of Contractor.
For this purpose, Insurance shall be taken by the Contractor. Such Insurance shall be taken to include both employees/workmen covered by the Workman's Compensation Act 1923, as well those employees /workmen not covered by the said Act. Separate insurance policies may be taken for employees/ workmen covered by Workman's Compensation Act 1923, and employee's workmen not covered by the said Act. The Contractor shall pay all the premia. Policy/Policies taken The Contractor shall provide AKVN with documentary evidence from time to time, that he has taken over all the insurance policies mentioned in the foregoing paragraphs and that he has paid the necessary premia for keeping the policies valid till the expiry of the defects liability period.
- e) No work shall be commenced by the Contractor unless and until he has obtained the insurance or insurance's required to be obtained by him under or by the foregoing clauses and no work shall be carried out or continued by the Contractor unless and until each insurance is current and valid at that time. The Contractor, for the payment of the premia shall furnish all the receipts in original along with two photocopies thereof, to the AKVN. The original receipts will be returned to the Contractor after verification. The AKVN reserves the right for payment on works done subject to fulfillment of this condition & shall instruct the Consultants accordingly.

- f) In the event of any claim for insurance becoming due on account of any eventuality covered by the respective insurance policy/policies, the Contractor shall reinstate the installation, replace the materials or equipments or pay compensations to the affected personnel / Employees without waiting for settlement of the claim from insurance company.

42. GRIHA RATING

This project is to be designed taking in to consideration that “The GRIHA rating system is to be followed to ensure achievement of at Least 2 star rating, as applicable for this complex”

The following points to be completed by the bidder during execution:

1. Contractor has to fulfill all the requirements mentioned in the various Criteria's in the GRIHA Version 3 for the desired rating level. Criteria's that have to be fulfilled by the contractor for work:
 - Contractor should provide 'Construction Time Schedule' & 'Waste Minimization plan' for overall activity of the project before starting construction. Detailed chart highlighting the 'type of activities with respect to time schedule' in conjunction with seasonal variations.
 - Preventing air pollution during construction has to be practiced as per GRIHA requirement. Barricades & Dust screens have to be used for the same wherever needed. Contractor should follow below stated methods
 - Identify roads on-site that would be used for vehicular traffic.
 - Upgrade vehicular roads during construction (if these are unpaved) by increasing the surface strength by Improving particle size & shape that make up the surface and base.
 - Add surface gravel to reduce source of dust emission. Limit amount of fine particles to 10%–20%.
 - Providing hoardings/barricading 3.5m high along the site boundary.
 - Covering dusty load on vehicles by impervious sheets before they are taken into account for work.
 - Providing dust screens, sheeting or netting on the perimeter of building site.
 - Transferring, handling/storing dry loose materials like bulk cement and dry pulverized fly ash inside a totally enclosed system.
 - Carry out wheel washing of vehicles entering/exiting the site during construction.
 - Best practices for terminating air pollution on the site should be necessarily adopted like covering sand pile on site during construction.
2. Contractor has to practice Best Site Management Strategy, as per National Standard (NBC) to fulfill GRIHA requirement. All the mandatory health & safety facilities have to be provided to the labors. Water & Sanitation facility provided to the labor has to be certified by the nearby National Laboratories to ensure that health measures adopted are as per applicable standards.
 - Proper signage as per GRIHA requirement has to be followed during construction on the site. For example: No Child Labor Allowed, Stop Excavation is carried out, e.t.c.
 - No smoking to be allowed on-site during the construction .Contractor to put display

boards for the same on the site.

- Provide adequate and clean toilets for labors on-site with proper drainage system (at-least 1 toilet for each 10 labors).
 - Provision of fire extinguisher on site
 - Conduct regular fire safety drills for labor workers.
 - Provide sufficient artificial light on site.
 - Provide labors with safety equipment's as per IS Codes
 - Hard Helmet (For protection of falling materials) should be made compulsory on the site.
 - Use of Safety Goggles (while drilling, cutting, welding etc.) to be made .
 - Safety Boots, Gloves/Hand shields etc. (During welding and gas cutting etc.) should be used.
 - Cordon off areas during construction (To avoid getting hurt from hitting the structure).
 - Electrical equipment used during construction to be well earthed.
 - Safety belts and rope wherever required to be provided.
 - Workers to be directed to avoid wearing cloths which may cause accidents.
 - Provision of Clean Drinking water on the site should be made. 6 monthly certificates to be submitted of water quality which is provided to labor.
 - Clean and healthy Toilet facility for workers on-site should be provided.
 - Collaboration with nearby by hospital during emergency (for labor safety) has to be submitted. Also onsite provision of First-aid needs to be provided.
 - No child labor should be allowed to work on the site.
 - If women with children are working on-site, then proper care off has to be taken. Also a small and safe entertainment area needs to be developed for labor's kids.
 - Provision of labor hutments to be made on-site with proper facilities for drinking, bathing and sanitation. Also ensure that proper cleanliness and hygienic environment is provided.
 - Loose waste piles and diesel containers (empty/filled) must be covered and kept on PCC slab or any other impervious hard surface.
- Contractor has to preserve all the top soil of the project site. At least 200mm of the top soil has to be excavated & preserved till post construction.
 - Proper staging, spill prevention plan, sedimentation and erosion control systems during construction activity on site should be done.
 - Contractor should try to reduce use of potable water on site by taking following measures:
 - Use waste jute bags to cover columns and beams during curing
 - Add admixtures to concrete which cause a reduction in the water required for curing etc.
 - Proper or Isolated spaces has to be prepared for storage of various construction material and thus to be preserved and protected. Material has to be segregated as per there physical condition (such as liquid, solid, etc) and also need to have segregated as per there sensitivity i.e. toxic or non-toxic. All the applicable national/international standards have to be followed for the preservation of the materials. Following strategies should be done:
 - Designate proper area for waste storage until sent out of the site or reused.
 - Loose waste piles and diesel containers (empty/filled) must be covered and kept on

- PCC slab or any other impervious hard surface.
 - Enlist the prospective type of waste to be generated and suitable actions to be taken for recycling (selling to scrap dealer/vendor) and reusing on/off-site.
 - Make record of waste quantity generated weekly/monthly basis (as per on-site suitability).
 - Cordon off areas where construction waste is stored to avoid disruption and for easier transportation
 - Retain receipts with exact quantity of waste - sold to scrap dealer; quantity of containers, other materials - sent to vendors; quantity of concrete/brick debris – reuse on site.
 - Use different colored bins for the collection of different categories of waste during the construction. (Has to separately done for plastic, liquid, hazardous, metals, and so on).
 - Allocate a separate space for the collected waste before transferring it to the recycling/ disposal stations.
 - Solid Waste generated during the construction has to be segregated and preserved for the reuse or has to be sold for the same or recycling.
- It will be responsibility of contractor to provide complete coordination to Consultant and provide the relevant data whenever required such as AutoCAD drawing, Reports, Calculation excels, purchase bills or similar document required and its fulfillment has to be submitted in guidance/coordination of Consultant.
 - Certificates/Declaration/Quantification has to be submitted as required for the project's GRIHA Certification in guidance/Coordination with the Consultant.
 - Material adhesives and sealants or similar products used for the project have to be as per minimum requirement of the GRIHA.
 - All the products used in the project such as Insulation, Refrigerant, Fire Extinguisher etc has to be CFC free.
3. Existing trees and other forms of vegetation to be preserved by avoiding disturbance/damage due to construction activities. All existing vegetation should be marked on the site survey plan. The tree survey must be carried out and data must be recorded before starting construction activity. Adequate fencing to avoid disturbance/damage to trees and other vegetation to be provided.
 4. The contractor should appoint a senior person who is knowledgeable about GRIHA Green Rating System.

He would be responsible for preparing & compiling the various GRIHA compliance documents including photographic evidence at regular intervals as per GRIHA consultants advice requirement on a day-to day basis and the same to be got retted from the Engineer-in-charge on weekly basis.

He would also be responsible for insuring that the various GRIHA rating requirements as listed above and as advised by the GRIHA consultants are duly implemented at site during the course of construction of the project.

The above are to be complied by the contractor for getting GRIHA & Star Rating subject to approval of GRIHA / Consultant.

43 ENVIRONMENT HEALTH AND SAFETY

First Aid & first Aider :- Contractors should have kept first Aid box near to each unit of work & also provide trained First aider in the ratio of 1:100 on site during the period of worked

Safety assembly point:-Contractor should identify safety assembly point in consultation with engineer and properly mark the place with sign board. Assembly Points must be communicated to labour during training program. Also conduct Mock Tests for emergency evacuation.

EHS Plan:- Contractor should have to maintain EHS plan during the commencement of the work as submitted in PQ document.

44. EARTHING

During construction of work All Temporary Electrical connection and D.G.Sets should have proper Earthing at site with the specification

45. Hard Barricading

Contractor should have create Hard Barricading at his own cost to cover up the site/premises with proper gate Entry/Exit as per approved plan from Engineer-In-Charge minimum Height of barricading should 12 Feet from OGL. Barricading should have painted with (yellow, Black) Danger marking. Reflective tape to be pasted on top & bottom of barricading on both side Top of barricading should have well illumination at an interval. All Excavated pit should be cover up with safety Caution. No claim on this account shall be entertained.

46. Excavated Stuff and Dismantled material:

All Excavated stuff is the property of contractor subjected to recovery of the cost at prescribed rate .

Excavated stuff hard rock - as mentioned in prevailing SOR of MPPWD .

47. Water & Electricity

Contractor should have make his own arrangement for water and power for construction.

48. The contractor shall not be permitted to tender for work in the AKVN, if his near relative is posted in the Nigam. He shall intimate the names of persons who are working in any capacity or subsequently employed by him and who are near relative to any staff/officer in the AKVN. Any breach of this condition, by the contractor would render his tender/contract void. Note: By the term near relative is meant wife, husband, parents and grandparents, brothers and sisters, children, uncles and their corresponding in laws.

49. The contractor shall have to furnish a ROYALTY CLEARANCE CERTIFICATE from the District Collector before final bill.
50. The contractor has to get himself registered regarding the service tax with the Commissioner, customs central excise & service tax, Govt. of India as per rules applicable.
51. Fair wages: The contractor shall pay not less than fair wages to labourers engaged by him on the work
52. Removal of undesirable persons: The contractor shall on receipt of the requisition from the Engineer-in-Charge, at once remove any person employed by him on the work who in the opinion of the Engineer-in-Charge is unsuitable or undesirable.
53. Amount due from contractor: Any amount due from the contractor on any account concerning work may be recovered from him as arrears of land revenue.

54. SPECIAL CONDITIONS FOR LANDSCAPE- :

Tree Plantation

A. Supply of Trees

1. Physical Condition- All plant materials shall be healthy, sound, vigorous with good foliage, Plants supplied shall be conforming to the names listed on the plant list. No plant materials will be accepted if branches are damaged or broken. All material must be protected from the sun and weather until planted
2. Health of Trees- All plant materials shall be free from plant diseases, insect pests, or their eggs, and shall have healthy well-developed root systems. Plant material shall be well formed and shaped true to type and free from disease, insect and defect such as knots, windburn, sun-cold, injuries, abrasion or disfigurement.
3. Specification of Trees- In no case, the specification of the material in terms of height, Girth & Foliage as mentioned in the BOQ shall be acceptable for plantation works. In case of in-availability of the particular species or the planting material as per specification in BoQ ,the alternate species as the case may be shall have to be approved by site-in- charge in special case after due confirmation of the consultant.

B. Plantation method

1. Pit Size- Minimum Pit Size for all trees should be of the size 1mtX1mtX1.2mt Incase of larger trees pit size should be of 1.2mtX1.2mtX1.5mt
2. Soil Preparation- The soil shall be essentially good Earth mixed with 1/3rd of decomposed farmyard manure along with additives like Gypsum, sulphur ,Zinc Sulphide (ZnS)etc to maintain ph-value of the soil between 7 - 7.5. Planting of trees and stacking / propping to protect the trees from wind and irrigate on need basis. Maintain the tree basins - free of weeds by regular hoeing.
3. Planting of trees- Planting the tree -with root ball in the pit (tin grown / poly bag grown) after removing carefully and without disturbing the root. Pressing the soil firmly around the tree planted. Preparing the basin around the tree and watering after staking and tying. The plant should be well maintained, disease free, well trimmed at the time of handing over. In case of death of the plant the contractor need to replace the same with equally well grown healthy plant.
4. Stacking / Propping- To ensure protection from Winds-staking/ propping it with bamboo tripod using jute string. In all condition, tree should be standing in erect position. The staking should have anti-termite treatment.

5. Fertilizers /organic solid manures & liquid manures, spray bio- insecticides, parasites, predators. All the planting materials shall be periodically examined for termite attacks or plant disease and appropriate measure (application of liquid manures/ growth regulators/ pesticides as per need, weeding regularly so as to keep the plant healthy all the time) shall be undertaken for entire period of maintenance as per Maintenance Schedule.

6. Watering Arrangement- Making basin around Trees (1mtr dia clear space) and maintaining Tools and Tackles/Hose-pipes, tractor mounted Water Tankers or as required in sense all arrangement for water distribution and watering equipment's/manpower to be managed by the Contractor for watering the trees.

C. Maintenance of Trees

1. Maintenance of Trees- Apart from the essential watering of the plants as per the maintenance manual ,Nurture the trees with organic solid manures and liquid manures, spray bio insecticides, parasites, predators to protect the trees from pest and disease. Amend the soil on regular basis with proper soil amendments to keep the pH level between 7 - 7.5 after completion of (36) Thirty six month maintenance period the plants should be maintained by regular watering, weeding, replacing dead plants, applying pesticides, Use of plant physical protection measures etc. so as to grow them vigorously.

Newly Planted should be maintained by

- 1) Watering as per maintenance manual
- 2) Applying FYM @ 10kg/ tree/ annum
- 3) The Trees should have proper staking so as the tree should stand erect till the Tree settles with no possibility of bending due to Wind or Rain
- 4) Trimming, pruning as & when required under guidance of the site in-charge

D. Shrubs Plantations

A. Supply of Shrubs, Creepers, Ground Covers

1. Health of Shrubs/Ground Cover/Creepers etc- Plant material shall be well formed and shaped true to type and free from disease, insect and defect such as knots, windburn, sun-cold, injuries, abrasion or disfigurement.

2. Physical Condition- All plant materials shall be healthy, sound, vigorous with good foliage, and free from plant diseases, Insect pests, or their eggs, and shall have healthy well-developed root systems. Plants supplied shall be conforming to the names listed on the plant list. No plant materials will be accepted if branches are damaged or broken. All material must be protected from the sun and weather until planted.

3. Specification of Shrubs- The species should be in appropriate specification in terms of height as provided in BoQ. In case of in-availability of the particular species or the planting material as per specification in BoQ ,the alternate species as the case may be shall have to be approved by site-in-charge in special case after due confirmation of the consultant.

B. Planting of Shrubs, Creepers, Ground Covers

1. Bed Sizes- As per the specification and depth should be minimum 300 mm deep exclusive of the top 50mm where top edge is defined for watering and flooding. The plantation bed shall be the basis of all billing purpose including maintenance charges to be paid to the contractor.

2. Soil Preparation- Dig and remove all weeds, debris, rubbles, and stones from 18" depth of the surface soil level to be maintained in due course. The soil shall be essentially good Earth mixed with 1/3rd of decomposed farmyard manure along with additives like Gypsum, sulphur etc to maintain ph-value of the soil between 7 - 7.5.

3. Preparation of soil for grass, ground cover, edges, shrubs and flower beds- Then prepare the same soil with 2-3" thick layer of well decomposed, weed free farm yard manure or vermicompost. Treat the soil with chlorophyriphos / Lindane / Neemcake depends upon the infestation of soil borne pests. Treat the soil with proper herbicide to control the weeds only on need basis. Finally level the soil as per the drawing or planting details.

4. Preparation of pits for shrubs, creepers and hedges- The bed shall be prepared with good earth mixed with 1/3rd quantity of decomposed faryard manure along with

5. Planting- a sapling of shrubs, ground covers, lilies, suckering plants etc. as per design plant spacing – 30-60 cm. maintaining(application of liquid manures/ growth regulators/ pesticides as per need, weeding regularly so as to keep the plant healthy all the time) it for a period of 36 months days from the date of virtual completion of development work.

6.Planting shrub/ground cover- Planting of shrub in the bed prepared earlier by filling garden soil and manure (67:33 ratio).Planting the shrub with root ball in the pit (tin grown / poly bag grown) after removing carefully and without disturbing the root. Pressing the soil firmly around the tree / shrub planted. Preparing the bed around the shrub and watering after staking and tying. Maintenance of shrub/ground cover up to 36 months by regular watering and attending the inter-cultivation practices such as weeding, racking, watering gap filling ,free of weeds by regular hoeing. etc. The plant should be well maintained, disease free, well trimmed at the time of handing over. In case of death of the plant the contractor need to replace the same with equally well grown healthy plant. Nurture the shrubs/ground cover with organic solid manures and liquid manures, spray bio-insecticides, parasites, predators to protect the trees from pest and disease. Amend the soil on regular basis with proper soil amendments to keep the pH level between 7 - 7.5

7. Planting Ground cover - Planting of ground cover plants in the ground prepared earlier by filling garden soil and manure. Preparing a pit of require size in the ground. Planting the ground cover plant root ball at nine inches apart in the pit after removing carefully and without disturbing the root ball. Pressing the soil firmly around the plant Preparing the basin around the plant watering. Maintenance of ground cover up to two month by regular watering and attending the inter-cultivation practices such as weeding, raking, gap filling, trimming and pruning etc. The ground cover should be well maintained, disease free, well trimmed at the time of handing over. In case of death of the plant the contractor need to replace the same with equally well grown healthy plant.

8. Maintenance of Shrubs

The plants should be maintained by regular watering, weeding, replacing dead plants, applying pesticides etc. so as to grow them vigorously. Trees & plants should show regular healthy growth through regular maintenance by manuring, fertilizing. Use of plant protection measures, adequate watering etc.

- Maintenance of all developed features ground cover, hedges and shrubs etc. of the complex. Maintenance work includes timely pruning, weeding and cutting of ground cover plants, hedges, edges, plants planted in the areas mentioned above. Application of fertilizers, manure, etc to the lawn, plant and spraying pesticide etc. as and when required.
- Seasonal flower beds have to be replaced as and when required (approximately thrice in a year). Plant species can be changed w.r.t. season only in consultation with engineer in charge.
- Removal of wild grass normally found growing in rainy season by cutting and/or uprooting so as to keep the areas free of grass.

E. Lawn plantation

Plant material shall be well formed and shaped true to type and free from disease, insect and defect such as knots, windburn, sun-cold, injuries, abrasion or disfigurement.

1. Supply and planting of lawn- Planting of lawn grass (Paspalum/ cynadon sp./ zoasia sp./ stenotaphrum etc) as per drawing without disturbing the desired gradient and level, maintaining (forking, mowing, weeding, fertizer application) it for a period of 36 Months after handing over.

2. Specification of Lawns- Supply and Laying of lawn as per BoQ without disturbing the desired gradient and level, maintaining (forking, mowing, weeding, fertilizer application) it for a period of 36 Months after handing over.

3. Soil Preparation- Top 200 mm depth: The soil shall be essentially good Earth mixed with 1/3rd of decomposed farmyard manure along with additives like Gypsum, sulphur etc to maintain ph-value of the soil between 7 - 7.5.

4. Dibbling of grass- Fine level the soil, apply thin layer of sand, vermicompost and Neemcake mixture of 1" thickness and dibble the grass at 3" distance. Roll the lawn after planting. Irrigate the lawn regularly. Remove weeds on periodical basis. Nurture the lawn with organic, bio-insecticides, parasites, predators to protect the lawn from pest and disease. Mow the lawn regularly and maintain the grass at 50 mm (2") height. Trim all the edges after mowing, keep the edges with trees, shrubbery and flower beds clean.

6.Fertilizers /organic solid manures & liquid manures, spray bio- insecticides, parasites, predators required at the time of Plantation or as per maintenance schedule.

6. Watering Requirements- Tools and Tackles/Hose-pipes, tractor mounted Water Tankers or as required to be managed by the Contractor for watering the trees.

7. Handing Over of Lawns- The lawn areas should be considered fit for handing over once the lawns have settled and the surface starts showing the lawn effect.

8. The Lawns should be maintained by regular watering, weeding, replacing dead Spots, applying pesticides etc. so as to grow them vigorously.

55. CLAIM FOR COMPENSATION FOR DELAY IN STARTING THE WORKS: No compensation shall be allowed for any delay caused in the starting of the work .

56. **Description Of work For Integrated Property Management Services :**

(Operation & Maintenance for 3 years after expiry of initial one year defect liability period)

It will be responsibility of the bidder to operate and maintain the property on 24x7 hrs basis . All parameters for various services as mentioned in BOQ/ executed at site will be monitored , checked and record maintained.

The Operation and Maintenance shall include all Utilities including MEP(HVAC, Electrical, BMS, Plumbing, STP, Fire fighting), Landscape, Lift and other Miscellaneous works, including all consumables, repairs i/c spares, fulltime and shift-wise provision of manpower and any other services required to run the system successfully. For Operation and maintenance of HVAC, Electrical system, BMS Systems, DG Operations, Plumbing Services, STP, Fire Fighting, etc shall be read as MEP systems.

The Scope of work as mentioned below are the minimum expected from the contractor apart from break down maintenance and any other work required for operation and maintenance in proper way as per the operation and maintenance manuals of respective equipments and as per good engineering practices will be required to be done under this scope of work. Successful contractor will make LOG Books for daily operation of various plants. Maintenance shall be done on daily, weekly & fortnightly, half yearly & yearly basis as recommended by manufacturer or respective equipment's requirement

GENERAL GUIDELINES FOR OPERATION AND MAINTENANCE" OF ALL UTILITIES INCLUDING HVAC, ELECTRICAL SYSTEM, BMS SYSTEMS, DG OPERATIONS, PLUMBING SERVICES, STP, FIRE FIGHTING, LIFTS, LANDSCAPE AREA AND MISCELLANEOUS WORKS -

1. The contractors shall comply with the provisions of all applicable labour rules and legislations mandatory. All statutory obligations such as PF, ESI, Minimum Wages, etc. has to follow. The bidder or his vendor shall not pay wages lower than minimum wages of labour as fixed by the Govt. of M.P.
2. The bidder, his agents, workers and representatives are required individually to be in possession an identity card or pass to be obtained from AKVN. The identity card or pass will be examined by the security staff at the time of entry into or exit from the restricted area and also at a time or number of times inside the restricted area.
3. The bidder shall be bound by the Official Secret Act 1923 and will be signed before physically taking over site for operation.
4. The bidder shall permit free access and generally, afford reasonable opportunity to other agencies or departments, workman engaged by the MPSEB,IMC or others if required to carry out their part of the work, if any under separate arrangement.

5. The bidder shall not communicate any classified information regarding the work either to sub-bidders or to others, without the prior approval of the management. The bidder shall also not make copies of the design/drawings and other documents furnished to him in respect of the work or earlier on termination of the contract.
6. Upon commencement of services, a register detailing the inventory of all equipments and various facilities will be prepared by the Bidder. It is the sole responsibility of Bidder to update this inventory on a quarterly basis in consultation with P.A.K.V.N.(I)LTD.INDORE. On completion of the contract period, the Bidder has to handover the premises to M.P.A.K.V.N.(I)Ltd Indore as per the Inventory register. Any and all losses if any, will be recovered from payments due to the Bidder.
7. Conservation and economical use of electricity energy and water is to be made in the premises by the Bidder. Electricity and water required for operation & maintenance work will be provided by MPAKVN free of cost.
8. Bidder shall assume full responsibility for all property in its case, custody and control, except for loss by fire, flood, strike, riots and acts of God or other causes beyond Bidder's control and, upon termination of this agreement/contract, surrender possession of the same to owner/occupant/bidder in the good condition .
9. The Unit Manager/ Supervisor appointed by the Bidder for the said premises will be fully responsible for the day-to-day operations of the services within the scope of services mentioned earlier.
10. The bidder will be required to monitor the use of energy, producing reports and recommendation on how to improve efficiency and reduce costs. This services will be considered part of the contract and as such there will be no additional payment.
11. Managerial and security personnel, Electrician, Plumbers and other essential staff should have walky-talky for proper control.
12. This whole document will be part of service agreement.
13. Assets register as per requirement of MPERC for power supply activity shall be prepared in the required format.
14. After the completion of the contract the bidders shall handover all assets to AKVN /its authorized agency in healthy condition failing which MD, AKVN reserve the rights to deduct the losses from the security deposit.
15. LOG-Book for recording or parameters related to MEP systems shall be provided and maintained by the contractor showing the complete working and maintenance done on the MEP systems and it should be made available to the engineer-in-charge.
16. All spares parts and consumable materials shall be used genuine and or same make and type as installed and a minimum quantity of spares, refrigerants (R-134a) and materials for routine maintenance may be kept at site to minimize time or maintenance. The contractor has to keep all equipment well maintained for each MEP systems so as to give proper output at all times.
17. Tools and equipment required for proper operation and maintenance for whole MEP systems shall be maintained at site by Contractor.
18. Deployment or manpower-. MEP system shall be made available in three shifts (round the clock) i.e. 24X7 mode for operation and maintenance. All of team members should be technically qualified and well experienced to operate the systems and attend to repairs/ maintenance work of these systems. Any other manpower required shall be made available by the contractor for proper functioning. Proper supervision or contractor's senior engineers /operators/helpers have to be provided to oversee the whole work for the smooth operation and maintenance services . The team configuration shall be as below-

- At least one Team leader having Degree in engineering with MEP background.
 - One shift supervisor with BE/ Diploma in electrical or mechanical engineering.
 - One Fire and life safety officer with BE in fire engineering.
 - For each discipline of HVAC, Electrical, DG set, STP, Plumbing, Fire fighting and Lift there shall be a combination of team having senior engineer of respective discipline with BE/ diploma qualification along with shift supervisor, helpers and operators having relevant ITI qualification.
 - There shall be a team of gardener with helpers for landscape areas.
 - There shall be an accounts executive for billing of electricity supply, water supply, lease rent and other charges and collection of revenues and preparation of separate power accounts.
19. The contractor shall provide maintenance of entire landscape area with specified manpower, watering schedule, required manure and necessary care with all possible components.
20. The contractor shall provide separate bins as per colour coding of GRIHA version 3 norms. The categories shall be - bins for organic waste, bin for paper card board, bin for glass and metal, bin for mixed waste. Two bins or 75 Liter capacity each of all four categories should be provided floor wise in common areas in two different locations.
- The same provision shall be made at site level, considering each corner of the site. Over and above four categories as specified above, there shall be a separate bin for horticultural waste from landscape areas. These provisions shall be made in landscape areas of site and podium floor level.
- There should be separate bins for dry and wet waste each of adequate capacity in all toilets of every floor.
21. The contractor shall submit all the CV's of candidates of Operation and maintenance team to AKVN and take necessary approval before deputing them to site.
23. The contractor himself or his representative of at least Manager / Engineer level shall meet with AKVN his nominated officer once a day and attend the office whenever called by him.
- 24.. Care shall be taken so that the MEP systems do not lead to major breakdown. In the event of any breakdown, the same will be rectified immediately failing which such rectification will be done at the risk and cost of the contractor. Similarly, if any breakdown takes place due to negligence or contractor, the whole component has to be replaced/ rectified to bring it to the original condition immediately.
25. The rates shall be quoted for three years.
26. Payment shall be made on quarterly basis.
27. The Managing Director, AKVN reserves the irrevocable authority to accept or reject any tender in part or whole without assigning any reasons.
28. The rates at any stage once quoted shall not be withdrawn. The bidder shall send the original tender document duly signed by them in each page in token of acceptance for all the conditions of this tender.
29. No advance payment will be made at any circumstances. However, on successful completion of every quarter, payment will be released within 15 days from submission or bill.
30. The services required are for **Three Years**.
31. Precaution against any fire hazards or other damages to Plant and equipment shall be arranged by the firm. AKVN shall remain indemnified by the contractor from any encumbrances /loss on this account.

32. The contractor shall fulfill the requirement or various law enforcing agencies / local authorities, such as Pollution control Board, Directorate or Electricity Safety etc by taking their approvals as and required.
33. The contractor will be responsible for the safety of their deputed staff during the performance or their duty at site.
34. In case any of staff is not found up to mark and not able to do work properly, he will have to be replaced as per the instruction/consent of AKVN.
35. In case of any problem with the equipment, the -/contractor's deputed staff will keep AKVN informed immediately.
36. All disputes are subject to Indore Jurisdiction.
37. The firm/ agency/ contractor shall keep the equipment well maintained, neat and clean and adhere to the operations and maintenance schedule of various equipments given in the respective manuals. Upon placement of work order they will prepare the maintenance schedule and discuss the same with AKVN's engineer for its implementation. This may be revised from time to time as per the requirement.
- 38 Safety Regulations :
 - a. In respect of all labor, directly or indirectly employed in the work the contractor shall at his own expense arrange for all the safety provisions as per safety codes of Public Works Department, Indian Standards Institution, the Electricity Act, Regulations, Rules and Orders made there under and such other Acts as applicable.
 - b. The contractor shall observe and abide by all fire and safety regulations. Before starting construction work, contractor shall consult engineer-in-charge and must make good to the satisfaction of the engineer-in-charge any loss or damage due to fire to any portion of the WORK done or to be done under this contract.
 - c. Non-compliance to statutory requirements may lead to termination after a notice period or 15 days. AKVN reserves the right to terminate the Contract, during the course of O&M of the Works, for other non-compliances/violation (s) or misbehaviour.

The contractor shall provide safety Personal protective equipments to all his workers having following quality standards:

- Safety Helmet (White)
- Safety spectacles (Clear).
- Safety Gloves.
- Safety Shoes with steel toe.
- Ear plug - sort rubber – regular.
- Goggles - Safety - Chemical Splash proof.
- Gloves - complete leather and welder gloves.
- Gloves - PVC supported for acid and alkaline protection
- Dust Respirator – Disposable
- Face shield – transparent
- Ear Plug – un-corded - disposable
- Full body harness - Regular

- Contractor shall engage a license holder electrician at site to carryout electrical works. The electrician shall maintain the entire electrical fixture in safe working condition at all time.
- Proper power distribution boards with sufficient sockets and switches and in sufficient numbers shall be provided at proper place for smooth and safe working.
- All electrical power distribution shall be through MCB and ELCB.
- All electrical installation shall be properly earthed and grounded.
- Good quality cable shall be used and as far as possible avoid joints in the cable.
- Any joints in the cable shall be properly insulated.
- Cables shall not run on floor. Cables shall be routed through sufficient height to avoid any obstruction.
- Only PVC body drill machine shall be used on site.
- Water shall not be allowed to accumulate near electrical installations.
- Electrical cables shall not run or placed on metal body or pipe scaffolding.
- Switch boxes or switch boards shall be properly fitted and should not lie on floor.
- Electrical connection shall be taken through proper electrical fittings.
- Do not overload switch. Provide switches of required capacity.
- Provide adequate lighting at the work place and in storage area. Also the site should be properly illuminated by providing adequate lighting.
- Carbon dioxide type fire extinguishers shall be kept near electrical installation.
- Access to fire extinguishers and electrical installations shall be free from any obstructions.
- All precautions shall be taken to identify and pre-empt any and all situations that can cause accidents, with a particular attention to major or main causes like Gravity, Electricity, Compressed air etc. peculiar to the nature of work in progress including of other contractors in the vicinity.

39. MODE OF PAYMENT

Payments shall be made quarterly for the services rendered in the preceding months. Billing cycle will be 1st of the month to the last day of the month. The bidder shall submit bill and after scrutiny payments shall be released by MPAKVN Indore.

Payment shall be made in Indian Rupees only.

The bidder shall also ensure that payments to vendors working under contract are made within reasonable time. The delay in payment of bill by MPAKVN Indore shall not affect the payments to vendors and all payments to vendors shall be released not later than 30 days of the completion of service by them.

40.PENALTY FOR NON-PERFORMANCE

The bidder or authorised person engaged by the bidder shall personally visit installations under operation daily in every shift and ensure work schedule is followed strictly. He shall also ensure proper manning of each installation by authorized Technician and by organizing the operators engaged by the bidder in such a manner that all services are manned, operated by 24x7 hrs basis or as ordered by management. In case it is found that any installation is not clean tidy penalty for each activity, not performed as per schedule will be as follows-

S.N.	ACTIVITY	PENALTY	REMARK
1	LANDSCAPE/ WATERBODIES	Rs.200/- per day.	If not satisfactory
2	LIFT OPERATION If lift operator not found on duty	Rs.200/-per person per shift	
3	HVAC Operation	Rs.100/-per person per shift	For coordination with HVAC supply agency.
4	WATER SUPPLY Water supply was not done to units timely /overhead tank not filled, /overflow of tank /leakage not taken care/Absenteeism.	Rs.500/-per mistake per shift	Any genuine reason for break down will be considered
5	ELECTRICAL WORK There should not be any power failure. All electrical installation like control panel, switch yard/substation be mentioned preventive.	Rs.500/-per activity per shift	All electrical equipments should be in running condition. 24x7
6	SEWARAGE TREATMENT PLANT Men power not available	Rs.500/-per activity	If not found satisfactory
7	HELPSDESK/RECEPTION/CONTROL ROOM	Rs.200/- per for non conformance	
8	a) Local complaints of units will be handled within 2 hours. b) Personnel will be always be available 24x7 on helpdesk	Rs.200/- per shift	
9	BUILDING AND REVENUE COLLECTION a) Billing of units and revenue collection from units timely Deposit bills in time period	Rs.1000/- for this activity Rs.1000/- for delay per day	If not found satisfactory
	CLEANING of DRAINS Drains should be cleaned regularly and it should be free flow	Rs. 500/- activity per shift	If not found satisfactory
10	DG SET SHOULD WORK PROPERLY	Rs. 500/- per day	If not found satisfactory
11	BMS SYSTEM PROPERTY	Rs. 2000/- per activity	If not found satisfactory

41. It will be responsibility of the bidder to operate and maintain the property on 24x7 hrs basis . All parameters for various services as mentioned in BOQ/ executed at site will be monitored , checked and record maintained .

42. Materials, Consumables & Spares

To provide and maintain an efficient material management system, Bidder will regularly assess on the requirement of the material & consumables based upon the inventory levels as per the site requirement. Bidder has to assess requirement well in advance to tackle situation. All materials ,consumables &spares will have to be arranged by bidder only. All spares and consumables required for all the services including lamps, tubes, CFL, LEDs, Vapor lamps, chokes, electronic spare are included in the scope of work of the bidder and no additional payment shall be made.

AKVN Indore will not provide any materials.

43. WORKING HOURS

Business hours of the building on average will be 12 hours, 6 days a week, but this I.T. Complex is commercial building it may happen that few staff may halt for late hours to finish assigned work . After hours there will only be skeleton staff and / or Plan Preventive maintenance staff. Bidder has to provide 24/7 Operations & Technical Support .

44 . DESCRIPTION OF VARIOUS WORKS FOR INTEGRATED PROPERTY MANAGEMENT SERVICES :

1. HT AND LT DISTRIBUTION SYSTEM

Bidder shall provide and deploy license holder staff including Shift In-charge / Sub Station In-charge / Operator who is authorized to handle, operate and maintain HV / EHV system including metering and billing of power supplied to IT units . The billing shall be done as per electricity tariff approved by MPERC from time to time. The EMS installed shall be used for the billing by incorporating the MPERC tariff.

Shift In-charge / Sub Station In-charge / Operator on duty will receive HT supply of electricity and lap supply from secondary side of transformer.

Shift In-charge Sub Station In-charge / Operator will maintain distribution network through various LT panels and controls relays 24X7 hrs basis, charged, unless there is planned shutdown which will be notified well in advance to all concerns.

In case of any power break down / failure of the system repairs shall be immediately attended to, under the supervision of Shift In-charge / Sub Station In-charge / Operator. All parameters and load details shall be recorded in log sheets including details of tripping and failures. In case of differential relay tripping no seem trial will be taken unless faults are identified and rectification done.

Bidder will be responsible to maintain switch yard free from grass, dust free control room, oil spill free area near transformers, metering units sealed and intact, Moisture free and dust free panels, cable joints and well ventilated and well lit control room.

Bidder's staff will follow all safety rules and use protective clothing's, tools, aids and equipments to ensure safe working without any chance of accidents/electrocution. Bidder will be responsible for all liabilities as he will be the principal employer for his staff.

Bidder will carry out trouble shooting and replacement of faulty equipments, spares, and consumables required for sub station and distribution systems, at the same time Bidder will be responsible to keep it operational up to user end

Bidder will ensure power back up from alternative feeder available at site and if same also fails then through DG Sets

Bidders shall provide all safety apparel/instruments to his staff and shall thus be sole responsible for their safety

DOCUMENTATION REQUIRED IN SUPPORT OF DELIVERABLES :-

Following are the deliverables, documents for the same shall be submitted along with the quarterly bills bills for payment: -

- a) Monthly readings of all the energy meters installed for IT Units, common utilities, main meter and energy audit report.
- b) Monthly energy bills as per MPERC tariff through Energy Management system installed as well as manual readings of meters duly countersigned by the IT units.
- c) Daily Energy consumption forecast based on the requirement of IT units.
- d) Preparation of separate power accounts as per MPERC requirement. The accounts shall be prepared in coordination with electrical consultant and AKVN accounts department as per MPERC regulations in such manner and form that AKVN /Consultant can file the Annual Revenue Requirement (ARR) and retail tariff application before MPERC by October month every year.
- e) Coordination with AC AMC and DG AMC agencies for economical and efficient operation of the power system. Reading of BTU meter for supply of chilled water to respective IT units and common area AC and preparation of bills for the same as per the agreement signed between AKVN and IT units for the
- f) Daily reporting of electrical faults.

2. OPERATION & MAINTENANCE — HVAC SYSTEM

The bidder has to maintain complete system of HVAC for 3 years as mentioned in MEP guidelines.

3. Air Distribution System

Bidder will ensure that complete air distribution system is maintained serviceable including complete supply air and return air system.

4. FIRE DETECTION AND FIGHTING SYSTEM

Bidder will ensure that fire hydrant and sprinkler lines are always (24 X 7 hours) remain charged with designed pressure. All hydrants will be maintained serviceable and sprinklers line charged with the pressure as applicable. He will be responsible to operate fire pumps as per requirement on auto/manual modes.

The selector switches of all the pumps will always be on auto mode and tested for its serviceability by releasing the pressure for activation of Jockey Pump once in a week and

All fire detection system shall be wired to fire panels and interfaced through BMS for parallel action of fire fighting, closing of ventilation system and operation of fire/smoke exhaust system as applicable. He will carry out exercise and record maintained for the same.

DOCUMENTATION REQUIRED IN SUPPORT OF DELIVERABLES :

Daily report of charging of fire hydrant, sprinkle lines at design pressure through BMS and weekly report of Jockey pumps.

Maintenance

Bidder will be responsible for all types of maintenance of the system as per approved program whenever required including all fire hydrants and extinguishers.

5. WATER PUMP HOUSE AND DISTRIBUTION SYSTEM :

It will be responsibility of bidder that water supply to building is maintained available with adequate pressure in 24 X 7 hrs basis including for fire fighting system. He will maintain and operate all equipments installed in pump room and isolating valves / controls provided at various places in the building. He will maintain updated drawing of layout of distribution diagram of system, displayed appropriately for reference and action.

It will be his duty to ensure that water is tested for its safe usage as per IS norms and records of various PPM tests and chlorination level achieved is maintained for verification.

He will ensure that adequate protections to handle hazardous gases used in the system are available and maintained serviceable at site.

Before start of installation, operator will ensure that adequate power and water is available for distribution system before pumps are put on. He will record all parameters in the log sheet including any failures and breakdowns occurred.

Maintenance of Pump House

It will be duty of bidder to ensure that all equipments installed in the pump house including pump house building is maintained safe for operation through planned and predictive maintenance. He will check all sumps and overhead tanks for suspended and bacterial

impurities; action taken to clean them with adequate advance notice to conserve water and shutdown of supply is planned to bare minimum period.

All tools, tackles, scaffoldings and test kits required to attend various repairs, operations shall be deemed to be included in bidder's offer.

6. SEWAGE TREATMENT PLANT

It will be responsibility of bidder to maintain and operate sewage treatment plant for safe and economical operation.

He will ensure that bar screen chamber is cleaned periodically for clogging matter. The level of equalizer/ receiver tank is maintained within limit and adequate aeration through compressed air is pressed in to it to avoid settlement of solid waste.

All grease traps will be maintained clean and sludge transfer pumps aeration in FAB system including filtration and softener pumps are operated to maintain BOD, COD level within limits. It will be responsibility of bidder to dispose of liquid sludge deposited. After treatment, treated water is terminated safely as per designed scheme. He will ensure that operator uses all safety kits while working with hazardous gases to avoid any accident. Operator before entering into installation will ensure that ventilation and exhaust system of room is working and is switched on.

Record of parameters and test results obtained are maintained in the log sheet. Test kit and tools, safety kits required at site will be maintained serviceable always.

7. LIFTS AND ELEVATORS

Bidder will maintain Lifts for 3 years after expiry of defect liability period and at the same time bidder has to depute men to operate Lifts 24x7 for 3 years.

DOCUMENTATION REQUIRED IN SUPPORT OF DELIVERABLES: - as per requirement as mentioned in MEP guidelines.

- 8. DG SETS:** -As per agreement bidder will operate & maintain DG sets for 3 years after expiry of defect liability period, It will be responsibility of bidder to test run for all safety systems before working hours starts.

DOCUMENTATION REQUIRED IN SUPPORT OF DELIVERABLES: - As per requirement as mentioned in MEP guidelines.

9. LANDSCAPE MANAGEMENT

The work includes, maintenance of all common areas including slopes, lawns, maintenance of Potted plants (Outdoors and Indoors), Trees, shrubs, Hedges, Creepers, Ground corner, water bodies , pathways. etc. Bidder will water the all plants and grass. The bidder is responsible for sweeping or blow cleaning of all sidewalks and/or concrete areas affected by gardening work. All landscaping debris will be removed from the premises by bidder at his cost.

Bidder will furnish all necessary labour, supervision, equipment, tools, transportation, permits, insurance to staff.

Watering shall be carried on in such a manner as to avoid excessive erosion by sprinklers or hand watering and prevent run-off into adjacent walks and roadways. Each section shall be irrigated for the appropriate time based on the condition of the soil and plant materials and water will not be wasted.

For irrigation by sprinkle damaged heads and lines will be repaired immediately. All repairs shall be made by Bidder necessary at its expense. Irrigation control valves shall be kept in working order. Bidder shall replace washers when required.

Bidder shall maintain the landscaped areas of the premises in a first class condition as may be determined from time to time by site in charge.

Bidder has to ensure that the trees, shrubs and ground cover must be kept off fire hydrants, signs, and fences, walls, sitting areas, walkways and driveways especially it doesn't obstruct the vehicular and pedestrian movement along the access ways.

Maintaining indoor plants potted at lobbies, corridor and entry gate etc. approximately 200 no.

Landscape Maintenance Tasks

- Fertilization
- Mowing
- Mulching
- Pest and Plant Disease Control
- Pruning
- Soil Amendments
- Aeration
- Trimming
- Weed Control
- Removal of dead plants, shrubs and grass carpets,

Manpower

- Normally , Working hours will be 8:00 a.m. to 5:00 p.m. Monday to Saturday. In case of shift duty instructions will be issued as per requirement.
- All personnel will appear on site uniformed, in a neat and clean manner at all times.

Equipments and Consumables

Bidder will be responsible for maintaining a high level of safety in equipment and work conditions. The maintenance includes timely cutting, pruning, watering, manure, spray of insecticide and Pesticides, Proper dose of Fertilization, Cleaning of Landscape Areas.

To carry out the maintenance work the following material will be provided by the bidder as and when required. Bidder has to bear all costs.

- Manure
- Urea
- Chemicals
- Insecticides and Pesticides
- Good Earth, Soil etc.
- Replacement of dead plants.

MPAKVN (I)Ltd. Indore reserves the right to inspect the quality and quantity of such material.

Grassed Areas

- All grassed areas shall be kept free of weeds, moss or extraneous growth;
- All landscaped grassed areas shall be kept neatly cut to the edge of the borders, fence lines, building lines, path edges, hedge bases, tree bases etc.;
- All grassed areas shall be kept free of large accumulations of litter and foreign matter such as stones, animal faeces, bricks and glass.

Horticultural Works

- All horticultural works shall be undertaken in a manner so as to maintain a pleasing, tidy appearance;
- All trees, perennial plants, hedges and shrubs shall be maintained so that they are in healthy growth;
- Trees and shrubs shall be kept to an acceptable height and form and are to be pruned time to time. Plants or shrubs shall not obstruct or encroach pedestrian or vehicular traffic routes;
- All plants/ trees and shrubs etc., which have or appear to be dying, should be removed and replaced as soon as possible following removal of dead plant(s) by a suitable replacement.

Lawn Area Maintenance

- Bidder shall mow and edge lawn areas weekly during peak growing season and as frequently as needed during the winter months or periods of excessive rainfall.
- All cuttings from mowing and edging shall be promptly collected and disposed of off-site, the same day as mowing.
- Complete fertilization of all lawns shall be at a accordance with subsequent fertilization specifications.
- Bidder shall provide labour for complete chemical weed, fungus, and insect control as necessary.

Tree, Shrub, hedges, Plants and Flowers and Flowerbed Maintenance

- Trees and shrubbery shall be manicured regularly to contain their size in respect to species, size of planter or relative surrounding landscaping and for the best health of the plant.
- All pots/ containers shall be cleaned and replaced where necessary;

Trimming

Removal of excess or unwanted grass or similar plant material on the edge of a turf area, walkway, or planter bed, and along fence lines and building foundations. These areas are generally trimmed at each mowing.

Weed Control methods to be adopted by bidder

There should be a regular maintenance for all seasons for trees, grass, shrubs, hedges leaves by using fertilizer, mulching, watering, pruning, weed control, diseases control

Replacement of Dead Plantation

All plant material is the responsibility of Bidder, at Bidder's expense. Bidder shall be liable for replacement of plants, including but not limited to, loss through negligence or improper cultivation such as improper fertilization, careless use of chemical weed controls, lack of water or mechanical damage from the equipment of Bidder or its employees, or otherwise.

Plant sizes for replacement shall be recommended by Bidder and finalized by MPAKVN (I) Ltd. Indore

DOCUMENTATION REQUIRED IN SUPPORT OF DELIVERABLES:-

- a) Up keeping record of number of plants (with type, reference and numbering), trees, hedges, water bodies, lawns with location every month.
- b) Addition and subtraction every month.
- c) Submission of report with challan of fertilizer and all required material like manure, Urea, Chemicals, Insecticides, pesticides, good earth soil etc.

10. CLEANING OF DRAINS

Cleaning of road side gutters/CD works at frequent time interval especially before and after monsoon.

45. DOCUMENTATION REQUIRED IN SUPPORT OF DELIVERABLES:

- a) Generation of electricity bills (through energy meters) as per electricity tariff approved by MPERC for IT Park.
- b) Generation of chilled water supply (through BTU meters) to all IT units as per agreement entered between MPAKVN and IT units.

- c) Operational report of all utilities.
- d) Faults and breakdowns in the system.
- e) Energy management and audit reports.
- f) log books / site order books of all utilities

46. SHUTDOWNS

Bidder will be responsible for acquiring advance approval per site requirements and coordinating units! Site shutdowns with the M.P.A.K.V.N.(I)LTD.INDORE The coordination activity involves but not limited to selecting shutdown dates and conducting update meetings with all affected business unit representatives, and communicating the shutdown plan to all customers.

Work shall be scheduled in nights and weekends when necessary in order to affect a minimum number of building occupants, as determined by.P.A.K.V.N.(I)LTD.INDORE

47. MANAGEMENT REPORTING

Within Seven days after the completion of the month, bidder is required to provide a Monthly Management Report to.P.A.K.V.N.(I)LTD.INDORE outlining activities for that month.

48. SAFETY GUIDELINES

- The bidder must know and follow their duties related to safety for all personnel, These guidelines are applicable to bidder deployed by them at the site.
- The bidder shall ensure that no access (passages/access to emergency apparatus /exits) is blocked.
- The bidder shall ensure that proper fencing, lighting and warning signs are placed on and around the work site for safety at all times, bidder will only be responsible for any accidents if occurred.
- The bidder shall report all modifiable accidents, dangerous occurrence and potential hazard situations to M.P.A.K.V.N (I)LTD,INDORE representative on site.
- The bidder shall provide prior information to the MPAKVN(I)LTD.,INDORE representative about any hazardous material being brought on the site and shall ensure security storage of such material.
- The bidder must not remove or displace any guard, fencing or other safety equipment, which is designed to protect personnel or machinery or any place where safety equipment has been provided without the written permission of MPAKVN (I)LTD.INDORE representative.
- No work may be carried out above the heads of people or over gangway or roads or near power cables unless all precautions have been taken to ensure the safety of the person below, and until permission is given by the MPAKVN (I)LTD INDORE representative.
- All temporary structure, erected by contractors for the purpose of allowing their staff to work at heights of more than 4m above floor level, must be constructed in accordance with the

safety regulations.

- The bidder must provide consumables, tools and equipment based on applicable regulations / codes / guidelines, The bidder must inform Site Engineer of MPAKVN (1)LTD.INDORE and units before shut down of services such as water lines or electricity.
- The bidder should ensure that proper qualified / trained / licensed personnel carry out the jobs and that proper supervision is done for all jobs, Any power / compression / percussion tools must be used by trained personnel with proper safety precautions during operation / storage.
- The bidder should ensure that their personnel do not consume alcohol / do not smoke / do not take drugs on site.
- All workmen of the bidder must have valid identifications cards issued by the MPAKVN(I)LTD INDORE and shall display at all times during duty hours.
- During electrical work, the bidder shall ensure that rubber gloves / boots of correct grade and all safety equipments of standard make are used; temporary supply is tapped from source panel which is properly fabricated /fixed and earthed each tapping shall be through ELCB; have double earthing for 3-phase connection. All provisions of The Electricity Act 2003 and MPERC, CERC regulations shall be followed by the bidder.

49. PF AND ESI

All liabilities for ESL PF for the men power deployed for the O&M would be the responsibility of the Bidder.

50. INSURANCE

Bidder shall obtain workmen and CAR policy within 2 days of the award of the contract.

51. SCAFFOLDING AND REQUIRED TOOLS

Bidders shall arrange all tools, scaffolding required for the O&M and MPAKVN will not provide any tools or scaffolding.

52. TEMPORARY POWER CONNECTION FOR MAINTENANCE

During O&M if permanent power connection is required to be disconnected temporary then the bidder shall arrange the same at his cost. Only energy charges and statutory charges shall be payable by MPAKVN.

53. HELPDESK MANAGEMENT

- The Helpdesk Services of IPM pertain to the problems on Helpdesk and resolving the problems to closure, which occur on day to day basis. Bidder will be required to manage Helpdesk in the building wherein the problems will be logged either on telephone, in person or through email. Helpdesk will classify all such calls and would forward / allocate to the concerned departments, i.e. Engineers / Technicians, Supervisor or any concerned operational staff for resolution. For each type of problem, the response time would be defined and bidder will adhere to it.
- Helpdesk will be manned and managed on a 24/7 basis by qualified computer literate Helpdesk Operators with soft spoken, polite person.
- Helpdesk will be allotted a dedicate (Telephone Extension No. by M.P.A.K.V .N.(I)LTD.INDORE

- Any Complaint lodged in Helpdesk will be responded depending on nature of the problem but not later than 1 hour and resolved within 2 hours (routine Complaint) of logging the complaint.
- Once the call is closed the respective attendant will get the signature of the complainant on the work order. Helpdesk operator will counter check before closure of any problems assigned.
- Resolution of the problem will be reconfirmed by the Helpdesk operator with the complainant and then will close in the register.
- At the end of each day, the unattended and pending problems will be carried forward to the next day and a report of such problems will be prepared and forwarded to the respective team in premises All routine problems, Helpdesk related problems, Operations related problems, will be handled by the bidder without any intervention of M.P.A.K.V.N. (I) LTD., INDORE

Documentation Required in Support of Deliverables :-

Copy of the complaints attended along with the signature of the complainant for closing of complaint with time and date.

54. Other Conditions

1. Unless otherwise specified or called for by the Engineer-in-charge, cement shall be Pozzolanic Portland cement (having 15% to 25% Fly Ash Content) in 50 kg bags. The use of bulk cement will be permitted only with the approval of the Engineer-in-charge. Changing of brands or type of cement within the same structure will not be permitted. Pozzolanic Portland cement (PPC) manufactured as per I.S. 1489-1991 (Part-1) specification of reputed brands like Ultratech / Birla Super / Coromondal or any other brands as approved by the Engineer-in-charge from time to time shall be procured and used on the work. Joint account of cement consumed at site for every day for items of work carried shall be maintained by the Contractor for verification to ensure effective control on quality of cement used in the work.

Samples of cement arranged by the contractor shall be taken by the Engineer-in-charge and got tested in accordance with provisions of relevant IS codes. In case test results indicate that the cement arranged by the contractor does not conform to the relevant IS codes, the same shall stand rejected and shall be removed from the site by the contractor at his cost within a week's time of written order from the Engineer-in-charge, to do so.

(i) The cement shall be brought at site not less than 25 tones lots or as decided by the Engineer-in-charge.

(ii) The cement store room shall have a capacity of minimum of 2000 bags of cement to store should be constructed by the contractor at site of work for which no extra payment shall be made. The contractor shall be responsible for the watch and ward and safety of the cement store room. The contractor shall facilitate the inspection of the cement store room by the Engineer-in-charge at any time.

(iii) The contractor shall supply free of charge the cement/other material required for testing. The cost of tests shall be borne by AKVN if test results are satisfactory otherwise contractor will bear the same.

(iv) The actual issue and consumption of cement on work shall be regulated and proper accounts maintained. The theoretical consumption of cement shall be worked out as per procedure prescribed in the contract and shall be governed by conditions laid therein.

(v) Cement brought to site and remaining unused after completion of work shall not be removed from site without written permission of the Engineer-in-charge at any time.

- 2) The contractor shall have to produce test certificate in the Performa prescribed/approved by B.I.S. from the manufacturer for every batch of cement & steel, brought to site of work/ plant and to be used for the work. Each lot of cement brought to site would be permitted to be used in the work only after the satisfactory test results are received.
- 3) For Exposed Concrete Work on façade of circulation core, landscape element and front side boundary wall of the project as per attached drawings and details shall not be paid extra. Refer to CSR item number 5.31.2 and 5.28.1, necessary arrangements like provision of tie rods as per design requirement etc shall be provided with no extra cost.
- 4) Any underground/overhead utilities found within the area and are damaged during the construction has to be repaired and maintained by the contractor at his own cost and no extra payment will be made on this account.
- 5) Any claim on account of delay in removal of encroachments, if any, will not be entertained except time extension.
- 6) After completion of the entire work, test report should be submitted to the Competent Authorities of M.P.P.K.V.V. Co. Ltd. and M.P. Licensing Board and also to the Engineer in Charge and NOC is to be obtained from M.P. Licensing Board and submitted to the Competent Authorities of M.P.P.K.V.V. Co. Ltd. and AKVN.
- 7) The contractor should submit Two C.D. and Six copies of the completion drawing of the work.
- 8) The contractor shall procure steel reinforcement bars -FE-500 conforming to relevant IS codes from SAIL, TISCO, Jindal & RINL. Structural steel of main Producer only shall be permitted for use. The contractor shall have to obtain and furnish test certificates to the Engineer-in-charge in respect of all supplies of steel brought by him to the site of work. Samples shall also be taken and got tested by the Engineer- in-charge as per the provision in this regard in relevant IS codes. In case the test results indicate that the steel arranged by the contractor does not conform to BIS codes the same shall stand rejected and shall be removed from the site of work by the contractor at his cost within a week's time from the written orders from the Engineer-in-charge to do so. The cost of steel, testing charges and to & fro cartage shall be borne by the contractor.
 - (i) The steel reinforcement shall be stored by the contractor at site of work in such a way as to prevent distortion and corrosion and nothing extra shall be paid on this account. Bars of different sizes and lengths shall be stored separately to facilitate easy counting and checking at any time as and when desired by the Engineer-in-charge/ Architect.
 - (ii) The contractor shall supply free of charge the steel required for testing.

The rates shall be inclusive of making any holes in walls/ RCC work for fixing any fixture/ frame work and making good the structure to its original shape and finish.

- 9) The rate of items of flooring shall be inclusive of work for sunken or depressed floors.
- 10) The rate shall be inclusive of working under water and adverse of foul conditions and including pumping out or bailing out water, this will include water encountered from any source such as rains, floods and any other cause whatsoever and including sub-soil water for which no extra payment will be made by AKVN.

- 11) The contractor shall provide adequate lighting arrangements as approved by the Engineer-in-charge for carrying out the work during night time, if so required and also provide all other facilities for the labour employed to carry out the work as per direction of Engineer-in-Charge.
- 12) The Contractors (s) will have to keep on site complete survey instruments like Total Station / Theodolite / Auto Level along with full time technical personal to operate those instruments to facilitated and obtain the information required as instructed by Engineer-in-Charge and Architect, for which no extra payment shall be made.
- 13) The discrepancy in the drawing issued, if any shall be brought to notice of Consultant /PMC / Engineer-in charge for immediate decision before execution of the work. The contractor, alone, shall be responsible for any loss or damage occurring by the commencement of work on the basis of any erroneous information and no claim whatever, shall be entertained on this account.
- 14) The contractor shall take photographs of the site prior to commencement of work, during construction and after completion of every item of work as suggested and shall submit the photographs in(5"x7") size & in soft and hard copies regularly to AKVN for which no extra payment will be made.
- 15) Make list of items is enclosed and from this list the consultant/Engineer-in-charge shall decide the make & model of item which is to be used, for this work during construction period.
- 16) Any material brought to the site shall not be taken out form the construction site without prior permission of EIC. The contractor may be asked for verification of empty containers of consumable items like paint etc after execution.
- 17) **PERMITS AND COMPLIANCE OF LAWS**
 - A) **THE CONTRACTOR SHALL, WITHOUT ADDITIONAL EXPENSES TO THE AKVN, OBTAIN ALL REQUIRED LICENSES AND PERMITS AND BE RESPONSIBLE FOR ALL DAMAGES TO PERSONS OR PROPERTY THAT OCCUR AS A RESULT OF HIS FAULT OR NEGLIGENCE IN CONNECTION WITH THE PROSECUTION OF THE WORK AND SHALL BE RESPONSIBLE FOR THE PROPER CARE AND PROTECTION OF ALL MATERIAL DELIVERED AND WORK PERFORMED UNTIL COMPLETION AND FINAL ACCEPTANCE.**
 - B) **CONTRACTOR SHALL COMPLY WITH ALL THE LAWS AND REGULATIONS INCLUDING VARIOUS LABOUR LAWS IN RESPECT OF THE WORK COVERED UNDER THIS CONTRACT AND IN RESPECT OF WORKERS, EMPLOYEES AND SUB-CONTRACTORS EMPLOYED BY THE CONTRACTOR.**
- 18) Protection of Work and Property- The contractor shall continuously maintain adequate protection of all his work from damage and shall protect the owner's property from injury or loss arising in connection with this contract. He shall make good any such damage, injury or loss, except such as may be directly due to errors in the contract documents or caused by Representatives, or employees of the owner.

He shall adequately protect adjacent property as provided by law and the contract documents.

The contractor shall take all necessary precautions for the safety of employees on the work, and shall comply with all applicable provisions of Central, State and municipal safety laws and erection codes to prevent accidents or injury to persons on, about or adjacent to the premises where the work is being performed. He shall erect and properly maintain at all times, as required by the conditions and progress of the work, all necessary safeguards for the protection of workmen and the public and shall post danger signs warning against the hazards created by such features of erection as protruding angles, well holes, elevator hatchways, scaffolding, window openings, stairways and falling materials, and he shall designate a responsible member of his organization of the work, whose duty shall be the prevention of accidents. The contractor shall report the name and position of the person so designated to the consultant.

19) NOTICE TO LOCAL BODIES

The Contractor shall comply with and give all notices required under any law, rule, regulations, or bylaw of parliament, State Legislature or Local Authority retaining to works. The Contractor shall before commencing the execution of work issue a certificate to the AKVN or his "Clerk of Works" that he has obtained all the permission and give all the notices as are required to be obtained or given under law particularly blasting permission etc.

20) SAFETY

All equipment shall be complete with approved safety devices wherever a potential hazard to personnel exists, and with provision for safe access of personnel to and around equipment for operational and maintenance functions. The contractor will ensure that the helmets are provided and used by all workmen / supervisors and engineers at site. Consultant will approve the colour of helmet. All the workmen will use safety belts while working on heights.

21) RESTRICTED AREA

For all purposes of this contract the site is considered as a Restricted Area. The Contractor shall ensure that he obtains entry passes for all his workmen and employees. The Contractor shall obtain special permission in writing from the Owner if he desires to continue working beyond office hours or on Holidays. The Contractor shall also observe and abide by the security regulations applicable during the currency of the contract.

22) PROTECTION OF SAFETY OF PERSONNEL AT SITE

In case of any such loss or damage the Contractor shall take full responsibility for same and shall bear all cost and expenses thereof. Also, the Contractor shall be responsible and liable for all delays caused due to such damage and or injury and for the consequences which the Agencies may have to face or to which they may be subjected to or be accountable for as a result of such delays.

23) SAMPLES AND CATALOGUES

Before ordering the material necessary for these installations, the contractor shall submit to the EIC/Consultants for approval, a sample of every kind of material. Also contractor shall

ensure that the dimensional details of the equipment fit into the allotted space provided in the building. All approved samples should be kept in Engineer-in-charge/ SQC consultants' office.

24) MANUFACTURERS

Where manufacturers have furnished specific instructions relating to the materials used in this job, covering points not specifically mentioned in these documents, these instructions shall be followed in all cases. Where manufacturer's names and/or catalogue numbers are given, this is an indication of the quality, standards and performance required.

For items not covered under the 'List of Approved Makes', contractor shall offer items of first class quality, standards and performance and obtain the approval of EIC/Consultants before procuring them. Where interfacing occurs, equipment shall be mutually compatible in all respects.

25) Carrying out Work Beyond Normal Working Hours or in Shifts-

In order to achieve the milestone and completion dates and to keep pace with the approved construction program, the Contractor shall be permitted to carry out his work beyond the normal working hours or in shifts. The Contractor shall be responsible for obtaining any necessary permission from the relevant authorities that may be required for him to carry out the work beyond the normal working hours or in shifts. Also, the Contractor shall give prior notice to and make arrangements with the EIC for the supervision of work carried out beyond the normal working hours or in shifts. The Contractor shall make his own arrangements in respect of the provision of adequate lighting and any other facilities that may be required for carrying out the work beyond the normal working hours or in shifts. No extra payments shall be made to the Contractor for or in connection with any such overtime or shift work. The Contractor will not be required to bear the overtime expenses of the EIC in respect of the supervision of such overtime or shift work of the Contractor.

26) REFERENCE DRAWINGS

- a) The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on Site. All important drawings shall be mounted on boards and placed in racks indexed, no drawings shall be rolled.
- b) All correction, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings. All changes to be made shall be initialled by Architect/ Engineer-in-Charge /PMC

27) SAFETY NORMS:

- a) All employees shall wear helmet and shoes while working at site at all times. Contractor shall issue an identity card to all his employees working on site and the same shall be displayed by the employees at all times.
- b) The contractor will supply / provide to all his persons required safety and personal protective equipment as required by legislation, Site regulations or the method of work. The contractor will borne all the expenses for providing the above equipment.
- c) Persons below 14 years of age shall not be employed to work on site. Persons under the influence of alcohol shall not be allowed on site.
- d) The contractor must ensure that his workmen are following safe working practices / procedures.
- e) Do not take undue risk or chances while at work.
- f) For carrying out work involving height proper and stable pipe scaffolding should be used.

- g) The contractor shall not use any of the AKVNs property or material without written permission from the AKVN.
- h) Ensure that all his employees and those of any sub-contractor have sufficient information, instruction, training and competence to enable them to carry out safely the work specified in the contract.
- i) Supply and use of equipment and material that are suitable and adequate for the task being undertaken and are in every case maintained in good repairs and of sound construction.
- j) Devise and follow a safe system of work that has pre-identified hazards inherent in the job and safety measures necessary to reduce those hazards as far as reasonably practicable.
- k) Ensure that employees with supervisory roles for the work on site fully understand the health and safety responsibilities they have both under the contract and under the various relevant authorities and that these are properly fulfilled.
- l) Contractors shall co-ordinate the activities of any sub-contractor.
- m) The contractor shall assure compliances as mentioned below :-
 - i. All work will be carried out in accordance with agreed work method / procedures, and that all employees, including those of sub-contractor will not stray from specified area.
 - ii. The work area will be established and maintained in a safe and orderly condition.
 - iii. Good housekeeping will be established and maintained.
 - iv. Safe system of work on site will be established and followed.
 - v. Employees as well as sub-contractors employees who are working in hazardous area are made aware of location of first aid facilities, fire extinguishers, assembly point, fire exit etc, in the vicinity of the work area.
 - vi. The contractor will supply / provide to all his persons required safety and personal protective equipment as required by legislation, Site regulations or the method of work. The contractor will borne all the expenses for providing the above equipment.
- n) Only trained and competent persons should be employed to operate earth moving machine, machines and equipment, lifting equipment or any other complicated equipment.
- o) Contractor shall provide safe drinking water, toilets facilities at site for their labours in required numbers. Rest room provision for the labours shall be made at site. If female workers engaged on site are having small children then contractor shall make provision of crèche facility at site.
- p) The contractor during the course of the contract should comply with various statutory rules and regulations of various enforcing authorities apart from safety .

Contractors must supply and ensure the use of personal protective equipment of standard quality required by law that is both appropriate for the job and meets the site requirement as suggested by the Engineer. Following personal protective equipment should be provided to workers as required and their use enforced. Helmet, hand gloves, safety goggles, welding screen and goggles, safety belt, face shield, breathing apparatus, dust gumboots etc.

28) Work at Height:

- Only experience person shall be engaged to carry out work involving height.

- Scaffolding erected shall be strong, stable and properly secured. Strong and sturdy working platform with handrails shall be provided for person to carry out the work at height in a safe manner.
- As per site condition use of safety net shall be made to arrest any fall of person or materials from height.
- The workers working at height shall wear safety belt with its life line fastened to a firm support.
- Make use of rope for taking up or lowering of materials or tools while working at height.
- The area of work and its surrounding shall be made free from other activities or cordon off the area.
- Do not keep or store any materials or tools on the scaffolding after the day's work.

29) **Handling of Reinforcement Rod**

- Reinforcement rod shall be stacked in proper place diameter wise and the area of reinforcement rod staking shall be barricaded. Proper walking place shall be provided in the reinforcement rod area.
- The machinery used for cutting / bending rod shall be properly guarded.
- Authorized and trained operator only shall operate the machine. The working area around the machines should be free from any obstruction.
- Electrical connection to the machines shall be taken by using proper electrical fittings.
- Cut pieces shall be stored lengthwise in proper place.
- A waste bin shall be provided to store scrap materials and it shall be disposed periodically.
- While carrying long bars on site both ends of the bars should be tied with binding wire to avoid swinging movement.
- Workers should wear helmet, shoes and hand gloves as required.
- Reinforcement rod should not be used in fencing, barrication, for levels marking etc.

30) **Formwork**

- The formwork materials shall be stored in a proper manner and in proper place.
- Ensure that all accessories provided to the formwork are properly locked and fitted to prevent any fall of formwork while carrying out concreting.
- Proper staging shall be provided for carrying out formwork at height in a safe manner. Persons engaged in the work activity shall wear safety belt, which should be fastened to a firm support.
- During concreting operation form work person shall be present to rectify any irregularity.
- The protruding nails on the formwork shall be removed. Scrap formwork materials shall be collected and stored in a separate waste bin and disposed off periodically if not required.

SECTION 4

BILL OF QUANTITIES (BOQ)

General Description of work: Construction of Administrative /IT/ITES complex adjoining crystal IT park, Khandwa road Indore i/c all allied work like HVAC, Electrical, Lift, Plumbing, Fire fighting, Landscape, STP, BMS, Outer development etc. including 3 yrs Integrated property management (operation and maintenance)

Probable Amount of Contract:

(Rs. In Figure) . Rs. 44.34 Crores

(Rs. In Words) : Rs. Forty Four crores thirty four lakhs

Sr. No.	Description	Specification	Probable Amount of Package	Unit	Quotated Rate (% of total project cost)
A	FOR CONSTRUCTION WORK				
1	MAIN BUILDING WORKS (19838 sq mt. Slab Area)	Building work consists of RCC framed structure with Column and footing foundation. Excavation depth for footing is 4.5 mt. from NGL. RCC work of design mix M30 grade , to be prepared by RMC plant.	256118976.09		
		Muram filling in plinth and in pits of foundation up to depth of BC soil and rest depth by available excavated good soil. Anti termite treatment in foundation and plinth.			
		Masonry work in AAC block with adhesive, confirming to IS 2185 part 3.			
		Building with Stilt, podium parking and two wings of six and eight floors with a common circulation core and service core. Floor heights- stilt 3.10 Mt., podium 5 Mt. and regular floors of height 3.75 Mt. Total slab area of the building is 19838 sqmt.			
		Main lobby having lifts 3 nos (13 pax. each) & a service lobby with 1 no service lift (15 pax.), 1.5 m/s. with machine rooms at terrace level.			
		Spider glazing for entrance façade @ stilt floor.			
		Toughened glass doors with granite frame in common areas.			
		SS railing - stainless steel (Grade 304) with 10 mm thick toughened glass and 12 mm thick laminated toughened glass. S.S. railing in staircase.			

	<p>Architectural façade- Fixed "V / AERO" shaped aluminium alloy sun louvers System in east and south façade with necessary support system.</p> <p>Structural glazing in IGU on north façade along with north, east and south faces in first and second floor, With SHGC- 0.25.</p> <p>Horizontal and vertical trellis in MS fabrication at 2nd to terrace floor levels to support sun louver system and accommodate façade plantation.</p> <p>2 track Anodised aluminium glazed windows, fixed on granite frame.</p> <p>Skylight with polycarbonate sheet at 8th floor slab level in atrium area.</p> <p>Provision of flush doors.</p> <p>Exposed concrete work with glass slits in east façade of circulation core.</p> <p>MS pergola at Entrance, MS Trellis in courtyard at podium level.</p> <p>Italian marble flooring & wall lining in Entrance foyer.</p> <p>600 by 600 mm Vitrified tile flooring with adhesive and spacer in AKVN offices, DC office, Incubation centre, Conference and toilet block.</p> <p>Granite flooring in corridors & balconies with skirting</p> <p>CC Flooring with hardner in stilt and podium floor parking area.</p> <p>Toilet partitions with compact laminate panel.</p> <p>Water proofing with brick bat koba at terrace.</p> <p>6 and 12 mm thick Internal & 15 mm thick External cement plaster.</p> <p>Washed Stone grit plaster on external face of Stilt and podium floor.</p> <p>Internal paint work with Plastic Emulsion & External with Acrylic Smooth exterior paint and texture paint.</p> <p>RCC M30 overhead water Tank 3 nos having total capacity of 64 KLD excluding free board</p> <p>RCC M30 underground water Tank 3 nos having total capacity of 294 KLD excluding free board</p> <p>Building work Complete and finished in all respect.</p>			

2	BOUNDARY WALL & ENTRANCE GATE	Total running length of Boundary wall 390 mt with 2.4mt height, the design comprises of RCC framed structure with AAC block masonry finished with plaster and paint complete in all respect. Front boundary wall in exposed concrete finish with Integrated design of entrance gate with MS shutter. Complete and finished in all respect.	4048351.5		
3	SECURITY HUT	Security cabin of internal size 2.5 m x 5.3 m with a cooking platform and attached toilet Complete and finished in all respect.	448840.28		
4	DG ROOM	RCC framed structure upto plinth level, super structure comprising of both RCC and MS with RCC slab and GS roofing respectively, complete with pedestal foundation for DG, HT, LT & transformer panel. Complete and finished in all respect.	3218491.48		
5	INTERNAL CIRCULATION (ALL AROUND THE BUILDING)	Total Road length-331 m, width 7.5 m embankments in cutting and filling; 500mm thick Embankment material having CBR>5; 500mm thick sub base course having CBR>30; 230mm thick Dry Lean Concrete; 100mm thick PQC M-30; 200mm thick Traffic Signages and markings Paver Blocks 80 Mm Thick, M-35 Grade around the building Finished work complete in all respect	6206683.61		
6	STP	Planning, designing, procurement, constructing, Erecting, testing and commissioning of STP of 60 KLD, based on MBBR technology, System shall consist of screen chamber, grit chamber, Extended aeration tank, clarifier with filtration units, treated water tank and pumps for supply for horticulture including all civil work, complete in all respect finished work.	2635000		
7	LANDSCAPE	RCC water body with a water cascade finished with glass mosaic with all electro mechanical equipments and accessories. Pathways in RCC, finished with stone.	7724201.32		

		FRP modern sculptures of varying heights from 750mm to 900mm.			
		Mounds & various land gradients as per design.			
		Podium level landscape development with gazebo, sittings and pathways.			
		Plantation as shrubs, plants, hedges and tress etc of various heights.			
		Potted creepers in façade of the building.			
		Drip irrigation system for landscape watering requirements			
		Finished work complete in all respect			
8	PLUMBING	<p>Plumbing system have design as per NBC requirements with 1.5 Day water storage system.</p> <p>Provide & Fixing GI puddle flange pipes for RCC underground water Tank 3 no.s having total capacity of 294 KLD & RCC overhead water Tank 3 no.s having total capacity of 64 KLD</p> <p>PUMPS & EQUIPMENT:- SS vertical centrifugal pump with EFF-1 motor of 2 nos. for Domestic water transfer from Plumbing Plant Room to OHT & 2 nos. for Flushing water transfer from STP Plant Room to OHT.</p> <p>Submersible Centrifugal Non-clog Drainage Pumps.</p> <p>Water Treated Sytem having with SS vertical centrifugal pumps, Filters for Domestic Water Services, Activated Carbon Filters.</p> <p>FRP water softening plant (suitable for 3 Kg/Sqcm working pressure)</p> <p>Dosing system (for domestic water treatment plant)</p> <p>Internal drainage- SS grating, PVC SWR pipes grade B, PVC pipes 6kg/cm2 rating clean out plug , uPVC self cleaning traps Bottle traps for sink and wash basin.</p> <p>Sanitary Fixture:- Premium range with Wall hung WC ,urinals , partitions, bibcocks ,flexible tubes , soap dispensers, paper holders ETC are considered.</p> <p>Sanitary fixtures for disabled friendly toilets include support arms ,raised toilet seat with cover, flexible feed and waste pipes, grab bars etc.</p>	12039571		

		<p>CP Fitting:- C.P. brass pillar taps, CP brass bottle trap, CP brass waste coupling, C. P. Brass made Soap Dispenser, CP Brass Toilet paper holder with Flap, CP Brass Double coat Hook .</p> <p>UPVC pipes (heavy density) for rainwater down-takes on the external facia of the building.</p> <p>CPVC Pipes in chases and in shafts for domestic water supply & flushing water supply.</p> <p>Controlling Valves & Meters:- The Price shall be included Gun metal gate valve with C.I. wheel, Gun metal gate valve with brass lever handle , G.M. float valve with copper ball float, Butter fly, Ball Valve, Y stainer, Non return Valve, electronic type level indicator, water meter, CI Air release valve, pressure reducing valve, pressure switch, level controllers.</p> <p>Non-pressure NP2 class (light duty) RCC pipes for external sewage disposal (manhole to manhole connection).</p> <p>Gully trap:- square-mouth S.W. gully trap class SP1 complete with C.I. grating brick masonry chamber with water tight C.I. cover with frame of 300 x300 mm size (inside)</p> <p>Storm water drainage- RCC drain with MS grating, depth as per design</p> <p>2 nos rainwater harvesting pits with 150mm dia bore and 1 nos rooftop rain water harvesting system with Borewell adaptor .</p> <p>Finished work complete in all respect</p>			
9	FIRE FIGHTING	<p>Fire Fighting System designed as per NBC .</p> <p>fire water storage tank capacity 200cum pumping system</p> <p>Fire Pump- discharge of not less than 150 per cent of the rated discharge, at a head of not less than 65 per cent of the rated head. The shut off head shall be within 120 per cent of the rated head.</p> <p>Electric Hydrant Pump Capacity 2850 LPM 85 Mt head (Approx.)</p> <p>Electric Sprinkler Pump Capacity 2850 LPM 85 Mt head (Approx.)</p> <p>Diesel Engine Driven Pump Capacity 2850 LPM 85 Mt head (Approx.)</p> <p>Booster Pump (If Required) Capacity 900 LPM 45 Mt head (Approx.)</p>	12057671.67		

		<p>Jockey Pump Capacity 180 LPM 85 Mt head (Approx.)</p> <p>Fire hose Cabinet for Internal :- 2 nos. FHCs provided on all floors, (20 Nos.) with RRL hose pipe with male and female gun metal couplings duly binded with GI wire, rivets etc. confirming to IS 636 (type-A) as required, included double headed hydrant valve.</p> <p>Sprinkler system- Entire building considered sprinkled- quick response type, quartzoid bulb type sprinklers, set to operate at 68/79 degree Centigrade, with MS pipes,</p> <p>2 or 4 way fire brigade connection (FBC) of CI body with 2 or 4 nos. gun metal male instantaneous inlet couplings complete with cap and chain as required. For 150mm dia MS pipe connection, confirming to IS 904 as required.</p> <p>MS Pipes :- 'C' class heavy duty MS pipe confirming to IS 1239/3589 underground i/c fittings like elbows tees, flanges, tapers, jointing with nuts bolts, gaskets and welding etc. underground including excavation and providing cement concrete blocks as supports, at prescribed intervals and anticorrosive treatment with coaltar/asphalt tape as per IS 10221, with 4mm thick fiber reinforced tape and 12mm overlap and refilling the trench etc and open pipe fixing the pipe on wall/ ceiling with suitable hangers, clamps, supports, as required and painting with two or more coats of synthetic enamel paint of required shade</p> <p>Controlling Valves & Required accessories:- Sluice valves, butterfly valve PN 16, orifice plate, non-return valve, stainless steel strainer fabricate, gun metal valves, air vessel made of 250 mm dia, electrically operated flow indicating switches, Pressure switch, flexicon expansion joint (expansion bellows), C.I. wafer type check valve, annunciator panel for flow control switch, spring loaded relief valve, pressure gauge</p>			
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		<p>control valve of Cast iron body and brass/bronze working parts comprising of water motor alarm, bronze seat clapper. and clapper arm, hydraulically driven mechanical gong bell to sound continuous alarm when the Wet riser/Sprinkler system activates, pressure gauges, emergency releases, strainer, pressure switch, cock valve complete with drain valve and bypass, test control box. ball valves, MS pipe of required size, flanges, orifice plate, gasket etc</p> <p>FHC DOOR:- angle iron (40 mm x 40 mm x 5 mm) door frame and M.S sheet (2 mm thick) cum glass shutter of size 1.2 mtr x 2.1 mtr (N.S.) with 25 mm x 25 mm x 3 mm angle frame all around & stiffened in between including hinges. handle, locking arrangement, painting with approved synthetic enamel paint including sign writing on glass at internal hydrant including providing and fixing M.S. Sheet 2 mm thick on remaining portion above door to close opening including painting etc</p> <p>fire extinguishers:- Carbon-di-oxide type fire extinguishers, ABC Powder type fire extinguishers, Mechanical foam type Extinguisher.</p> <p>Miscellaneous items:-MS air cushion tank, fire buckets of 24 gauge galvanized steel sheet</p> <p>Finished work complete in all respect</p>			
10	Electrical- Internal	<p>Providing of Point wiring , Circuit wiring , Distribution Boards with MCB , Switches & Sockets including wires conduits & all Hardware & Accessories.</p> <p>Providing of Telephone wiring, Cabling ,TAG blocks , EPABX, Computer data cabling, Network Switches, including wires conduits & all Hardware & Accessories.</p> <p>Providing of LT Panels - Floor Panels , Common Area panels , Utility panels, AHU Panel , AC Panel etc complete with switch gears , capacitors, Bus bars, Powder Coated MS Housing indoor type including all Hardware & Accessories.</p> <p>LIGHTING FIXTURES AND FANS Supplying, fixing & testing of approved make Surface / Recess Type LED / CFL Light Fixtures complete as per specification with all accessories</p>	20308712.72		

		<p>CABLING WORK Supply,Laying of LT cables in excavated trenches, concrete trenches, along walls, through hume pipes, cable trays etc with testing & commissioning with terminations.</p> <p>Supply, fabrication and erection of Angle/Chanel/Flat iron fitting including nut bolts of required size, making holes, fabrication, welding, cutting, etc. and painting with one coat of red oxide paint & two coat of aluminium paint as required as perspecification.</p> <p>Supply, installation ,testing & commissioning of 10000VA Inverter suitable for 30 minutes back up including necessary SMF / Acid battery set , accessories , battery connection wire /cables , cable/wire lugs , fabricated stand to install inverter & battries.Inverter should be as per Technical Specifications of Tender.</p> <p>Supply ,installation ,testing & commissioning of GI perforated cable tray 2mm thick without cover and all accessories like perforated tee , 90 degree horizontal bend ,elbow , horizontal tee,,supports,hangers etc. of following sizes</p> <p>Supply & installation of Early Streamer Emission Lightening Conductor Air Terminal to protect the Buildidngs and complete with earth pits chemical type, Cabling work , all hardware & accessories.</p> <p>Finished work complete in all respect</p>			
11	Electrical- External	<p>Supply,Installation, testing & commissioning of H - Beam 152 x 152mm, Std weight 37.1 Kg / Mtr including of stay set ,Angle/Chanel/Flat iron fitting,33KV Porcelain pin,disk,LA, AB Switch, DO Fuse insulator complete with all assosaries - 111Mrt. With ACSR 0.1 sq inch (100 Sq.mm Al. EQ.) - (Dog) 0.6 Km.& High Tension XLPE Armoured Cable 33KV 3 Core 185 Sqmm. 140Mtr. All detailed given in BOQ.</p> <p>33KV HT VCB PANEL:- Supply,Installation, testing & commissioning of Panel set 33KV, 1250A, 31.5KA/3sec, Indoor type (including electrical & mechanical Interlocking between both incomers & Bus Coupler) including of voltmeter , kWh meter with RS-485 Port - Inos,Master Trip Relay - Inos,Trip circuit supervision relay - Inos etc.</p>	28988404.2		

		<p>DISTRIBUTION TRANSFORMER 33/0.415 KV, 1no. 1600 KVA 33/.415 KV2500A TPN ALUMINIUM BUSDUCT 65KA .</p> <p>Solar System Supply,Installation, testing & commissioning of 10KWp with Solar Panels IP-65 grade</p> <p>2x750kva DG SETSupply,Installation, testing & commissioning of 2x750kva dg set including of exhaust piping, M.S. Structural Support,M.S. day oil tank of 990 litres capacity & Fuel Oil Piping etc.</p> <p>LT PANELS Supply,Installation, testing & commissioning of following panels i as per technical speciifcation given in tender, Main Electrical Panel with APFCR - 1 no., Out Door Lighting Panel - 1no.</p> <p>EARTHING, LOOP EARTHING Earthing with G.I. /Coper Earth with charcoal or coke and salt . complete as required. with GI/pure copper earthing strip to connect to the DBS,Poles and equipments in outdoor yard and also in indoor portion of substation.</p> <p>STREET LIGHTING SYSTEM Providing and erecting hot dipped galvanized octagonal poles in single section</p> <p>LIGHTING FIXTURES AND FANS Supplying, fixing & testing of approved make 9 watt bollard-10no. , 40w post top lantern LED fitting 8no. , 90w street light with high power LED 20no. , &1 50w flood light with high power LED 4 no. complite as per pecification with all accessories All detailed given in BOQ.</p> <p>SLLEVE & CHAMBER Providng And Laying Non- Pressure Np-2 Class (Light Duty) R.C.C Pipe with Pull Chambers .</p> <p>CABLING WORK Supply,Laying of LT cables in excavated trenches, concrete trenches, along walls, through hume pipes, cable trays etc with testing & commissioning with terminations.</p> <p>Finished work complete in all respect</p>			
12	Fire & safety Work	<p>Supply Installation, Testing and Commissioning of Microprocessor Based , Addressable Fire Alarm System with 4 Loop Microprocessor based Fire Alarm panel with 1loop cords,1 Active Repeater Panel , oticalSmoke Detectors -258nos., Optical multi Detectors-1no., Manual Break</p>	7534318.6		

		<p>Glass Switch-24no., Loop Powered Sounder - 24no., Control Realy , Out put Modules, Response Indicator , Heat detectors , SMPS Power supply units , 2cX1.5 sqmm FRLS Copper armoured Cabling work</p> <p>Supply, Installation, Testing and commissioning of Volume control 30 Watt ABS Material with Override function.</p> <p>Supply, Installation, Testing and commissioning of public address audio system complete with Zone Controller,Amplifier , Mixer amplifier , Cellign &Wall Speakers , 2.5/4.0 sqmm cu speaker wiring with conduiting , Distribution boxes .</p> <p>CCTV System - Supply , installation, Testing & Commissioning of NVR network video recorder suitable for 32 Channel , IP Indoor & Outdoor Cammera with Poer supply, Network Switches , # TB hard disk , Colored monitor Sreen , 4U rack , 2KVA UPS, CAT E6 Cabling with PVC Conduiting.,</p> <p>Access Control System - Supply , installation, Testing & Commissioning of Access Control System with reader controller , Smart card readers , Magnetic Locks, Cabling work , Conduiting work , 5KVA UPS.</p> <p>Access Control System - Supply , installation, Testing & Commissioning of WI/FI System Routers, Access points , Network Switches, Fibre Optic Cabling , Media Converters.</p> <p>Supply , Installation,testing & commissioning Energy management system with Converters, data Loggers, Communication cables with Software.</p> <p>Finished work complete in all respect</p>			
13	BMS	<p>BMS architectural control system is connected to all service systems for effeciency with BMS software</p> <p>centralised server</p> <p>DDC controller</p> <p>field devices</p> <p>Finished work complete in all respect</p>	9570221		
14	HVAC WORKS	<p>Calculated cooling load-662.7 TR</p> <p>Diversified AC Cooling load 540TR</p> <p>Inside design temperature- 23-24 +/- 1 deg</p>	38166609		

	<p>cel and Rh ~50 to 55 %</p> <p>Centralised chilled water air conditioning system proposed - 2 nos. 270 TR water cooled screw chiller with multiple compressor working + 1 nos. 270 TR water cooled screw chiller with multiple compressor stand by.</p> <p>PUMP:- 3 Nos. Chilled Water Pumps + 3 Nos. VFD Operated Secondary chilled Water Pumps, 3 Nos. Condenser Water Pumps</p> <p>Cooling Tower:- 2 Nos. VFD Operated cooling tower will be installed at Terrace Lvl.</p> <p>Closed Pressurised Expansion Tank With Centrifugal Air Separator for entire Chilled Water system</p> <p>CS-AHUs for Lift Lobby:- 10 Nos. Ceiling suspended AHUs of 2000 CFM to 4000CFM</p> <p>TFA CUM AHUs for Common area:- 10 Nos. Ceiling suspended AHUs of 5000 CFM to 7000CFM</p> <p>DIDW Toilet Exhaust Fan :- Cabinet DIDW Toilet Exhaust fans of 7000 CFM to 9000CFM</p> <p>Axial Fan for Exhaust/Fresh :- Axial Fans for Services Plants Rooms.</p> <p>Axial Fan of Stair/Lift well Pressurisation:- Pressurisation system for Stair & Lift well in case of Fire</p> <p>Insulated Chilled Water Piping & Valve:- The Pipes of sizes 150mm & below shall be M.S. 'C' class as per IS : 1239 and pipes size above 150mm shall be welded black steel pipe heavy class as per IS: 3589, from minimum 6.35mm thick M.S. Sheet for pipes upto 350 mm dia., The Pipe shall be duly insulated by Nitrile Rubber. All control valve shall be include like Butter fly, Balancing, Strainers, Ball Valve, auto Purge valves, Pressure Gauges & Thermometers, Flexible Connection. Price shall be including MS support & Vibration Isolator.</p>			
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		<p>Condenser Water Piping & Valve:- The Pipes of sizes 150mm & below shall be M.S. 'C' class as per IS : 1239 and pipes size above 150mm shall be welded black steel pipe heavy class as per IS: 3589, from minimum 6.35mm thick M.S. Sheet for pipes upto 350 mm dia.The Pipe shall be duly Painted.</p> <p>All control valve shall be include like Butter fly, Balancing, Strainers, Ball Valve, auto Purge valve, Pressure Gauges & Thermometers, Flexible Connection. Price shall be including MS support & Vibration Isolator.</p>			
		<p>Insulated Rigid PVC AC Condensation Drain Pipes:- Rigid PVC Pipes of 6 kg/sqcm, duly insulated with 6 mm Thick Nitrile rubber pipe section.</p>			
		<p>G.I. Sheet Metal Factory Fabricated Duct Work As Per SMACNA Ducting Standards:- All Ducting work shall be SMACNA Standards with 22 Gauge to 26 Gauge. Ducting work should be suitable for external SP upto 250 Pa (ESP upto 25mmWg).Price shall be Included with MS supports.</p>			
		<p>Grill, Diffuser, Damper, Fire Motorized Damper, Jet Nozzle:- The all Items Shall be extruded powder coated aluminium. This Item shall be powder coated as per approved shade of colour.Sample to be submitted for prior approval.</p>			
		<p>Acoustic lining + Thermal Insulation : Acoustic Lining shall be 48 Kg/ M3 density resin bonded fiberglass included require accessories. Thermal Insulation shall be 5 mil fiber glass cloth factory Laminated with 12 or 13 mm thick Closed Cell Microcellular Elastomeric Nitrile Rubber.</p>			
		<p>Under deck Insulation for exposed slab with 50 MM Thk “TF” Quality Expanded Polystyrene with Washers, G.I. Crossed Binding Wires, Joints sealed with Bitumen etc.</p>			
		<p>Chilled water supply tapping with controlling valve as demand size with cooling metering by BTU meters for offices/ tenant area</p>			
		<p>Finished work complete in all respect</p>			
15	MISCELLANEOUS	Graphics and Signages	4390101.133		

	1	<p>Boom Barrier -6m barrier aluminum bar L = 6000 mm di. 100 x 40mm with fixed support, With VDC motor, control unit in box, double built-in LED flashing lights with Pair of Photocells with anodized aluminum vertical mountings.</p> <p>Photovoltaic Panel- • Solar PV Modules:- TP250 LBZ, 72 Cell, Polycrystalline Type With Tolerance- 0 To +2.5 % And 1.2 Mtr Cable, Length , Equipped With Bypass Diodes & Ip, 65 Junction Box, Configured With RFID Tags, IEC Certified. With Grid Interactive Solar Inverter (1 x 30KW, 415V AC, 50Hz, MPPT) Transformer less with DC to AC ratio 1.1, Earthing, super earthing kit - 1g635 along with accessories (maintenance free earthing) lightning arrester with 2 structure clamp.</p>		
		TOTAL COST FOR CONSTRUCTION WORK	413456153.60	
B	FOR OPERATION AND MAINTENANCE OF THREE YEARS			
1	MISCELLANEOUS 2	<p>Operation and Maintenance - 3 years Operation and Maintenance (after defect liability period of 1 year including O & M) for all work as mentioned in scope of work including HVAC, Electrical System, BMS Systems, DG Operations, Plumbing Services, STP, Fire Fighting, Lifts, Landscape Area and Miscellaneous Works, including all consumables, repairs i/c spares, replacement of equipments, fulltime and shift wise provision of manpower and any other services required to run the system successfully.</p>		
		a) for first year	6201842	
		b) for second year	10336404	
		c) for third year	13395754	
		TOTAL COST FOR THREE YEARS OPERATION AND MAINTENANCE.	29934000	
TOTAL PROJECT COST (A+B)			443390153.36	1 JOB

Executive Engineer

Mode of Payment of for various works

Mode of Payment of Building Work								
s.no.	Description	RCC Framed Strucure including water proofing (40%)	AAC Masonry (5%)	Flooring/ Wall lining (10%)	Finishing (inclusive of plaster, painting, S/S railing, toilet partitions,false ceiling) Doors and Windows (15%)	Steel work (5%)	Providing Fixing of structural facade and louvers (20%)	After complete finishing (5%)
1	Plinth slab/ Underground Water tank	8%	0.25%					After complete finishing (5%)
2	Stilt slab	4%	0.55%	1.50%	1.00%			
3	Podium slab	5%	0.60%	1.50%	1.50%	1%		
4	First floor slab	3%	0.40%	2.00%	1.50%	0.50%	5%	
5	Second floor slab	3%	0.40%	1.00%	1.50%	0.50%		
6	Third floor slab	3%	0.40%	1.00%	1.50%	0.50%	5%	
7	Fourth floor slab	3%	0.40%	0.50%	1.50%	0.50%		
8	Fifth floor slab	3%	0.40%	0.50%	1.50%	0.50%	5%	
9	Sixth floor slab	3%	0.40%	0.50%	1.50%	0.50%		
10	Seventh floor slab	2%	0.40%	0.50%	1.50%	1%	5%	
11	Eight floor slab	2%	0.40%	0.50%	1.50%			
12	Mumnty/ Over head tank/ Lift machine room	1%	0.40%	0.50%	0.50%			

Mode of Payment for Lift			
S.No.	Description	Providing and fixing of Lift systems (80%)	Testing and Commisioning with required approvals from concerning authorities if required (20%)
1	Passenger Lift 1	80%	20%
2	Passenger Lift 2	80%	20%
3	Passenger Lift 3	80%	20%
4	Service Lift	80%	20%

Mode of Payment for Development Work					
S.No.	Description				
1	Road Work	20% sub grade	70% on PQC	10% after completion	
2	Boundary Wall and Security hut and DG Room civil work	40% upto plinth	40% for super structure	20% after completion including finishing, flooring, glazed aluminum work etc.	
3	STP	40% on civil work based on approved drawings and designs.	50% at providing and fixing of all equipments AND PIPELINES.	10% after Testing and Commissioning including required approval from PCB.	
4	Landscape	30% after completion of civil work	30% after preparation of soil and irrigation system.	20% after plantation	20% after Testing and Commissioning of all systems

Mode of Payment for Internal Electrification Work					
S.No.	Description	Conduiting and Wiring, Switch and Sockets (50%)	Fittings and Fixtures(40%)	Testing and Commissioning (10%)	
1	Stilt slab	5%	4%	after successful Testing and Commissioning and approval (10%)	143
2	Podium slab	5%	4%		
3	First floor slab	5%	4%		
4	Second floor slab	5%	4%		
5	Third floor slab	5%	4%		
6	Fourth floor slab	5%	4%		
7	Fifth floor slab	5%	4%		
8	Sixth floor slab	5%	4%		
9	Seventh floor slab	4%	3%		
10	Eight floor slab	4%	3%		
11	Mumty/ Over head tank/ Lift machine room	2%	2%		

Mode of Payment for External Electrification Work				
S.No.	Description	On Supply of material & Equipments Transformer, HT VCB panel , Dg set , HT & LT cables , LT Panels & Distribution Panels , HT Over Head Line Equipments , External Light Fixtures etc.	On Installation of material & Equipments Transformer, HT VCB panel , Dg set , HT & LT cables , LT Panels & Distribution Panels , HT Over Head Line Equipments , External Light Fixtures etc.	On Successful commissioning & Testing
1	External Electrification work	60% against Providing and fixing of equipments	30% providing and laying cabling, wiring, over head lines etc.	10% after Commissioning after necessary approvals from MPEB / Safety department

Mode of Payment for Fire & safety system				
S.No.	Description	Providing Wiring ,Cabling , conduiting work	Providing and Fixing of Fire Alarm, CCTV ,Public Address , WI/Fi / Access Control / Energy Management Systems , Equipments , Hardwares , Software , Installation	Testing and Commissioning
1	Stilt Floor	30% against providing and fixing	60% against providing and fixing	1
2	Podium slab			4
3	First floor Floor			4
4	Second floor Floor			10% against Successful Installation Testing & commissioning with required approvals from concerning authorities if required
5	Third floor Floor			
6	Fourth floor Floor			
7	Fifth floor Floor			
8	Sixth floor Floor			
9	Seventh floor Floor			
10	Eight floor Floor			
11	Mumty/ Over head tank/ Lift machine room			

Mode of Payment for Fire fighting Work				
S.No.	Description	Providing and Fixing of Fire Fighting System(65%)	Providing and installing all equipments, hose reel along with pump.(25%)	Testing and Commissioning with required approvals from concerning authorities if required (10%)
1	Stilt slab	9%		
2	Podium slab	5%		
3	First floor slab	5%		
4	Second floor slab	5%		
5	Third floor slab	5%		
6	Fourth floor slab	5%		
7	Fifth floor slab	5%		
8	Sixth floor slab	5%		
9	Seventh floor slab	5%		
10	Eight floor slab	5%		
11	External Work	11%		
12	Total	65%	25%	10%

Mode of Payment for Plumbing Work						
S.No.	Description	Laying of PVC & CPVC pipe lines & Valves (17%)	Providing and fixing of CP Fittings and Sanitary Fixtures (40%)	Providing And Installing All Equipments Along With Pumps.(15%)	External Work (13%)	Testing and Commissioning (15%)
1	Plinth slab					
2	Stilt slab	2.0%	2.0%	9 % against Domestic & Flushing Pumps with Control valve accessories 6 % against on Water Filtration (WTP) system along with Pumps, Control valve accessories		After successful Testing and Commissioning (15%) 1 4 6
3	Podium slab	1.0%	2.0%			
4	First floor slab	1.5%	4.0%			
5	Second floor slab	1.5%	4.0%			
6	Third floor slab	1.5%	4.0%			
7	Fourth floor slab	1.5%	4.0%			
8	Fifth floor slab	1.5%	4.0%			
9	Sixth floor slab	1.5%	4.0%			
10	Seventh floor slab	1.5%	4.0%			
11	Eight floor slab	1.5%	4.0%			
12	Mummy/ Over head tank/ Lift machine room	1.0%	4.0%			
13	External Work	1.0%			13% against providing & Fixing Water supply, Drainage, stoma water & Rain water harvesting system all complete.	
14	Total	17%	40%	15%	13%	15%

Mode of Payment for HVAC Work				
S.No.	Description	Providing and Fixing of Chilled Water pipes, valves with insulation, Air distribution system, duct insulation.	Providing and fixing of Equipments- Chillers, CT, CHW & CDW Pumps, Expansion tank with Air Separator, AHUs, Cassette, FCU, Hi-Wall, Building ventilation fans & Smoke Evacuation Fan	Testing and Commissioning
		35.00%	55.00%	15.00%
1	Stilt slab	20%	37% against Chillers 9% Again Pumps, CT & Expansion Tanks with Air Separator 9% AHUs, Cassette, FCU, Building ventilation fans & Smoke Evacuation Fan	10%
2	Podium slab			
3	First floor slab			
4	Second floor slab			
5	Third floor slab			
6	Fourth floor slab			
7	Fifth floor slab	15%		
8	Sixth floor slab			
9	Seventh floor slab			
10	Eight floor slab			
11	Mummt/ Over head tank/ Lift machine room			
12	External Work			

Mode of Payment for Building Management System				
S.No.	Description	Providing Wiring ,Cabling , conduiting work	Providing and Fixing of BMS Systems , Equipments , Hardwares ,Software , Installation	Testing and Commissioning
1	Stilt Floor	30% against providing and fixing	60% against providing and fixing	10% against Successful Installation Testing & commissioning
2	Podium slab			
3	First floor			
4	Second floor			
5	Third floor			
6	Fourth floor			
7	Fifth floor			
8	Sixth floor			
9	Seventh floor			
10	Eight floor			
11	Mummy/ Over head tank/ Lift machine room			

Mode of Payment for Miscellaneous Work			
S.No.	Description		
1	Graphics and signages	100 % on completion	
2	Boom barrier	100 % on providing and fixing and testing	
3	Photovoltaic panels	80% on providing and installation	20 % on Testing and Commissioning
4	Operation and Maintenance	on quarterly basis	

SECTION 5

AGREEMENT FORM

AGREEMENT

This agreement, made on the _____ day of _____ between _____ (name and address of Employer) and _____ (name and address of contractor) hereinafter called "the Contractor" of the other part.

Whereas the Employer is desirous that the Contractor execute _____ (name and identification number of Contract) (hereinafter called "the Works") and the Employer has accepted the Bid by the Contractor for the execution and completion of such Works and the remedying of any defects therein, at a cost of Rs. _____

NOW THIS AGREEMENT WITNESSED as follows:

1. In this Agreement, words and expression shall have the same meanings as are respectively assigned to them in the conditions of contract hereinafter referred to and they shall be deemed to form and be read and construed as part of this Agreement.
2. In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to execute and complete the Works and remedy any defects therein in conformity in all aspects with the provisions of the contract.
3. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying the defects wherein Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.
4. The following documents shall be deemed to form and be ready and construed as part of this Agreement viz.
 - i. letter of Acceptance
 - ii. Contractor's Bid
 - iii. Condition of Contract: General and Special
 - iv. Contract Data v. Bid Data vi. Drawings
 - vii. Bill of Quantities and
 - viii. Any other documents listed in the Contract Data as forming part of the Contract.

In witnessed whereof the parties there to have caused this Agreement to be executed the day and year first before written.

The Common Seal of _____ was hereunto affixed in the presence of:

Signed, Sealed and Delivered by the said _____ in the presence of: _____

Binding Signature of Employer _____

Binding Signature of Contractor _____

ANNEXURE C 1

M.P. AUDYOGIK KENDRA VIKAS NIGAM LTD., INDORE

(A GOVT. OF MADHYA PRADESH UNDERTAKING – SUBSIDIARY OF MPTRIFAC LTD., BHOPAL)

Notice Inviting Tender (NIT) for PRE-QUALIFICATION OF CONTRACTORS

Construction of Administrative /IT/ITES complex adjoining crystal IT park, Khandwa road Indore i/c all allied works like HVAC, Electrical, lift, Plumbing, Fire fighting, Landscape, STP, BMS, Outer development etc. including 3 yrs Integrated property management (operation and maintenance)

Adjoining Crystal IT Park, Khandwa Road Indore (MP)

Employer

Managing Director,

**Reg. Office :- Free Press House,
first & second floor, 3/54, A.B. Road,
Press Complex, INDORE-11 (M.P.)**

E-mail : indoreakvn@gmail.com

Web. : www.mpakvnindore.com

**Phone : 0731-4070976, 2557363,
2574311, Fax : 0731-2572629**

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Abbreviations used:

HVAC	-	Heating Ventilating and Air Condition
ELVS	-	Extra low voltage supply
HSD	-	High speed Diesel
PWD	-	Public Works Department
INR	-	Indian National Rupees
BMS	-	Building Management system
EHS	-	Environment Health and Safety
RFP	-	Request for proposal

PRE-QUALIFICATION OF CONTRACTORS

- The Managing Director, Free Press House, First & second floor, 3/54, A.B. Road, Press Complex, INDORE-11 (M.P.) invites pre-qualification applications from reputed firms / contractors for the following work:

SCOPE OF WORK	PERIOD OF COMPLETION	ESTIMATED PROJECT COST
Construction of Administrative /IT/ITES complex adjoining crystal IT park, Khandwa road Indore i/c all allied works like HVAC, Electrical, Lift, Plumbing, Fire fighting, Landscape, STP, BMS, Outer development etc. including 3 yrs Integrated property management (operation and maintenance)	30 Months i/c rainy season from date of issue of work order	INR 44.34 Crores

Proposed Administrative/IT/ITES Office complex by MP AKVN Indore, Near Crystal IT Park, Indore									
Proposed Slab Areas (in sq.mt.)									
S.no	Floors	Proposed slab area	Circulation area			Area under Rest Room	Area under Services	Height in Mt. (Floor to Floor)	
			Parking slab	Lobby	Corridor Area				
1	Stilt Parking	2792	1954	195		21	622	3.1	
2	Podium Parking	2865	2552	236		21	56	5	
A	Total Parking	5657	Office area	431		42	678		
3	First	1920	1519	0	212	19	114	56	3.75
4	Second	1920	832	540	212	166	114	56	3.75
5	Third	1920	832	540	212	166	114	56	3.75
6	Fourth	1920	832	540	212	166	114	56	3.75
7	Fifth	1920	832	540	212	166	114	56	3.75
8	Sixth	1709	832	329	212	166	114	56	3.75
9	Seventh	1361	832	0	212	147	114	56	3.75
10	Eighth	1361	832	0	212	147	114	56	3.75
11	Mumty	150	0	0	150	0	0	0	3
12	STP & Security Hut	92							
B	All Floors	14273	7343	2489	1846	1143	912	448	
					2277		954	1126	
A+B	Total Area	19930	9832		3420		954	1126	

2. Contractors who fulfill the following requirements shall be eligible to apply:
- a) **Valid Registration** - At the time of submission of the Bid, the applicant should have valid registration with the Govt. of Madhya Pradesh, PWD in appropriate class. However, such bidders who are not registered with the Govt. of Madhya Pradesh and are eligible for registration can also submit their bids after having applied for registration with appropriate authority.
- b) **Similar Work** - The applicant should have satisfactorily completed/executed in any Government/Semi Government Department:
- (i) Three similar works costing not less than INR 15 Crores (under single contract) during the last five years
- OR
- (ii) Two similar works costing not less than INR 25 Crores (under single contract) during the last five years
- OR
- (iii) One similar work costing not less than INR 35 Crores (under single contract) during the last five years

Note:

- (i) For this purpose, Cost of work shall mean gross value of the completed/executed work. Contractor has to submit a certificate issued by the competent authority, not below the rank of Executive Engineer, as proof of work done.
- (ii) Similar work means multi storied building having at least five floors, excluding parking at any floor. Building should consist of R.C.C. framed structure and high end finishes, including all services such as HVAC, Electrical, lift, BMS, Plumbing, Fire Fighting etc all complete.
- c) **Financial Turnover** - The applicant should have total financial turnover not less than INR 100 Crores from construction works during last 3 years ending 31st March 2015 and submit proof of the same certified by a Chartered Accountant.
- d) **Bid Capacity** - Applicants who meet the minimum qualifying criteria in the evaluation are to be evaluated further for bid capacity as under:

$$\text{Bid Capacity} = (1.5 \times A \times B) - C,$$

Where,

- Bid Capacity derived by above formula should not be less than Estimated Project Cost
- A = Maximum value of building construction works executed in any one year during the last five years (10% weightage per year shall be given to bring the value of work executed at present price level)
- B = Proposed contract period in years
- C = Amount of work in hand at present

The applicant should enclose proof of same as per Form F.

Pending Litigation - The applicant should provide details of any pending litigations / arbitration, if any, in the format provided below:

S.N.	Description of Work Order	Name of Employer	Work Order Amount	Details of litigation / arbitration	Current Status

Applicants found providing false information or hiding required information during pre-qualification / tendering / construction shall be disqualified and appropriate action taken. In such cases, the awarded contract can be terminated and all costs arising out of this termination and appointment of another contractor shall be to the account of the applicant.

- e) **Blacklisting** – The applicant should not have been black-listed by any State / Central Department or PSU or Autonomous bodies and should submit a duly notarized affidavit to this effect. Application received without this declaration in original shall stand automatically rejected.
 - f) **Financial Resources** - The applicant must demonstrate access to or availability of financial resources such as liquid assets, unencumbered real assets, lines of credit and/or other financial means other than any contractual advance payments to meet minimum cash flow requirement of 25% of Estimated Project Cost.
 - g) **Net Worth**- The applicant should have average net worth not less than Rs 10.00 Crores (average of last 5 years). Certificate(s) from Chartered Accountant / Statutory Auditors specifying the net worth of the applicants, as at close of the preceding financial year and also specifying that the methodology adopted for calculating such net worth conforms to the provisions of this clause. For the purpose of this pre-qualification, net worth shall mean the sum of capital (paid up capital in case of companies) and reserves from which shall be deducted the sum of revaluation reserves, miscellaneous expenditure not written off and reserves not available for distribution to equity share holders (in case of companies). Applicant to provide data as per Annexure "G".
 - h) **Construction Quality & EHS Management** - The applicant should have a construction quality management and EHS management policy and system and should validate the same by enclosing relevant documents.
 - i) **Quality Management System** - The applicant should have a minimum of ISO 9001-2008 certification.
3. **Pre Bid Meeting** : As mentioned in Bid Document.
 4. The Managing Director, Free Press House, first & second floor, 3/54, A.B. Road, Press Complex, INDORE (M.P.) reserves the right to reject any prospective application without assigning any reason and to restrict the list of pre-qualified contractors to any number deemed suitable by it, if too many applications are received satisfying the basic pre-qualification criteria.
 5. The language for completing the application and for the accompaniment is English. All communication should be in English and type written.
 6. In case of any clarification required, it may be obtained from as below:

Managing Director,

Reg. Office :- Free Press House,
 first & second floor, 3/54, A.B. Road,
 Press Complex, INDORE-11 (M.P.)
 E-mail : indoreakvn@gmail.com
 Web. : www.mpakvnindore.com
 Phone : 0731-4070976, 2557363,
 2574311, Fax : 0731-2572629
 Website: www.mpeproc.gov.in

SECTION – I

BRIEF PARTICULARS OF THE WORK

1. Salient details of the work for which pre-qualification applications are invited are as under:

NAME OF WORK/ SCOPE OF WORK	PERIOD OF COMPLETION	ESTIMATED PROJECT COST
Construction of Administrative /IT/ITES complex adjoining crystal IT park, Khandwa road Indore i/c all allied works like HVAC, Electrical, Plumbing, Lift, Fire fighting, Landscape, STP, BMS, Outer development etc. including 3 yrs Integrated property management (operation and maintenance)	30 Months i/c rainy season from date of issue of work order	INR 44.34 Crores

Proposed Administrative/IT/ITES Office complex by MP AKVN Indore, Near Crystal IT Park, Indore									
Proposed Slab Areas (in sq.mt.)									
S.no	Floors	Proposed slab area			Circulatoin area		Area under Rest Room	Area under Services	Height in Mt. (Floor to Floor)
			Parking slab	Lobby	Corridor Area				
1	Stilt Parking	2792	1954		195		21	622	3.1
2	Podium Parking	2865	2552		236		21	56	5
A	Total Parking	5657	Office area		431		42	678	
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5	Third	1920	832	540	212	166	114	56	3.75
6	Fourth	1920	832	540	212	166	114	56	3.75
7	Fifth	1920	832	540	212	166	114	56	3.75
8	Sixth	1709	832	329	212	166	114	56	3.75
9	Seventh	1361	832	0	212	147	114	56	3.75
10	Eighth	1361	832	0	212	147	114	56	3.75
11	Mumty	150		0 0	150	0	0	0	3
12	STP & Security Hut	92							
B	All Floors	14273	7343	2489	1846	1143	912	448	
A+B		19930	9832		2277		954	1126	
					3420		954	1126	

2. The work is to be executed on plot admeasuring approx. 11290sqm area adjoining Crystal IT Park, Khandwa Road Indore (MP)
3. General features and major components of the work are as under:
 - i) Construction of Administrative /IT/ITES complex
 - ii) Internal External & External electrification
 - iii) HVAC
 - iv) Sewage Treatment Plant (STP)
 - v) Fire Protection System
 - vi) Development of Site including Roads , Landscaping work , boundary wall etc Security hut etc in 11290 sqm plot area
 - vii) DG Sets
 - viii) Plumbing & Water Supply works
 - ix) Sewage work
 - x) Internal and External Drainage
 - xi) Elevators etc
 - xii) Operation and maintenance for 3 yrs after one year defect liability period.
4. Work shall be executed according to general conditions of contract framed by Public works Department Govt. of Madhya Pradesh.

SECTION – II

INFORMATION AND INSTRUCTIONS TO APPLICANTS

1.0 GENERAL

1.1 Introduction

This Project provides for Construction of Administrative /IT/ITES complex adjoining crystal IT park, Khandwa road Indore i/c all allied works like HVAC, Electrical, Plumbing, Fire fighting, Landscape, STP, BMS, Outer development etc. including 3 yrs Integrated property management (operation & maintenance) after 1 year defect liability period. It is proposed to get almost the entire project including the Civil and Structural Work, HVAC, Lift, Water Supply Work, Sewerage Work, Internal and External Drainage Work, Electrical Work, Fire Protection Work, Landscaping Work and all other Incidental Works executed through a single agency.

1.1.2 Employer

The Employer for the Project is the MPAKVN(I)LTD, Indore (MP). The Employer's address is:

Managing Director,

Reg. Office :- Free Press House,
first & second floor, 3/54, A.B. Road,
Press Complex, INDORE-11 (M.P.)
E-mail : indoreakvn@gmail.com
Web. : www.mpakvnindore.com
Phone : 0731-4070976, 2557363,
2574311, Fax : 0731-2572629

1.1.3 Site

1. The work is to be executed on plot measuring approx. 11290sqm area adjoining Crystal IT Park, Khandwa Road Indore (MP)
The following information is given as a general guidance. The bidder is expected to make his own enquiries and visit the site and ascertain all relevant information regarding the site conditions.

1.1.4 Scope of Work

The project consists of following :

A) Construction Activities:

- i) Administrative /IT/ITES complex
- ii) Internal External & External electrification
- iii) HVAC
- iv) Sewage Treatment Plant (STP)
- v) Fire Protection System
- vi) Development of Site including Roads , Landscaping work , boundary wall etc Security hut etc in 11290 sqm plot area
- vii) DG Sets
- viii) Plumbing & Water Supply works
- ix) Sewage work
- x) Internal and External Drainage
- xi) Elevators etc

B) Defect Liability Period : 4 years

1. Initial, One year defect liability period after completion of the project including operation and maintenance of the system . No additional payment shall be made for any repair, replacement etc in civil, MEP equipments , Lift., Landscape & operation and maintenance of the system during defect liability period..
2. For further 3 years DLP, additional payment for 3 yrs O&M shall be made based on quoted rates. Scope of work for operation and maintenance of complete system shall include all consumable materials, repairs with spares, replacement of equipments, manpower for various services like HVAC , electrical, plumbing, landscape, fire system, BMS, Accounting, billing of electricity, water supply all facilities etc to run the system successfully.

1.1.5 General Instruction to Applicants

- a) Pre-qualification applications shall be for the entire scope of work. Partial and incomplete applications may be rejected.
- b) Application for pre-qualification duly supported by prescribed Annexures shall be uploaded as per e-procurement guidelines a hard bound hard copies of the same shall be submitted at the following address as per the notification:

Managing Director,
Reg. Office :- Free Press House,
First & second floor, 3/54, A.B. Road,
Press Complex, INDORE-11 (M.P.)
Phone : 0731-4070976, 2557363,
2574311, Fax : 0731-2572629

The documents submitted in connection with Pre-qualification will be treated as confidential and will not be returned.

- c) Cost incurred by the applicants in making the offer, in seeking or providing clarifications or on travel for whatsoever reason, will not be reimbursed by the Employer.
- d) The Prescribed schedules should be filled in completely and all questions should be answered. All information, as required in the schedules, should be furnished. If any particular query is not relevant, it should be answered as NOT APPLICABLE.
- e) Financial data and project costs should be stated in terms of and in INR.
- f) The information furnished should distinctly show if the applicant has satisfactorily executed works of comparable size and nature and that the applicant is capable of successfully completing the envisaged work. The submission should include copies of brochures, photographs and other documentation giving full information regarding the work so completed as also clients certificates for satisfactorily and timed completion which should not be below the rank of Executive Engineer.

1.2 ALL INFORMATION CALLED FOR IN THE ENCLOSED FORMS SHOULD BE FURNISHED AGAINST THE RESPECTIVE COLUMNS IN THE FORM. IF FOR

ANY REASON, INFORMATION IS FURNISHED IN A SEPARATE DOCUMENT REFERENCE TO THE SAME SHOULD BE GIVEN AGAINST RESPECTIVE COLUMNS. IF INFORMATION IS „NIL“ IT SHOULD ALSO BE MENTIONED AS „NIL“. INCASE ANY PARTICULAR / QUERY IS NOT APPLICABLE TO THE APPLICANT, IT SHOULD BE STATED AS „NOT APPLICABLE“. HOWEVER THE APPLICANTS ARE CAUTIONED THAT INCOMPLETE INFORMATION, APPLICATION FORMS NOT GIVING CLEAR TERMS OR MAKING ANY CHANGE IN PRESCRIBED FORMS MAY RESULT IN THE APPLICANT BEING SUMMARILY DISQUALIFIED. APPLICATIONS MADE BY TELEGRAM, FAX, TELEX OR EMAIL AND THOSE RECEIVED LATE WILL NOT BE ENTERTAINED.

- 1.3 The application should be printed. The applicant's name along with signature should be made on each page of the application.
- 1.4 Overwriting is not allowed. All pages of the pre-qualification document shall be numbered and submitted as a package with signed letter of transmittal.
- 1.5 References, information and certificates from the respective clients certifying suitability, technical know – how or capability of the applicant should be signed by an officer not below the rank of Executive Engineer / Equivalent Competent Authority.
- 1.6 The applicant is advised to attach any additional information, which he thinks is necessary in regard to his capabilities. He is however, advised not to attach superfluous information. No further information will be entertained after pre-qualification document is submitted unless it is called for by the employer.
- 1.7 Any information furnished by the applicant found to be incorrect either immediately or at a later date, would render him liable to be debarred from tendering / taking up of work with Govt. of India. If such applicant happens to be enlisted contractor of any Govt. Department, his name shall also be removed from the approved list of contractors.

2.0 DEFINITIONS

- 2.1 In this document the following words and expressions have the meaning hereby assigned to them.
- 2.2 EMPLOYER: Means the Managing Director, Free Press House, First & second floor, 3/54, A.B. Road, Press Complex, INDORE-11 (M.P)
- 2.3 APPLICANT: Means the individual, proprietary firm, in partnership, limited company, private or public corporation.
- 2.4 “Year” means “Financial Year” unless stated otherwise.

3.0 METHOD OF APPLICATION

- 3.1 If the application is made by an individual, it shall be signed by the individual above his full typewritten name and current address.
- 3.2 If the application is made by a proprietary firm, it shall be signed by the proprietor above his full typewritten name and the name of his firm with his current address.

- 3.3 If the applicant is a firm in partnership, it shall be signed by all the partners of the firm above their full typewritten names and current addresses or alternatively by a partner holding power of attorney for the firm in which case a certified copy of the power of attorney shall accompany the application. A certified copy of the partnership deed and current address of all the partners of the firm shall also accompany the application in both cases.
- 3.4 If the applicant is a limited company or a corporation, the application shall be signed by a duly authorized person holding power of attorney for signing the application accompanied by a copy of power of attorney. The applicant should also furnish a copy of the Memorandum of Articles of Association duly attested by a Public Notary.

4.0 FINAL DECISION MAKING AUTHORITY

The employer reserves the right to accept or reject any application and to annul the pre-qualification process and reject all applications at any time, without assigning any reason or incurring any liability to the applicants.

5.0 PARTICULARS PROVISIONAL

The particulars of the work given in Section –I are provisional. They are liable to change and must be considered only as advance information to assist the applicant.

6.0 SITE OF WORK

The applicant is advised to visit the site of work, at his own cost, and examine it and its surroundings to himself collect all information that he considers necessary for proper assessment of the prospective assignment.

7.0 INITIAL CRITERIA FOR ELIGIBILITY FOR PRE-QUALIFICATION:

- 7.1 The applicant should have sufficient number of Technical and Administrative employees for the proper execution of the contract. The applicant should submit a list of these employees stating clearly how these would be involved in this work.
- 7.2 The applicant should own construction equipment as per list required for the proper and timely execution of work. Else, he should certify that he would be able to manage the equipment by hiring etc.
- 7.3 References, information and certificates from the respective clients certifying suitability, technical know – how or capability of the applicant should be signed by an officer not below the rank of Executive Engineer / Equivalent Competent Authority.
- 7.4 The employer shall judge the eligibility of the contractor based upon above points and the final decision of pre-qualification of contractor rests with employer. Satisfying the minimum qualification does not earn the right to the contractor of pre-qualification.

8. FINANCIAL INFORMATION

Applicant should furnish the following financial information.

- a) Annual financial statement for the last five years (in form „A□). This should be supported by audited balance sheets and profit and loss accounts duly certified by

a Chartered Accountant, as submitted by the applicant to the Income Tax Department.

- b) Application specific financial arrangement for this project (Amount in Indian rupees).
 - (i) Own resources
 - (ii) Bank credit
 - (iii) Other (specify)
- c) Credit facilities:
 - (i) Name, Address of first class/Nationalized Bank providing credit line.
 - (ii) Total amount of credit line (attach certificate from the Bank).

9. EXPERIENCE IN CIVIL WORKS HIGHLIGHTING EXPERIENCE IN SIMILAR WORKS in Govt/Semi Govt departments :

9.1 Applicant should furnish the following:-

2014) A list of all works of similar nature successfully completed during the last five years (in Form „B□).

b) List of the project under execution or awarded (in Form „C□)

9.2 Particulars of completed works and performance of applicant duly authenticated / certified by an officer not below the rank of Executive Engineer / Equivalent Competent Authority should be furnished separately for each work completed or in progress.

10. ORGANISATION INFORMATION

APPLICANT IS REQUIRED TO SUBMIT THE FOLLOWING IN RESPECT OF HIS ORGANISATION

- a) Name and postal address including telephone, telex and fax number etc.
- b) Copies of original documents defining the legal status place of registration and principal place of business.
- c) Name and title of Directors and officers to be concerned with the work, with designation of individuals authorized to act for the organization.
- d) Information on any litigation in which the applicant was involved during the last five years, including any current litigation.
- e) Authorization for employer to seek detailed references.
- f) Number of Technical and Administrative employees in parent company, subsidiary company and how these would be involved in this work

11. CONSTRUCTION PLANT AND MACHINERY

Applicant should have sufficient equipments for construction along with centering and scaffolding and all other related items likely to be used in carrying out the work and complete the work in stipulated time.

12. AWARD CRITERIA

12.1 The employer reserves the right without being liable for any damages or obligation to inform the applicant to:-

- a) Amend the scope and value of contract.

- b) Reject any or all the applications without assigning any reason.
- 12.2 For any of the above action, the Employer shall neither be liable for any damages nor be under any obligation to inform the Applicants of the grounds for the same.
- 12.3 Any effort on the part of the applicant or his agent to exercise influence or to pressurize the employer would result in rejection of his application. Canvassing of any kind is prohibited.
- 12.4 Bidder shall also intimate the names of persons working with him in any capacity or subsequently employed who are near relatives to any officer in MPAKVN(I)ltd , Indore(MP)

13. SITE VISIT TO APPLICANTS SITES

The Employer reserves the right to visit the sites of pre-qualified bidders to ascertain the validity of information submitted in the pre-qualification document.

REPLIES TO PRE-QUALIFICATION QUESTIONNAIRE

Name of Work: Construction of Administrative /IT/ITES complex adjoining crystal IT park, Khandwa road Indore i/c all allied works like HVAC, Electrical, Lift, Plumbing, lift, Fire fighting, Landscape, STP, BMS, Outer development etc. including 3 yrs Integrated property management (operation and maintenance)

GENERAL

- 1. a) Name of Company-----
- b) Registered Address-----
Registered Address -----
- c) Telephone No. -----
Fax No. -----
- d) E-mail : -----
- e) Name and Status of Senior representative -----

1. Type of Works carried out –

2014) What is the nature of the Company / Firm? (Give details on separate sheets, if necessary)

2014) Independent -----

b) Member of Large Group -----

c) Supported by technical resources from some other source.

2014) Name, Address and experience of Consultants are enclosed at page no.
to

6. Certificate of financial soundness from the Banker/s of applicant. Enclosed at page

7. a) Name and address of the Bankers (from whom references can also be obtained).
 b) Can such reference be obtained directly by the Employer? No/Yes
Authorization letter
 Enclosed at page

8. Business Association to which the Company belongs;

9. Enclose copies of documents to substantiate registration with Govt. of Madhya Pradesh / Govt. of India.
 Enclosed at pages to

10. Enclose copies of trade license issued by authorities _____
 Enclosed at pages to

11. Enclose copies of relevant documents to substantiate registration of the company with the Chamber relevant in India.
 Enclosed at pages to

12. Enclose copies of relevant documents authenticated by the Civil Court to substantiate the association of the Company.
 Enclosed at pages to

13. Number of years experience as a Contractor briefly as follows
 Enclosed at pagesto

Experience
No of years.

Signature of Applicant (s)

Annexure "B"

(a) Similar Projects completed during the last 5 years

Title, Location and Brief Description of work	Cost in INR Crores	Client i/c Name and contact details of person with whom reference check can be made	Consultant	Contract Period for Completion	Actual period for Completion	Litigation / Arbitration pending, with details	c

Signature of App

Annexure "C"

(a) **Similar Projects under progress.**

Title, Location and Brief Description of work	Cost in INR Crores	Client	Consultant	Due Date for Completion	Up to date Progress		Slow Progress, if any, and reasons thereof
					Rs.	%	

Signature of App

Annexure "D"

PERFORMANCE REPORT OF WORKS REFERED TO IN ANNEXURE "B"

1. Name of work / Project and location
2. Agreement No.
3. Estimated Cost
4. Tendered Cost
5. Date of start
6. Date of completion
 - a) Stipulated date of completion
 - b) Actual date of completion.
7. Amount of compensation levied for delayed completion if any
8. Amount of reduced rate items, if any
9. Performance reports
 - i) Quality of work Very good Good Fair Poor
 - ii) Financial soundness Very good Good Fair Poor
 - iii) Technical Proficiency Very good Good Fair Poor
 - iv) Resourcefulness Very good Good Fair Poor
 - v) General behavior Very good Good Fair Poor

Dated:

Execute Engineer or Equivalent

Annexure "E"

STRUCTURE AND ORGANISATION

1. Name and address of applicant :
2. Telephone No. / Fax No./Mobile No./Email :
3. Legal status of the applicant (attach Copies of original document defining The legal status)
 - a) An Individual
 - b) A proprietary firm
 - c) A firm in partnership
 - d) A limited company or corporation
4. Particulars of registration with various Government bodies (attach attested photocopy)

Sl. No.	Organization / place of registration	Registration No.
---------	--------------------------------------	------------------

- i.
- ii.
- iii.
- iv.
5. Name and Titles of Directors and officers with designation to be concerned with this work.
6. Designation of individuals authorized to act for the organization.
7. Was the applicant ever required to suspend construction for period of more than six months continuously after you commenced the construction? If so, give the name of the project and reason for not completing the work.
8. Has the applicant, or any constituent partner in case of partnership firm, ever abandoned the awarded work before its completion? If so, give name of the project and reasons for abandonment.
9. Has the applicant or any constituent partner in case of partnership firm, ever been debarred / black listed for tendering in any organization at any time? If so, give details.

10. In which field of Civil Engineering construction you claim specialization and interest?
11. Has the applicant or any constituent partner in case of partnership firm, ever been convicted by a court of law? If so give details.
12. Any other information considered necessary but not included above.

Signature of Applicant(s)

Annexure "F"

Bid Capacity:

Bid Capacity derived by above formula should not be less than Estimated Project Cost. The bidding capacity shall be work doubt by the following formula:

$$\text{Bid Capacity} = (1.5 \times A \times N) - B,$$

Where,

- A = Maximum value of building construction works executed in any one year during the last five years (10% weightage per year shall be given to bring the value of work executed at present price level)
- N = Number of years prescribed for completion of work for which pre-qualification has been invited
- B = Total value of existing commitments irrespective of the completion period of those works

Signature of Applicant(s)

Annexure "G"

Net worth:

Year	Net worth
2010-11	
2011-12	
2012-13	
2013-14	
2014-15	
Average	

Signature of Applicant

Annexure "H"

List of Minimum Technical Personnel For The Key Positions

Minimum requirement						Available with the bidder					
S.No	Key Position	Minimum requirement	Qualification	Age	Similar work experience	S.No	Key Position	Minimum requirement	Qualification	Age	Similar work experience
1	Project Head	1	BE-Civil	<50	20						
2	Project manager MECHANICAL	1	BE-MECHANICAL	<50	15						
3	Project manager ELECTRICAL	1	BE-ELECTRICAL	<50	15						
4	Project manager CIVIL CONSTRUCTION	1	B.E.Civil	<50	15						
5	Senior Engineers CIVIL-UTILITY / PLUMBING / BILLING	4	B.E.Civil	<50	8-10						
6	Junior Engineers CIVIL-UTILITY / PLUMBING / BILLING	3	D.C.E	<50	5						
7	Safety Project manager Civil, Electrical and Mechanical works	1		<50	10						
8	Project manager HVAC	1	BE-Mechanical / Electrical	<50	10						
9	Project manager Fire fighting and safety works	1	BE-Civil / Mechanical / Electrical	<50	10						
10	Manager Landscape	1	Horticulture	<50	5						
11	BMS EXPERT	1	Degree in relevant field	<50	5						

12	Sewerage treatment plant Expert	1									
13	Lift expert	1									
14	Accounts Executive for billing of electricity supply, water supply, lease rent and other charges and collection of revenue and preparation of separate power accounts for ARR filing before MPERC through consultant	1									

Annexure “T”

Guideline for Key Equipment/Machines for Quality Control Labs

Guideline			Available with the bidder	
S.No	Name of Equipment/Machinery	Quantity	Name of Equipment/Machinery	Quantity
1	All Equipments/Machines which are required at site to perform recommended tests as per MORTH , NBC , PWD , MPSEB etc specifications as per scope of work.			
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				

Annexure “J”
Guideline for Key Equipment / Machines / formwork for Construction
Work

Guideline			Available with the bidder		
S.No.	Name of Equipment/ Machinery	Quantity	S.No.	Name of Equipment/ Machinery	Quantity
1	All Equipments/Machines/formwork which are required at site for successful completion of the work in given time limit as per scope of work and specification mentioned in . MORTH , NBC , PWD , MPSEB etc				
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

ANNEXURE-E1

MAIN BUILDING WORK

For all SOR items refer MPPWD SOR 2014 with effective from 1st August 2014 / NBC/ CPWD with all amendment up to date.

Technical Specification of SS Railing:-

SS Railing of approved make and design shall be supplied for installation with height and width as per Railing drawings.

The SS Railing shall conform as per drawing and approved by engineer-in-charge or consultant with following accessories:-

- SS Knock down railing system with ø38mm Handrail.
- SS Flat Baluster 10X50mm.
- SS Glass Holding Accessories.
- SS top bracket to hold hand railing.
- 10MM Thick Toughened Glass.
- 12MM Thick Laminated toughened Glass to sustain high wind pressure at building height up to 38 Mt.
- Balusters fixed onto floor with casted base plate of minimum 6mm thickness.
- Base Plate shall be concealed with suitable S.S. 304 Grade cover cap so that the mounting anchor fasteners are not visible after installation.
- Wall thickness of Handrail & Baluster Pipes shall be taken as 1.5mm & Mid Rail Shall be 1.2 mm along with all visible components developed in High Grade S.S.
- Whenever required, joints to be filled with Bushings for extra strength.
- All Stainless Steel items should be of Grade 304 and 16 gauge.

Technical Specification of Architectural Façade (Aero/V Shaped SUN LOUVERS):-

Horizontal Fixed louvers for building facade of approved make and design at locations as per drawing details.

SPECIFICATIONS:

Fin Measurement: Width=200 Height=70 Distance=200/400(As per drawings)

Principle elements:

1. Installing Bracket
2. Assembly Channel
3. Press Plate
4. Nylon End Cap
5. Aluminum Skin Fin

Center to Center Distance of Fin:

The center to center distance of the Fins has been calculated according to the solar altitude angle and the solar azimuth angle of the site and must be as per the detail drawings.

SPECIFICATIONS:

Wall thickness – Aluminum extrusion minimum 2 mm

Pre-coated Aluminum Sheet

Alloy extrusion – Al-Mg–Si 0.5 F22 (EN 755-2-6063-T66)

Thickness-0.7mm

Fixation – Click-in Sliding U-Profiles and Plastic fixation disks and fin-suspension connector.

Surface Treatment:

- Natural anodized in 20 micron thickness with ISO -10546-93
- One layer polyester powder-coated; 60 micron
- Two layer polyester powder-coated; 60 micron
- Two or three layer PVDF powder coated; 30 or 40 microns

Color:

According to RAL standard color card as approved by consultant.

Supporting structure:

Steel or aluminum structure to be as per MPPWD SOR 2014 and suitable to support occurring loads. Contact between mild steel and aluminum to be avoided.

Technical Specification of Lift:-

Passenger lift:-

- 3 no. passenger lift of 884kg capacity of 13 person with machine room.
- At speed of 1.5 meter per second with gearless machine.
- Car size of 1550 x 1400x 2200.
- Door opening: - 900x2000 m.
- Pit depth of 1600 mm.
- PVC car flooring.
- 415 volts, 3 phase, 50 Hz.
- Car indicators at all landings.
- Stainless Steel Hairline Finish with half-length mirror on rear wall and axial fan for ventilation.
- Handrail on each wall of car.
- Automatic center opening doors with VVF drive.
- Door open and close.
- Pit ladder.
- Fireman's control switch.
- Attendant function.
- Intercom and Car Arrival chime on car top.
- Infra-red screen for car door.
- Door nudging.
- Voice Announcement in car.
- Overload device.

Service lift:-

- 1 no. bed cum pax elevator capacity of 15 person with machine room.
- At speed of 1.5 meter per second with gearless machine.
- Car size of 1000 x 2400x 2200.
- Door opening of 900 x 2000mm.
- Pit depth of 1700 mm.
- PVC car flooring.
- 415 volts, 3 phase, 50 Hz.
- Car indicators at all landings.
- Stainless Steel Hairline Finish with half-length mirror on rear wall and axial fan for ventilation.
- Handrail on each wall of car.
- Automatic center opening doors with VVF drive.
- Door open and close.
- Pit ladder.
- Fireman's control switch.
- Attendant function.
- Intercom and Car Arrival chime on car top.
- Infra-red screen for car door.
- Door nudging.
- Voice Announcement in car.
- Overload device.

Technical Specification of Toilet partition

Toilet partition of approved make and design shall be supplied for installation with overall height of 1955 mm including gap of 150mm from bottom which includes 600mm door size shall with 12 mm Thick Compact Laminate Board of Single color.

The partition shall conform as per drawing and approved by engineer-in-charge or consultant with following accessories:-

- SS Top Rail (Stainless Steel Grade 304 with Satin Finish).
- SS Coat Hook (Stainless Steel Grade 304 with Satin Finish).
- SS Hinges (Stainless Steel Grade 304 with Satin Finish).
- SS door knob (Stainless Steel Grade 304 with Satin Finish).
- SS thumb turn Occupancy Indicator (Stainless Steel Grade 304 with Satin Finish).
- SS "U" Channel (Stainless Steel Grade 304 with Satin Finish).
- SS "F" Channel (Stainless Steel Grade 304 with Satin Finish).
- SS Palm Design Adjustable Foot (Stainless Steel Grade 304/316 with Satin Finish).
- SS Screws & Inserts (Stainless Steel Grade 304 with Satin Finish).
- Rubber Lining for Door Stopper.

Approved Make List of Building Work					
S.no.	Item	Make			
1	CONCRETE				
	Concrete Admixtures	Fosroc	BASF	Cico	
	Cementitious Non Shrink Grout	Sika	Kerakoll		
	Grey Cement (PPC)	Ultratech	BirlaSuper	Lafarage	Coromondal
	White Cement	Birla	J.K Cement		
	Floor Hardner	Fosroc	Sika AG	Kerakoll	
	Integral Water Proofing Compound	Sika	Fosroc	MYK Shomburge	Pidilite
	TMT "Fe-500 D" Ribbed bars	TATA	SAIL	RINL	Jindal
	Structural Rolled Steel sections- beams, channels,tee, flats, angles, bars(round, square, hexagonal)	TATA	SAIL	RINL	Jindal
	Structural Hollow Steel Sections (Square & Rectangular)	TATA	SAIL	RINL	Jindal
	Structural Tubular Sections	TATA	SAIL	RINL	Jindal
	Coarse Aggregates (machine cut) 6mm to 40 mm sizes	Approved quarry from Pithampur	Approved quarry from Devguradiya	Approved quarry from Dhar Road	
	Stone Rubbles & Gravels	Approved quarry from Pithampur	Approved quarry from Devguradiya	Approved quarry from Dhar Road	
	Shuttering Plywood	Green	Century	Mayur	
	Anti-termite treatment of buildings	Pestcontrol India			
	Anchor fasteners	Hilti	Fischer	Anchorman	
	Construction Chemicals (SBR Latex, Bonding agents, Plasticisers, Micro Concrete)	Fosroc	BASK	MYK Shomburge	
2	MASONRY				
	AAC Block	Wonder	Magicrite	Siporex	Xtralite
	Plaster mesh/ Brick mesh	Kerakoll	Amax International		
	Blocks joining mortar	Magicbond	Fixobloc		
3	FINISHING				
	Stone Grit Plaster	Birla White	JK Cement		
	PAINTS - Premium Emulsion for Interior/Premium Exterior Emulsion/ Hi-Gloss Enamel/ Satin Enamel/Acrylic Wall Putty / Cement Based Wall Putty/ All Surface Primer	AsianPaints	Axzonobel	Berger	
4	DOORS & WINDOWS				
	Fire Door	Shaktimat	AGEW	Radiant	
	Aluminium Sections	Jindal	Hindalco	Indal	
	Glass / Reflective Glass	Saint Gobin	Modi guard	Ashai India	

	Flush door	Greenply	Woodside	Century	Mayur
	Ply & Block Boards shutters	Greenply	Century	Mayur	
	Pressed Steel Door	Perfect (pil) Ahemdabad	AGW	Anand Windows (New Delhi)	
	Hardware (Door fittings)	Godrej	Kich	GKW	Palladium
	Laminate/Veeners	Greenlam	Merino	Century	Mayur
	ACP Panels	Alstone	Alucobond	Eurobond	
	Doorlock	Godrej	Dorma	Ozone	Enox
	Hydraulic Door Closer	Dorma	Ozone	Enox	
	Patch Fittings	Ozone	Dorma	Kanz	
	Glass door handle	kich	Dorma	Ozone	Godrej
	Mortice handles	kich	Dorma	Ozone	Godrej
	Prelaminated particle board	Tesa	Century	Archid	Greenlam
	Wood Adhesive	Fevicol SH	Araldite	Vamicol	
	Silicon Sealant	Sika	Pidilite	Chawksey	
5	FLOORING				
	Floor Adhesive	Kerakoll	BAL Endura	Laticrete	
	Vitrified Tile	Nitco	Asian	Somany	Kajaria
	Antiskit Vitrified Tile	Nitco	Asian	Somany	Kajaria
	Tactile	Endura (Johnson)	Asian		
	Ceramic Tile	Nitco	Asian	Somany	Kajaria
	Paver Block				
6	MISCLLEANEOUS				
	MS Rolling Shutter	Gandhi	Avians		
	Polycarbonate Sheet	DPI System	Danpalon	Solalite	Everlite
7	NON SOR				
	Elevators	Thyssenkrupp	Johnson	Otis	
	Toilet Partition	Greenlam	Merino		
	SS Railing	Kich	Fitwell	Shakti	
	Louvers	Hunter Dougous			
	Photovoltaic Panel	TATA	Divakar PV Solutions		
	STP	Eureka Forbes	Fleix	WEEW	
NOTE :					
All The materials to be ISI marked.					
The materials shall be only of the approved makes as specified in this .					
The Contractor shall submit samples of all the makes as specified in this list and the Consultant / AKVN shall have the power to select any of them.					
Consultant/ AKVN decision in this regard shall be binding on the Contractor.					
In case any material is not available for any one or all of these approved makes the Consultant/ AKVN shall select and approve alternative make(s).					

ANNEXURE–E2

DEVELOPMENT WORK

For all SOR items refer MPPWD SOR 2014 with effective from 1 August 2014 / NBC/ CPWD with all amendment up to date.

Sewage Treatment Plant:

- Sewage Treatment Plant of 60 KLD using MBBR technology, of approved make and design shall be supplied for installation.
- The treated sewage shall confirm to State Pollution Control Board norms and shall be reused for gardening /flushing.

The STP shall have following specifications:

- TDS, Hardness, Un-biodegradable matter resistant.

• **Water Quality:**

Sr. No.	Parameters	Unit	Raw Sewage	Treated Sewage
01.	Flow	cum/day	60	54 -57
02.	pH	---	6.0 – 7.0	6.5 – 7.5
03.	C.O.D.	mg/l	450	<75
04.	B.O.D.	mg/l	250	<10
05.	Total Suspended Solids	mg/l	300	<10
06.	Oil & Grease	mg/l	15	<10

- Hydrolyzing and Aeration Tanks
- MBBR Media for Aeration Tank with either Cylindrical ring or Gel Based with quantity as per design.
- Twin lobe or other Equivalent Air Blower.
- Tube / disc type - Air Diffuser with Fine Bubble Size.
- Secondary Settling Tank.
- CDTS 60 or Eq. Type - Tube Settler for Settling Tank
- Treated Water Tank as per design
- Submersible sludge pump for Treated water Transfer Pump with Flow and Head = 2.5m³/Hr @ Head of 20 Mtr.
Quantity = 1W + 1S
- Sand Filter with capacity of 2.5m³/Hr.
- Activated carbon Filter with capacity of 2.5m³/Hr and Activated Carbon Media = 1000 IV.
- MS/CPVC Pipes, Valves & other Fittings.
- Interlocked Electrical Control Panel for operation of various pumps, blowers etc. Auto & manual mode, preferred PLC control as design and blower operation control.
- All civil work should be done with M25.
- There should not be any unlined underground water storage in the radius of 100 meters.
- Whole system should preferably be Compact, low maintenance, low energy input, high efficiency and must not create odour nuisance.

Specifications for Fountain:-

- Electromechanical equipment with top mounted filter plant with flow of 5cum /hr @ 33 mt,
- Filter media- quartz silex 16/32.
- Filter dia 450mm, with 7.5 HP, CI body circulation pump III phase for water fall and bubbler nozzles.
- Electrical panel in 16 gauge powder coated CRCA sheet with DOL starter.
- Water level dependant cascade geyser jet nozzle code 3450 size 1" giving 6m³/hr at 8 m head.
- Al powder coated LED 6x1 watt warm white extra flat SS surface mounted light 12v DC with control panel.
- PVC Ball valves, NRV, butterfly valves, foot valves, sluice vales in sizes suiting to PVC pipes / uPVC sch 40 pipes.
- RPVC pressure pipes manufactured as per IS standard including all fittings such as bends, elbows, reducers, tees, unions, couplers, tail pieces, rubber gaskets, GI nut bolts etc.
- Supports as per specifications- **LS** 1100 volts grade PVC insulated copper conductor wires in conduit.
- Plumbing in water body - Pr class 6 PN- **LS**.
- 1100 volts grade PVC insulated copper conductor wires for Single phase / 3 phase wiring (2 core 2.5 sq mm and 4 core 2.5 sq mm).

Specifications for Irrigation System:-

- Drip Irrigation system.
- Pipes -PVC ISI marked Pipe-6 kg/sq cm.
- Inbuilt PC Drip line- 16mm/30cm/2Lph.
- Sprinkler – Brass RQRC Popup spray head VAN nozzle, Rotary nozzle(50x $\frac{1}{2}$ ", 40x $\frac{1}{2}$ ", 50x $\frac{3}{4}$ ", 40x $\frac{3}{4}$ "),
- PP saddle Tee.
- Valves and filtration unit- lateral line pvc ball valve, glycerine filled pressure gauge.
- Submersible Pump –bottom suction pump 4HP having discharge 12cum@ 50 mt. head with control panel DOL starter, MCB , voltmeter, ammeter, I phase preventer with required accessories like suction and delivery pipe, NRV, ARV & water level controller.
- Automation unit-
- 1.0"-1.5" solenoid valve, 10" valve box, 16 station controllers, including 1.4 sq mm.
- 1.3 sq mm, 2 solid core copper conductor direct burial cables.
- DB series water proof wire connector with splices.

Approved Make List of Development Work				
S.no.	Item	Make		
1	PUMP	Franklin	Texmo	Shakti
2	Drip Irrigation & Pop-up system	Rain bird	Toro	Harit
3	Plasctic Pots	Harshdeep	Supremo	Neelkamal
4	Light fixtures	Hybac	Abba	Wipro
5	PVC Pipes	Kasta	Phenolex	Supreme
6	Glass Mossaic Tiles	Inex	Matrix	
7	Fountain bubbler nozzles & other acessories	Premier	Garden jewels	Vinayak
NOTE :				
All The materials to be ISI marked.				
The materials shall be only of the approved makes as specified in this .				
The Contractor shall submit samples of all the makes as specified in this list and the Consultant / AKVN shall have the power to select any of them.				
Consultant/ AKVN decision in this regard shall be binding on the Contractor.				
In case any material is not available for any one or all of these approved makes the Consultant/ AKVN shall select and approve alternative make(s).				

ANNEXURE – E3

ELECTRIFICATION WORK

- INTERNAL WORK
- EXTERNAL WORK
- FIRE & SAFETY WORK
- BMS WORK

TECHNICAL SPECIFICATIONS FOR INTERNAL WORK

WIRING SYSTEM :

1.1 SCOPE:

The scope of work under this section covers installation and wiring for lights, fans, exhaust fans, call bells, fan coil units, geysers and power sockets etc., The wiring shall generally be done using PVC insulated copper conductor multi strand wires FRLS in PVC HMS FR grade conduits as called for including providing switches, sockets, plug tops, electronic fan regulators, outlet boxes etc.

1.2 STANDARDS:

The following latest standards and rules shall be applicable:

IS : 732	Code of practice for electrical wiring installation (System voltage not Exceeding 1100 V).
IS : 1646	Code of practice for fire safety of buildings (General) Electrical installation.
IS : 9537	Conduits for Electrical installations (Part 1-4)
IS : 2667	Fittings for rigid steel conduits for electrical wiring.
IS : 3480	Flexible steel conduits for electrical wiring.
IS : 3837	Accessories for rigid steel conduit for electrical wiring.
IS : 694	PVC insulated cables.
IS : 6946	Flexible (Pliable) non-metallic conduits for electrical installation.
IS : 1293	Plugs and sockets outlets of rated voltage upto and including 250 V.
IS : 8130	Specifications for conduits for electrical installation.
IS : 3854	Switches for domestic and similar purposes.
IS : 3419	Fittings for rigid non-metallic conduits.
IS : 4648	Guide for electrical layout in residential building.
IS : 4649	Adapters for flexible steel conduits.
IS : 5133	Boxes for enclosures of the Electrical.
IS : 4615	Switch socket outlets.
IS : 8884	Code of practice for installation of Electric bells and call system.
IS : 2551	Electric Danger notice plates.
IS : 3646	Code of practice for interior illumination.
IS : 371	Ceiling Roses.

IS : 302	General and safety requirements for household and similar electrical appliances.
IS : 3043	Code of practice for earthing.
IS : 5216	Guide for safety procedures and practices in electrical work.

Indian Electricity Act and Rules.

Regulations for the electrical equipment in buildings issued by the concerned Electrical Authorities.

All standards and codes mean the latest.

1.3 POINT WIRING FOR LIGHTS, FANS, EXHAUST & 6 AMPS CONVENIENCE SOCKETS:

1.3.1 A point wiring shall consist of the wiring from switch/electronic fan regulator as required, including providing conduit & accessories, pendant holder or a swan holder, or ceiling fan hook box or socket etc., with suitable termination. A point wiring shall include, in addition, the earth continuity conductor/wire from the switch board to the earth pin/stud of the outlet/switch box/ light fitting & fans & all other such non current carrying metals shall be earthed and to the outlet points. No tee jointing or looping of wires shall be done anywhere except at a switch box or a light fitting or a plug socket outlet as shown in drawing.

The point wiring shall be carried out in the under mentioned manner :

1.3.2 Supply, installation, fixing of conduits and Steel wire/ G.I. pull wire with necessary accessories, junction/pull/ inspection/switch boxes and outlet boxes/Fan hook box etc. However Switches, Switch plates & switch boxes are not required for the lights which are controlled directly from the MCB DB's.

1.3.3 Supplying and drawing of wires of required size including earth continuity PVC insulated wire.

1.3.4 Supply, installation and connection of flush type switches, sockets, cover plates, switch plates & fixing fan regulator, lamp holder, ceiling rose etc.,

1.3.5 The point shall be complete with the branch wiring from switch board, conduit with accessories, junction, pull/inspection boxes, control switch, socket, outlets boxes, ceiling roses, lamp holder, connector, extension cord wire, flexible conduits etc.

1.4 POINT RATE:

For the purposes of installation the rate for point wiring shall include the following:

i) Point Wiring.

And for the purpose of measurements and payments the points shall be designated as follows:

ii) One light controlled by one switch.

These points are light/fan points of given length from switch to the first point.

iii) Two nos. of lights controlled by one switch and so on.

These points include wiring for first point as mentioned above and subsequent points looped from the first point to next light points and are controlled from the same switch as the first point.

a) The Circuit Main:

The circuit main for lights/fan/6A sockets (where 6 A sockets connected to light circuit) shall include the wiring from the switch board / MCB DB as specified in schedule of quantity upto the first switch/light point/fan point. The scope of work shall include the following:

- i) Supply and wiring in concealed/surface conduit from switch board/DB's as specified in schedule of quantity to first switch/light/fan point.
 - ii) Providing PVC insulated copper conductor earth wire.
 - iii) Providing Steel/G.I. fish wire (pull wire) in the conduit.
 - iv) Termination of wires in switch board / DB's & switches using proper tinned copper lugs of soldering/crimping type.
 - v) Providing necessary pull/junction boxes where necessary.
 - vi) Identification of circuits shall be done with ferrule nos.
- b) Point Wiring:

The point wiring shall include supply, installation, connection, testing and commissioning of point wiring in conduit. The exact scope of work included in the point wiring is enumerated as stated below :

- i) Wiring from the first switch/light/fan point, where the circuit main is terminated to the various lights/fans/sockets (where 6A sockets connected to light circuit loop), and then looping between the switches/lights/fans/6A sockets etc.
- ii) Providing all necessary switches, switch plates, sockets, outlet boxes/pull/junction/fan hook boxes etc.
- iii) Providing insulated earth continuity wire with each circuit in the conduit along with the wiring system.
- iv) Providing G.I. fish wire (pull wire) in the conduits.
- v) Providing & installing lamp holders where ever necessary.
- vi) Providing PVC insulated, PVC sheathed flexible three core 2.5 sq. mm extension cords including flexible conduits from outlet points mounted at false ceiling point to the light outlet.

NOTE:

The point shall be measured in nos/sets/group of lights controlled from switch board / DB as mentioned in the BOQ.

c) Wiring for 6/16 Amps Power Sockets for Equipment Wiring

The work for wiring of 6A/16A sockets and wiring for power outlets shall include following:

- i) Supply & installation of conduits from DB (concealed/ surface) with its accessories up to the 6/16 A power point in required size of conduit.
- ii) Wiring from DB to the 6/16 A power point including earth wire of specified size.
- iii) Supply and installation of the socket outlet with outlet boxes of approved make and Control switch of approved make.

All 6/16 A, power socket outlets shall be measured in numbers.

1.5 SYSTEM OF WIRING:

Unless otherwise mentioned on the drawings, the system of internal wiring shall be as follows:

The system of wiring shall consist of single core, PVC insulated, 1100 Volt grade, stranded copper conductor wires/cables FRLSH laid through concealed or exposed PVC/MS conduits as mentioned elsewhere or as directed by Construction manager /Consultant.

1.6 GENERAL:

Prior to laying and fixing of conduits and light outlet boxes, contractor shall carefully examine the layout drawings and prepare detailed shop drawings, indicating the exact location of light outlets, with distances marked, conduit routing, with sizes, No. of wires run in each conduit, control switch location etc. The contractor shall obtain the approval of all shop drawings by the Construction manager/Consultant prior to the installation of conduits. Any discrepancy noticed in the design drawings shall be brought to the notice of the Construction manager/ Consultant. Any suggestions or modifications suggested by the contractor shall have the approval of Construction manager/Consultant before execution.

1.7 CONDUITS :

1.7.1 Type of Conduit

Unless otherwise specified all conduits for concealed/ surface/exposed installation including conduits running above

false ceiling shall be of 2mm thick FR Grade HMS PVC conduits.

1.7.2 PVC Conduits :

Conduits and Accessories shall conform to IS:9537 (Part-2). All conduits shall be PVC conduit of 2mm wall thickness High Mechanical strength FR grade ISI marked.

No conduit less than 20mm in diameter shall be used. Conduits shall be wall thickness of 2mm wall.

The conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer & ISI Mark (Engraved Markings) or painted markings.

Conduit accessories such as bends, coupling etc., shall be conforming to relevant Indian Standard Specifications.

The number of 1100 volt grade PVC insulated copper conductor wires that may be drawn in the conduits of various size shall be in conformity with code of practice for electrical wiring installation IS 732.

1.8 CONDUIT ACCESSORIES :

1.8.1PVC. Conduit Bends & Collars:

The pvc conduit bends and collars shall be of pvc . The bends and collars shall conform to IS 2667 & having ISI mark. The conduit bends & collars shall preferably be of the same make as of conduit. The minimum radius of conduit bend shall be 2 1/2 times the outer diameter of the conduit pipe. Where necessary conduit bends with inspection door shall be used, only factory made ready made bends shall be used.

1.8.2Junction/Pull/Inspection Boxes:

The boxes for junction/pull/inspection boxes to be used with PVC conduit installation shall be heavy gauge black enameled M.S. boxes. These boxes shall be manufactured in conformity with ISI specification and to match the type of conduit used.

The boxes shall be of round/square or rectangular shape and shall have minimum 50mm depth. The box shall have threaded stub projection to terminate M.S. conduits. The boxes shall have concealed screwed sockets for fixing the ceiling rose or cover plate.

2 SWITCH OUTLET & SOCKET OUTLET BOXES :

2.1 Concealed Type outlet Boxes

The concealed outlet boxes for switches, sockets, power outlets, telephone outlet, fan regulator etc., shall be of same make as of switches/sockets etc. to match the exact requirement of combination of outlets. The boxes shall be fabricated out of heavy gauge CRCA cold rolled carbon alloy sheet steel with zinc plating (G.I). The size of boxes should match the type of outlet/switch plate to be mounted on the box. The adequate No. & size of knockout holes shall be provided to terminate the conduits in the box. These boxes shall be standard factory made product of same make as of switch plates & sockets. Separate screwed earth terminal shall be provided in the box for earthing.

The outlet box shall be of minimum depth of 50mm. Boxes shall be suitable for grid mounting type of accessories. Long screw shall be provided to take care of the extra plaster thickness to mount the switch plates. Provision shall be made in the box & switch plate to have the minor adjustment of alignment of switch plate to plumb level.

2.1.2 Surface Type Boxes:

The boxes for mounting switches, sockets and other wiring devices shall be either moulded plastic or heavy gauge CRCA sheet steel painted to match the colour of wall. The box shall be suitable to terminate the M.S. surface conduit into the box. The size and shape of box shall match the exact type and combination of switch plates, receptacles & wiring devices. Deep boxes shall be used to facilitate easy termination of conduit & wires/cables. Separate screwed earth terminal shall be provided in the box for earthing.

2.1.3 Light Outlet Boxes :

For concealed PVC conduit installation the light outlet box shall be of PVC (round/square) with knock out holes, conduit projection suitable to terminate the conduit to the box. The box shall be made of heavy gauge PVC & the sample to have the approval of Construction manager/Consultant before use. The boxes shall have concealed screwed socket to fix the ceiling rose. The boxes shall be minimum 50 mm deep.

For surface conduit installation the light outlet box shall be of black enameled M.S. boxes. The boxes shall have threaded stub projection having internal threading to terminate the conduit of different sizes. The boxes shall be minimum 50mm deep.

2.1.4 Ceiling Fan Hook Boxes:

The ceiling fan hook box shall be fabricated of 2mm thick M.S. with adequately sized M.S. rod/hook to fix the ceiling fan. The hook shall be concealed within the fan hook box. The side extensions of rod shall be sufficiently long enough to provide adequate anchorage in the concrete. The size of the box shall be such that it should be totally covered by the plastic canopy of the ceiling fan. The box shall have anticorrosive primer coating.

2.1.5 COVER PLATES FOR SWITCHES & OUTLETS

Switches/socket/wiring devices plates shall be the same product as of switches/sockets/wiring devices. This shall be of best quality moulded plastic grid mounting type device plates/frames and shall match with the type of switches/sockets & boxes.

2.1.6 COVER PLATES FOR INSPECTION/JUNCTION/PULL BOXES

The cover plate for PVC boxes shall be minimum 3mm thick of Perspex /formica sheet cover. For M.S. boxes cover plate shall be black enameled M.S. plates. The shape of the plate shall match that of the box.

2.1.7RECEPTACLES

The sockets shall conform to IS 1293. Each socket shall be provided with control switch of appropriate rating. The sockets shall be moulded type rated for 250 volts and of full 6 Amp or 16 Amp capacity as mentioned on the drawings.

The 6/16 Amps sockets shall be multi pin (6 pin) automatic shutter type suitable for plugging 6 Amps/16 Amps tops. The shutter shall open when the earth pin of the plug top inserts in the socket. Where called for the 16 Amps socket shall have indicating lamp. The socket outlets & switches shall be of grid mounting type. Where called for sockets shall be provided with three pin plug top suitable to the socket & of the same make as of socket. The socket outlets installed outside the building/open to sky or in damp/wet areas shall be weather proof water tight type.

2.1.8INDUSTRIAL TYPE SOCKETS

The socket outlets single phase or three phase installed in basement area, kitchen etc., shall be three pin or 5 pin industrial type with MCB (Single phase or three phase) control. The socket & MCBs shall be mounted in a sheet steel enclosure and shall be the standard factory made product.

2.1.9CONDUCTORS :

All PVC insulated Copper conductor wires shall conform in all respects to standards as listed under sub-head 'Regulations and Standards' and shall be of 1100V Grade.

2.1.10 PVC insulated wires (for light & small power wiring)

- a) The PVC cables shall conform to IS : 694/1977. For all internal wiring PVC insulated cables of 1100V grade, single core shall be used.

The conductors shall be plain annealed copper conductors complying with relevant ISS.

The conductors shall be circular stranded copper conductor.

- b) The minimum number and diameter of wires for circular stranded conductor shall meet the requirements set out in the relevant Indian Standards.
- c) The insulation shall be PVC compound complying with the requirements of relevant ISS. It shall be applied by an extrusion process and shall form a compact homogeneous body.

The thickness of PVC insulation shall be as set out in the relevant standards.

- d) The cores of all cables shall be identified by colors in accordance with the following sequence.

Single phase	- Red
Three phase	- Red, Yellow, Blue
Neutral	- Black
Earth	- Green or Green/Yellow.

A means of identifying the manufacturer shall be provided throughout the length of cable.

2.1.11 Wire Sizes:

Unless otherwise specified in the drawings the size of the cable/wires used for internal wiring shall be as follows :

In case of circuit wiring for lights, exhaust fans, ceiling fans, bell, convenience socket outlet points:-

2.5 Sq. mm - From DB's to the junction boxes, FCU, first switch board etc. with no joints. In between joints may be at switches, socket outlet, light points only.

2.5 Sq. mm - From junction boxes to lights/fan/ 6 A sockets outlets etc.

In case of power socket outlet circuit.

6.0 Sq. mm - From D.B. 20/30 Amps Industrial type sockets.

4.0 Sq. mm - From DBs to 16/20 Amps sockets.

The earth continuity conductor size as indicated in the drawing/BOQ shall be drawn through conduit along with other circuit cables/wires. For general guidance the size of the earth continuity conductor shall be as follows :-

UNLESS OTHERWISE SPECIFIED MINIMUM SIZE OF EARTH CONTINUITY CONDUCTOR WIRES NOT FORMING PART OF THE SAME CABLE AS THE ASSOCIATED CIRCUIT CONDUCTOR.

<p>NOMINAL Cross-sectional area of largest associated copper circuit conductor in Sq.mm</p>	<p>NOMINAL Cross-sectional area of earth continuity Conductor in sq.mm (PVC insulated green colour wire).</p>
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Separate circuit shall run for each water heater, pantry/kitchen equipment, window air conditioner, and similar outlets at location as shown on drawings.

2.1.12. INSTALLATION OF CONDUIT:

Open/Surface Conduit System with PVC Conduits:

- a) Wherever specifically called for, surface conduit system shall be adopted. All conduits shall be of 2mm thick HMS FR grade . Conduits shall run in square and Symmetrical lines. Before the conduits are installed, the exact route shall be marked at the site and approval of the Construction manager/ Consultant shall be obtained. Conduits shall be fixed by heavy gauge saddles, secured by suitable rawel plugs, at an interval of not more than 1 meter. Wherever, couplers, bends, or similar fittings are used saddles shall be provided at either side at a distance of 300 mm from the centre of such fittings. Conduits shall be joined by means of screwed couplers and screwed accessories only. In long distance straight runs of conduit, inspection type couplers /junction boxes shall be provided. Threading shall be long enough to accommodate pipe to the full threaded portion of the couplers and accessories. Cut ends of conduits shall have no sharp edges nor any burrs left to avoid damage to insulation of wires.
- b) Bends in conduit runs shall be done by using pipe bending machine. Sharp bends shall be accomplished by introducing solid bends, inspection bends or PVC inspection boxes. Radius of solid bends shall not be less than 75mm. Not less than 90 degree bend shall be used in a conduit run from outlet to outlet.
- c) Wherever conduits terminate into control boxes, outlet boxes, distribution boards etc, they shall be rigidly connected to the box with check nuts on either side of the entry.
- d) Steel wire /fish wire shall be drawn in each conduit.
- e) Separate PVC insulated copper conductor earth wire shall be drawn in each conduit.

- f) Draw boxes shall be located at convenient location for easy drawing of wires.
- g) Every mains and sub mains shall run in an independent conduit with an independent earth wire of specified capacity along the entire length of conduit.
- h) The conduit to be installed shall be of ample cross section area to facilitate the drawing of wires. The diameter of the conduit shall be selected as per table specified in this specifications. But in no case it shall be less than 20 mm diameter.
- i) Entire conduit layout shall be done such as to avoid additional junctions boxes other than for outlet points. Conduits shall be free from sharp edge and burrs. Conduits shall be laid in a neat and organized manner as directed and approved by the Construction manager/Consultant. Conduit runs shall be planned so as not to conflict with any other services pipe, lines/duct.
- j) The conduit shall be painted with two coats of enamel paint, color as approved by the Construction manager/ Consultant after installation if required.
- k) If required, connection between PVC and steel conduits shall be through a junction box. Direct connection between PVC and steel conduits are not allowed.
- l) Where exposed conduits are suspended from the structure, they shall be clamped firmly and rigidly to hangers of design to be approved by the Construction manager/Consultant Where hanger supports are to be anchored to reinforced concrete, appropriate inserts and necessary devices for their fixing shall be left in position at the time of concreting, making holes and opening in the concrete will generally not be allowed. Where inserts are not provided, contractor shall use only anchor fasteners. In case, it is unavoidable, prior permission of the Construction manager /Consultant shall be obtained to make any openings in the concrete surface.

m) Conduit Joints:

Conduit pipes shall be joined by means of couplers and screwed accessories, as per IS : 2667. In long distanced straight runs of conduit, inspection type couplers at reasonable intervals shall be provided or running threads with couplers and lock nuts shall be provided. The bare threaded portion shall be treated with anti-corrosive paints. Threads on conduit pipes in all cases shall be between 11mm or 27mm long, sufficient to accommodate pipes to full threaded portion of couplers or accessories. Cut ends of conduit pipes shall have no sharp edges nor any burrs left, to avoid damage to the insulation of conductors while pulling them through such pipes.

Brass female bushes shall be used in each conduit termination in a switch box, outlet box, electrical panel or any other box.

Conduit shall be secure in each outlet box, switch box, electrical panel or any other box by means of one G.I. hexagonal lock nut and bush, outside and inside the box.

At each building expansion joints, approved oil tight double wire wound flexible steel conduit or any other approved method shall be used. This shall be united on both sides with the rigid conduits by suitable union.

Conduits installed in the plant room for mechanical equipment shall be properly clamped with the mechanical supports, but in no case, it shall be fixed with the body of the equipment.

The connection of conduit to the mechanical equipment shall be through oil tight double wire wound flexible steel conduit. In any case the length of the flexible conduit shall not exceed one meter. The flexible conduit shall be properly clamped with the body of the equipment. They shall not in any case be clamped to any cover or any removable parts of the equipment.

n) Bends of Conduits:

All necessary bends in the system including diversion shall be done by bending pipes or by inserting suitable solid or circular inspection type normal box or similar fittings. Conduit fittings shall be avoided as far as possible on conduit system exposed to weather, where necessary, solid type fittings shall be used. Radius of such bends in conduit pipes shall be not less than 75mm. No length of conduit shall have more than the equivalent of four quarter bends from outlet, the bends at the outlets not being counted.

o) Protection against Dampness:

In order to minimize condensation or sweating inside the conduit, all outlets of conduit system shall be properly drained and ventilated, but in such a manner as to prevent the entry of insects, as far as possible.

p) Bunching of Cables:

Unless otherwise specified, insulated conductors of different phases shall be bunched in separate conduit.

Wires carrying current shall be so bunched in the conduit that the outgoing and return wires are drawn in to the same conduit. Wires originating from two different phases shall not be run in the same conduit.

2.1.13 WIRING :

All final branch circuits for lighting and appliances shall be single conductor cables run inside conduits.

Branch circuit conductor sizes shall be as shown in the load analysis of drawing and conforming to the requirements of the I.E. Regulations & I.S. Code.

Home runs indicated on the drawings for the final branch circuits shall be kept in a separate conduit upto the panel board via switches wherever called for. No other wiring shall be bunched in the same conduit unless the other circuit main of same phase run in the conduit.

For each lot of wire supply, Contractor shall supply a certificate issued by the Manufacturer stating its origin, date of manufacture, constitution and standards to which it complies and the test certificates.

Looping system of wiring shall be used. Wires shall not be jointed inside the conduit or pull boxes. Where joints are unavoidable, they shall be made through approved mechanical connectors with prior permission of Construction manager / Consultant.

Control switches shall be connected in the phase conductors only and shall be 'ON' when knob is down. Switches shall be fixed in galvanised steel boxes. Chromium plated screws shall be used.

Power wiring shall be distinctly separate from lighting wiring.

Each circuit phase wire from the distribution boards should be followed with a separate neutral wire of the same size as the circuit wire.

Drawing of Conductors :

a) The drawing and jointing of PVC insulated copper wire and cables shall be executed with due regard to the following precautions. While drawing wires through conduits, care shall be taken to avoid scratches and kinks which causes breakage of conductors. There shall be no sharp bends.

b) Insulation shall be shaved off like sharpening of a pencil and it shall not be removed by cutting it square.

c) Strands of wires shall not be cut for connecting terminals. The terminals shall have sufficient cross sectional area to take all strands and shall be soldered. Connecting brass screws shall have flat ends. All looped joints shall be soldered and connected through block/connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less. Conductors having nominal cross sectional areas exceeding 10 sq. mm. shall always be provided with cable sockets. At all bolted terminals,

brass flat washer of large area and approved steel spring shall be used. Brass nuts and bolts shall be used for all connections.

d) Only certified wiremen and cable jointers shall be employed to do jointing work. All wires and cables shall bear the manufacturer's label and shall be brought to site in original packing. For all internal wiring, PVC insulated wires of 1100 volts grade shall be used. The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors. If the use of joints connections are unavoidable due to any specific reason, prior permission, in writing, shall be obtained from the Architect. No wire shall be drawn into any conduit, until all work of any nature, that may cause injury to wire, is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of wire. Before the wires are drawn into the conduits, the conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction by forcing compressed air through the conduits. The minimum size of PVC insulated conductor wires for all sub-circuit wiring for light points shall be 2.5 sq. mm as indicated in the drawing.

2.1.14 Joints :

All joints shall be made at main switches, distribution boards, socket outlets, lighting outlets and switch boxes only. No joints shall be made in conduits and in junction boxes. Conductors shall be continuous from outlet to inlet.

MAINS AND SUB-MAINS :

Mains and sub-mains cable or wires where called for shall be of the rated capacity and approved make. Every main and sub-main wire shall be drawn into an independent adequate size conduit. An independent earth wire of the proper rating shall be provided for every single phase sub main. For every 3- phase sub main, 2 nos. earth wires of proper rating shall be provided alongwith the sub main. The earth wires shall be fixed to conduits by means of clips at not more than 1000 mm distance. Where mains and sub- main cables are connected to switchgear, sufficient extra lengths of cable shall be provided to facilitate easy connections and maintenance.

2.3 LOAD BALANCING :

Load balancing of circuits in three phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

2.4 COLOUR CODE OF CONDUCTORS :

Colour code shall be maintained for the entire wiring installation: red, yellow, blue for three phases, black for neutral, green/yellow green for earthing.

The control wire from light control switches to the light/ fan points shall be the same colour as that of the phase/ circuit wires feeding that particular loop.

2.5 EARTHING:

All earthing system shall be in accordance with IS 3043 code of practice for earthing.

2.6 The type and size of earthing wire shall be as specified under the heading of cables.

Each conduit originating from the DB to various outlets shall have one earth wire (PVC insulated copper conductor green colour wire).

2.7 TESTING OF INSTALLATION:

Before a completed installation is put into service, the following tests shall be complied with.

2.8 Insulation Resistance:

The insulation resistance shall be measured by applying 500 volt megger with all fuses in places, circuit breaker and all switches closed.

The insulation resistance in megohms of an installation, measured shall not be less than 50 megohms divided by the number of points on the circuit.

The insulation resistance shall be measured between

Earth to Phase

Earth to Neutral

Phase to Neutral

2.9 Earth Continuity Path:

The earth continuity conductors shall be tested for electrical continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance or earth leakage circuit-breaker, measured from the connection, with the earth electrode to any point in the earth continuity conductor in the completed installation and shall not exceed one ohm.

Polarity of Single Pole Switches:

A test shall be made to verify that every non linked, single pole switch is connected to one of the phase of the supply system.

COMPLETION CERTIFICATES:

All the above tests shall be carried out in presence of Construction manager/Consultant and the results shall be recorded in a prescribed forms. Any default during the testing shall be immediately rectified and that section of the installation shall be re-tested. The completed test results forms shall be submitted to the Construction manager/Consultant for approval.

On completion of an electric installation a certificate shall be furnished by the contractor, countersigned by the certified supervisor under whose direct supervision the installation was carried out. This certificate shall be in a prescribed form as required by the local electric supply authority.

LIGHT FIXTURES & FANS:

3.1 SCOPE :

Scope of work under this section shall include Supply, installation inspection/testing and commissioning , receiving at site, safe storage, transportation from point of storage to point of erection, erection and commissioning of light fittings, fixtures and accessories for back of the house area including all necessary supports, brackets, down rods and painting etc as required.

3.2 INSTALLATION :

3.2.1 The light fixtures and fittings shall be assembled and installed in position complete and ready for service, in accordance with details, drawings, manufacturer's instructions and to the satisfaction of the Construction manager /Consultants. Pendant fixtures specified with overall stem lengths are subject to change and shall be checked with conditions on the job and installed as directed. All suspended fixtures shall be mounted rigid and fixed in position in accordance with drawings, instructions and to the approval of the Construction manager/Consultants. Fixtures shall be suspended true to alignment, plumb level and capable of resisting all lateral and vertical forces and shall be fixed as required.

3.2.2 All suspended light fixtures, fans etc, shall be provided with concealed suspension arrangement in the concrete slab/roof members. It is the duty of the Contractor to make these provisions at the appropriate stage

of construction. Exhaust fans shall be fixed at location shown on drawings. They shall be wired to a plug socket outlet at a convenient location near the fan. All switch and outlet boxes, for fans and light fittings shall be bonded to earth. The recessed type fixtures shall not be supported into the false ceiling frame work. This shall have independent support from the socket of ceiling using conduit down rods/steel chain with provision for adjusting the level of fitting. Wires shall be connected to all fixtures through connector blocks. Wires brought out from junction boxes shall be encased in flexible pipes for connecting to fixtures concealed in suspended ceiling. The flexible pipes shall be check-nutted to the junction box with a brass bush. Double checknut at the fixture and flexible pipes, wherever used shall be of make and quality approved by the Construction manager/Consultants.

H. - EARTHING:

4.1 SCOPE:

All the non-current carrying metal parts of electrical installation shall be earthed as per IS: 3043. All equipment, metal conduits, rising main cable armour, switch gear, distribution boards, meters, all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to earth electrodes. Earthing shall be in conformity with the provisions of Rules 32, 61, 62, 67 and 68 of IER 1956.

4.2 G.I.PIPE EARTH STATION :

G.I. pipe shall be of medium class, 40 mm dia and 4.5 m length. Galvanising shall conform to relevant Indian Standards. G.I. pipe electrode shall be cut tapered at the bottom and provided with holes of 12 mm dia drilled not less than 7.5 cm from each other up to 2 M of length from bottom. The pipe electrode shall be as far as practicable embedded below permanent moisture level. Except where rock is encountered, pipes shall be driven to a depth of at least 4.5 mtr. Where rock is encountered at a depth of less than 2.5mtr the electrode may be buried inclined to the vertical and the inclinations shall not be more than 30 deg from the vertical. The pipe electrode shall be made of one piece. Earth leads to the electrode shall be laid in a heavy duty GI pipe and connected to the pipe electrode with brass bolts, nuts and washers. GI pipe shall be terminated in a wire meshed funnel. The funnel shall be enclosed in a masonry chamber of 450 mm x 450 mm dimensions. The chamber shall be provided with C.I. frame and CI inspection cover. The earth station shall also be provided with a suitable permanent identification label tag. The earth electrode shall conform to IS:3043 latest edition. The soil around the earthing electrode shall be treated to reduce the resistivity of the soil by filling the complete depth of electrode with alternative layers of charcoal and salt.

4.3 PLATE EARTH STATION :

Plate electrodes shall be made of G.I./copper (CU) plate of 6mm/3mm thick and 600 x 600mm size. The plate shall be buried vertically in ground at a depth of not less than 4.5 meters to the top of the plate, the plate being encased in charcoal to a thickness of 300 mm all round. It is preferable to bury the electrode to a depth where subsoil water is present. Earth leads to the electrode shall be laid in a heavy duty GI pipe and connected to the plate electrode with brass bolts, nuts and washers. A GI pipe of not less than 20 mm dia shall be clamped with bolts vertically to the plate and terminated in a wire meshed funnel. The funnel shall be enclosed in a masonry chamber of 450 mm x 450 mm dimensions. The chamber shall be provided with GI frame and CI inspection cover. The earth station shall also be provided with a suitable permanent identifications label tag. The earth electrode shall conform to IS: 3043 latest edition.

ELECTRODE EARTHING :

The earthing electrode (AS per IS 3043 : 1987) has to be installed by doing bore of size 300mm up to a depth of 3000mm., then throw handful of compound (2 bag of betonite powder compound) soil mix into pit. After removing plastic sleeve carefully from electrode place electrode at center after this start refilling space around electrode with backfill compound in small quantity. Then pour some water and poke the pit with a long wooden rod to allow trapped air to escape .In this manner gradually continue refilling process till the electrode is buried in bore up to the green patch painted on top portion of electrode. Ensure that pit is not watery. Pack electrode nicely and tightly so that it stands firmly in pit. Pour a few bucket of water in and around pit . **In hard soil condition , do not mix compound with dug out soil.** Test earth electrode resistivity .If result is not

satisfactory give some time to electrode system to set in soil. After this connect it with equipment through suitable size down conductor (GI/CU strip) as specified. After this the PCC in 1:2:4 is to be applied in an area of 300mmx300mm and brick masonry chamber (thickness of chamber wall 200 mm) has the chamber cover and frame of 300mmx300mm of CI shall be supplied and grouted in brick masonry. The chamber cover shall have lifting hook and shall have space in frame for proper placement. The watering fennel, is to be installed over watering pipe. The test link between earthing electrode and running earthing strip is to be provided for testing. After completion of work, resistance of earthpit has to be measured by 4 pin method and results shall be recorded/handed over to Employer /consultant in 1 sets.

4.4 EARTHING CONDUCTORS :

The scope of work includes supply of hot dipped galvanized iron strips/wire as per details and drawings. The GI Strip supplied for purpose shall be continuous (minimum single length acceptable in 10 mtr.) The strip has to be straightened without damaging galvanizing. The strip has to be welded by overlapping and three side continuous welding joint. These joint shall then be cleaned and jute covering has to be provided (wherever strip is buried in ground). After this black bituminous anti corrosive paint has to be applied on all joints. Same process has to be adapted for all tapings also In case if earth wire is required to be connected on strip with the help of bolt, GI bolts, nuts are to be used along with covering and painting. The earthing strip wherever indicated in drawing, has to be supplied in ground at a depth specified in dwg. The earthing strip shall be covered with black soil and in no case sand has to be used around strip.

All earthing conductors shall be of high conductivity copper/or GI as specified and shall be protected against mechanical damage and corrosion. The connection of earth electrodes shall be strong secure and sound and shall be easily accessible. The earth conductors shall be rigidly fixed to the walls, cable trenches, cable tunnel, conduits and cables by using suitable clamps.

Main earth bus shall be taken from the main medium voltage panel to the earth electrodes. The number of electrodes required shall be arrived at taking into consideration the anticipated fault on the medium voltage net work.

Earthing conductors for equipment shall be run from the exposed metal surface of the equipment & connected to a suitable point on the sub main or main earthing bus. All switch boards, distribution boards and isolators disconnect switches shall be connected to the earth bus. Earthing conductors shall be terminated at the equipment using suitable lugs, bolts, washers and nuts.

All conduits cable armouring etc., shall be connected to the earth all along their run by earthing conductors of suitable cross sectional area. The electrical resistance of earthing conductors shall be low enough to permit the passage of fault current necessary to operate a fuse/ protective device or a circuit breaker and shall not exceed 2 Ohms.

4.5 LOCATION FOR EARTH ELECTRODE:

Normally an earth electrode shall not be situated less than 2 M from any building. Care shall be taken that excavation for earth electrode may not affect the column footings or foundation of the building. Further the location shall be such where the soil has reasonable chance of retaining moisture as far as possible. Entrances, pavements and roadways are definitely to be avoided for locating the earth electrode.

4.6 EARTHING SYSTEM :

Main earthing grid shall be of 50 x 6 GI strip laid in a grid formation. All other equipments shall be earthed to this strip. All panels, equipments and non current carrying conductor shall be earthed through the strip/wire of suitable size.

Main panels - 35 x 5

Main panels to sub panels - 25 x 5

Sub panel to DB - 25 x 3

DBs to sub DBs - 8 SWG G.I.

Earthing system shall be mechanically robust and the joints shall be capable of retaining low resistance even after subjection to fault currents.

Joints shall be tinned, soldered and/or double rivetted. All the joints shall be mechanically and electrically continuous and effective. Joints shall be protected against corrosion.

4.7 TESTING :

On the completion of the entire installation, the following tests shall be conducted :

- i) Earth resistance of electrodes.
- ii) Impedance of earth continuity conductors.
- iii) Effectiveness of earthing.

All meters, instruments and labour required for the tests shall be provided by the contractor. The test results shall be submitted in the prescribed tabulated form in triplicate to the consultants for approval.

M. -LIGHTNING PROTECTION SYSTEM:

SCOPE:

The scope of work under this section covers the specifications for supply, installation, connection, testing and commissioning of lightning protection system consisting of the following :

Air termination network.

Roof conductors.

Down conductors.

Testing joint

Earth termination network.

STANDARDS:

The lightning protection system shall comply with IS: 2309/ 1989 and Indian Electricity Act and Rules.

SYSTEM :

- a) The lightning protection system shall be installed as indicated on the drawings or in case such is not available the contractor shall prepare one as per IS-2309/1989 and get the same approved by Construction manager/Consultant.
- b) As air terminals shall be installed on the highest roof of the building, the air terminals shall be joined to horizontal roof conductor by means of rivets/clamps.
- c) Roof conductor shall be laid horizontally on the roof as indicated on the drawing.
- d) Down conductor shall be installed on the vertical surface of the building. The down conductor shall be joined with roof conductors in the method as prescribed by the code. A test joint shall be provided in the down conductor 1000 mm above the ground level at a place which is easily accessible for testing.

- e) The down conductor shall be joined with earth termination network or to the earthing station as indicated on the drawing.
- f) The earthing station and the earthing conductor shall be as per section under heading "EARTHING".

4.9 COMPONENT PART :

Air Terminals and Roof Conductors

- a) An air termination shall consist of vertical conductor or a system of horizontal conductors and shall be installed along the outer perimeter of the roof.
- b) No part of the roof shall be more than 9 m from the nearest horizontal protective conductor.
- c) All metallic projections, chimneys, ducts, vent pipe, railings, gutters etc., on or above the main surface of the roof of the structure shall be bonded to and form part of the air termination network. The method and nature of the fixing shall be simple, solid and permanent.
- d) The minimum dimension of the air termination network shall be as follows :

Above Ground Below Ground

Galvanised iron strip 20 x 3 mm 32 mm x 6 mm

- e) The Air terminal shall be installed vertical on the highest point of the roof and shall be clamped firmly with the structure. The roof conductor shall be laid horizontally above the finishing of the roof surface.

Down Conductor :

- a) The number of down conductors shall be as follows :
 - 1) A structure having a base area not exceeding 100 sq.m shall have only one down conductor.
 - 2) For a structure having a base area exceeding 100 sq.m, the number of down conductors shall equal to smaller of the following :

One, for first 100 Sqmtr plus one more for every 300 sq.m or part thereof in excess of the first 100 sq.m or one for every 30 m of perimeter.

- b) The down conductor shall be distributed around the outside wall of the structure.
- c) Any external metal running vertically through the structure shall be bonded to the down conductor at the top and bottom.
- d) A down conductor shall follow the most direct path possible between the air terminals and the earth termination.
- e) The size of the down conductor shall be similar to roof conductor/air termination network.
- f) Each down conductor shall be provided with a testing joint in such a position that, it is convenient for testing. (about 1000 mm above Ground level)

Joints and Bonds

- a) The lightning protection system shall have as few joints as possible. Joints and bonds shall be mechanically and electrically effective eg. clamped, screwed, bolted, riveted or welded. With overlapping joint, the length of overlapping shall not be less than 25mm for all types of conductor. Contact surfaces shall be first cleaned,

then inhibited from oxidation with a suitable non-corrosive compound. Joints of dissimilar metals shall be protected from moisture by an inert, tenacious material.

b) The lightning conductor shall be secured at not more than 2 M apart for horizontal run and 1.0 M for vertical run by fasteners resistive to corrosion.

4.10 Earth Resistance:

The resistance from any part of the lightning protection system to earth shall not exceed 10 Ohm before any bonding has been effected to metal in or on a structure or to services below ground. If the value obtained exceeds the specified 10 Ohm it shall be reduced by adding to the number of earth electrode.

In addition the resistance from the earth electrode to the nearest test clamps shall not exceed 0.2 Ohm.

4.11 Method of Measurement:

The complete earth conductor shall be measured and paid per unit length, including air termination network, down conductor, test joints and earthing termination network.

Q. - TELEPHONE WIRING SYSTEM:

5.1 SCOPE :

This section relates to specification for the supply, installation, testing & commissioning of works included in electrical section for telephone system.

The scope of work included in this section is as follows :

- a) Supply and installation of cables/wires G.I. fabricated perforated cable trays for laying telephone from the telephone exchange room.
- b) Providing & installing cable ladders in the telephone vertical duct
- c) Providing & installing PVC FR grade HMS conduits run from corridor to Guest room to connect between cable tray & the telephone tag block.
- d) Providing conduits for telephone wiring in the public areas with G.I. fish wire.
- e) Providing & installing G.I./PVC moulded boxes including telephone jack RJ11.
- f) Providing & installing pipe sleeves for incoming lines into the EPABX room if required.

The electrical contractor shall co-ordinate with P & T and other agencies to finalise the exact requirement.

5.2 CONDUITING :

a) All concealed /surface installation including the conduit run above the false ceiling space shall be PVC FR grade HMS Conduit. The specification for materials & installation shall be same as described in electrical section. All relevant clauses are applicable for telephone system as well. The conduit for telephone system shall be installed minimum 1 feet away from the power conduit. Care shall be taken so that no telephone conduit is run in parallel to Electrical conduit in close proximity. Wherever telephone conduits cross power conduits, they shall be at right angle, to each other. All telephone conduits shall be earthed.

Size of Cable	Conduit Size
Up to 5 pair single cable	25 mm
Above 5 pair up to 10 pair Single cable	32 mm

Above 10 pair up to 20 pair Single cable	32 mm
2 Nos. 2 pair	25 mm
3 to 5 Nos, 2 pair	32 mm
6 to 10 Nos, 2 pair cable	32 mm

The size of conduit shall depend upon no. of wires to be drawn. However minimum size of conduits shall be 25 mm.

b) All telephone wires shall be 0.71 mm dia annealed tinned copper conductor PVC insulated and PVC sheathed cables. All telephone cables inside the building shall be unarmoured Each out let shall be wired with 2 pair cables from final tag unless otherwise specified separately. From main tag block to sub tag block cabling shall be done with suitable size of telephone unarmoured cable laid in conduit/pipe/ cable trays.

5.3 BOXES & TELEPHONE OUTLETS:

All concealed boxes shall be of G.I. as described in the electrical wiring section & shall match with electrical wiring accessories. The boxes/main Junction box shall be suitable for wall mounting having opening for cable/ conduit entry. All PVC cable shall enter the telephone junction box from the bottom through brass cable glands and enough cable length shall be available for termination. Each PVC cable serving the telephone socket shall be marked for identification.

Junction boxes shall be fully enclosed, kept tight with locable hinged doors. Boxes shall be zinc anodised type & same make as of socket/outlets.

Prior to the system installation the contractor shall consult telephone department for their requirements and notify the Construction manager/Consultants on the same. All equipments like tag blocks, wires shall be Local Authority approved makes.

5.4 SUPPLY OF MATERIALS:

Exclusions:

- a) Telephone Exchange & Telephone instruments.
- b) Main incoming cable.

Rest all material for distribution of telephone system as covered in BOQ shall be in the Contractors scope.

The telephone outlet shall be RJ11 Type Jack. The switch plate shall be similar to the electrical wiring devices.

D. - LT SWITCHGEARS MAIN L.T. PANELS & DISTRIBUTION BOARDS:

7.1 SCOPE :

This section shall cover supply, assembly, installation, connection, testing and commissioning of medium voltage cubicle type MV Switchgear, Main LT Panel and Distribution boards as described in these specifications, drawings and schedule of quantities. The distribution boards are designated as:

Main LT Panels, Sub LT Panels

Floor Panels, Distribution Board

The unit rate per item shall include design supply, assembly, installation, connection, testing and commissioning of MV Assembly Distribution boards, with all the components in place, internal wiring, as

specified in this specification, and shown on the drawing, and load schedule complete with supply and fixing of M.S. channel/ angle iron support on wall/floor etc.

In case of switchgears and panels issued by owner for erection the unit rate shall include inspection, receiving, storage, installation, field testing and commissioning activities including co- ordination with the suppliers of the switchgears. The rate shall be quoted per set of switchgears/panels as identified in the BOQ. The details of design/Constructional features of these switchgears are specified here below.

7.2 GENERAL :

7.2.1 SYSTEM DETAILS :

All the Main Panels/Motor control centers Distribution boards, Sub-Main Distribution boards, shall be suitable for operation on three phase/ single phase, 415/230 volts, 50 Hz neutral solidly grounded at transformer and short circuit level not less than 415 Volts at 25KA or as specified elsewhere.

The Distribution boards shall be designed to withstand tropical condition at site, with maximum expected ambient temperature of 45°C and 100 percent humidity and dusty weather.

Enclosure of the switchboard shall have IP 52 protection for Indoor and IP 55 for outdoor.

7.2.2 STANDARDS AND CODES:

The Distribution boards shall comply with the latest edition of relevant Indian Standards and Indian Electricity Rules and Regulations. The following Indian Standards shall be complied with :

IS 1394 -	L.V. switchgear and control gear Part-I - 1993 General rules
IS 5578-85	Guide for marking of insulated conductors.
IS 11353-85	Guide for uniform system of marking and identification of conductors and apparatus terminals.
IS 2147-62	Degree of protection provided by enclosures for low voltage switch gear and control gears.
IS 2675-83	Enclosed distribution fuse boards and cutouts for Voltages not Exceeding 1000 V.
IS 2551-82	Danger notice plates.
IS 13947-1993	Circuit breakers.(Part-II)
IS 13947-1993	Switches, Disconnectors, switch disconnector (Part - III) and fuse Combination units.
IS 1818-72	Alternating current isolators (disconnectors) and earthing switches.
IS 8623-77	Factory built assemblies of switchgear and control gear for voltages upto and including 1000 V AC & 1200 V DC.
IS 8828	Miniature air break circuit breakers for voltages not exceeding 1000 V.
IS 9926	Fuse wires used in rewirable type Electric fuses upto 1100 Volts.

IS 2208	HRC fuse links
IS 2705	Current Transformers(Part- I,II & III)
IS 3156	Voltage Transformers(Part- I,II & III)
IS 1248	Indicating Instruments
IS 722	Integrating Instruments
IS 13947-93	Control devices and switching elements.(Part - 5)Section-1
IS 13947-93	Contactors and motor starter section 1 (Part - 4) Electromechanical. Section - 1 Section-1
IS 3231	Relays
IS 375	Marking and arrangement of busbars Indian Electricity Act and Rules.

7.2.3SHOP DRAWINGS:

Prior to fabrication of the Switchgears, Distribution boards, the contractor shall submit for Clients/Consultants approval the shop drawing, and design calculations, indicating type, size, short circuit rating of all the electrical components used, details & schedule of components & model Nos. type, rating etc., busbar size, internal wiring size, Distribution board dimension, colour, mounting detail etc. The contractor shall submit manufacturer's catalogues of the electrical components installed in the distribution.

7.2.4INSPECTION:

At all reasonable times during production and prior to transport of the distribution boards to site, the contractor shall arrange and provide all the facilities at their plant for inspection by Client/Consultant or authorised representative.

7.2.5 TESTS TO BE CONDUCTED ON PCCS ON PDBS

The Panel shall be subject to standard routine test as per IS-2026 1977 on amended up to date.

- a) 2.5 KV highpot test with leakage current measurement.
- b) Meggar test.
- c) Load test by primary injection test kit at 70% capacity of the incomer.
- d) Secondary injection test for relays, meters & CT's.
- e) Temperature rise test FOR MEP.
- f) Functional test.

The above tests must be conducted in the manufacture premises in presence of Consultant's/Client's representative. The bidder who are not having those testing facility are not entitled to participate in the bid. Protective relays are to be tested/calibrated at installation prior to commissioning. Test certificates of the above tests shall be approved by Client/Consultant. The test results shall be recorded on prescribed forms. The test certificates for the test carried out at factory or at site shall be submitted in six copies to the Construction manager/Consultants for approval.

7.2.6 TYPE TEST CERTIFICATES:

The bidder shall produce following type tests certificate of CPRI (certificates shall be between year 2000 to 2003).

- a) Short circuit test at 41.7 KA fault level.
- b) Temperature rise test.
- c) Degree of protection test-IP55/IP54
- d) H.V. test.

7.2.7 FIRE INSURANCE APPROVAL

The bidder shall have TAC approval from Tariff Advisory committee & copy of approval shall be enclosed with bid.

7.2.8 OPERATION MANUALS

Three sets of operation manuals with the technical leaflets of the components used in the CPC & PBS are to be provided after completion of job.

6.2.9 PERFORMANCE GUARANTEE

All the equipments shall be guaranteed for 12 months from the date of commissioning.

7.3 CONSTRUCTION :

7.3.1 CUBICLE TYPE MV SWITCHGEARS & DISTRIBUTION BOARDS:

7.3.1.1 STRUCTURE:

The MV Switchgears panels and Distribution boards shall be sheet steel enclosed cubicle pattern, floor mounted free standing, totally enclosed dead front, compartmentalised multitier formation design. The panels shall be both sides extensible type with provision for bus bar extensions. Generally all Switchgears, Panels, MDB's, SMDB's & DB's shall be of front access only & suitable for top entry of cables unless otherwise specifically specified for bottom entry.

All M.S. sheet steel used in the construction of Distribution boards shall be 2mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Sheet steel shrouds and partitions shall be of minimum 2 mm thickness. Joints of any kind in sheet steel shall be seam welded, all welding slag grounded off and welding pits wiped smooth with plumber metal. The height of the panels should not be more than 2200 mm. The operating levels shall not be more than 1800 mm. The operating level of the lower most cubicle shall not be less than 450 mm.

The Panels / Distribution boards shall be totally enclosed, completely dust and vermin proof. Synthetic rubber gaskets (neoprene/DPDM) between all adjacent units and beneath all covers shall be provided to render the joints dust proof. All doors and covers shall be fully gasketed and shall be lockable. Doors shall have concealed hinges. All the doors shall be suitably reinforced by channel to provide rigidity.

All panels and covers shall be properly fitted and secured with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with bolt and nuts. Self threading screws shall not be used in the construction of the panels/DBs etc.

A base channel of 75mm x 40mm x 5mm thick shall be provided at the bottom. A clearance of 300mm between the floor of the Panels/ Distribution Board and the bottom of the lower most unit shall be provided.

The Panels/ Distribution boards shall be preferably arranged in multitier formation. These shall be of adequate size with a provision of 20 Percent vacant space to accommodate future additional switch gear in addition to spare feeders presently provided. The size of the boards shall be designed in such a way that the internal space is sufficient for hot air movement, and the electrical component do not attain temperature rise more than 40 degree Celsius.

Knockout holes of appropriate size and number shall be provided in the gland plate of Panels/Distribution board in conformity with the number, and size of incoming and outgoing conduits/cables.

Alternatively the Panels/Distribution boards shall be provided with removable undrilled gland plates (3mm thick).

The switch boards shall be designed to facilitate easy inspection, maintenance and repair.

The Panels/Distribution boards shall be sufficiently rigid to support the equipment without distortion under normal and short circuit condition. They shall be suitably braced for short circuit duty. Provision shall be made for permanently earthing the frames and other non current carrying parts of the switchgear by two independent earth connections.

7.3.1.2 PROTECTION CLASS

All indoor Panels/Distribution boards shall have degree of protection conforming to class IP 42. While outdoor panels shall be weather proof dust and water tight IP-55.

7.3.1.3 METAL TREATMENT & FINISH

All sheet steel work used in the construction of switchboard shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating in seven tank metal treatment plant and shall be powder coated to the specified shade of IS.5 of approved colour. The total thickness of paint shall not be less than 50 microns. The finished panels shall be dried in storing ovens in dust free atmosphere to ensure fine quality finish. The paint shall be Berger Luxol Higliss, with siemens gray color for inside outside .

7.3.1.4 BUS BARS

The Bus bars shall be of three phases separate neutral and earth bar. The busbars, and interconnection between busbars and various components shall be of high conductivity, high strength aluminium alloy with current density 0.8A/sqmm complying with the requirement of grade E91E of IS 5082. The busbar shall be of rectangular cross section designed to withstand full load current for phase busbars and half rated current for neutral busbars unless specified otherwise and shall be extensible on both sides. The bus bar shall be rated for the rating of the main incoming breaker, but in any case not less than 200 Amp. capacity. The busbar shall have uniform cross section through out the length.

The busbars and interconnections shall be provided with heat resistant and colour coded sleeves. The busbars shall be supported on unbreakable, non hygroscopic insulated supports of SMC supports at sufficiently close intervals to prevent busbar sag and shall effectively withstand without damage electromagnetic stresses in the event of short circuit. The neutral as well as earth bar shall also be capable of withstanding the fault level.

The busbars shall be housed in a separate compartment. The busbar shall be shrouded with 3mm thick transparent sheet to avoid any accidental contact. All busbars connections shall be done by drilling holes in busbars and connecting by chromium plated high tensile M.S. bolts, spring washer and nuts. Additional cross section of bus bars shall be provided in all Panels/ Distribution boards to cover up the holes drilled in the busbars. Spring and flat washers shall be used for tightening the bolts.

All connections between busbars and circuit breakers/ switches and between circuit breakers/switches and cable terminals shall be through solid copper strips of proper size to carry full rated current. These strips shall be insulated with insulating heat resistant paint with colour coding.

7.3.1.5 CIRCUIT COMPARTMENTS

Each circuit breaker shall be housed in separate compartments and shall be enclosed on all sides. Sheet steel hinged lockable door shall be duly interlocked with the breaker units in "ON" and "OFF" positions. Safety interlocks shall be provided for air circuit breaker to prevent the breaker from being drawn-out when the breaker is in "ON" position.

The door shall not form an integral part of the drawout position of the circuit breaker. All instruments and indicating lamp shall be mounted on the compartment door. Sheet steel barrier shall be provided between the tiers in a vertical section.

7.3.1.6 INSTRUMENT COMPARTMENT

Separate and adequate compartment shall be provided for accommodating instruments, indicating lamps, control contactors/relays, and control fuses etc., these components shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker units, bus bars and connections.

7.3.1.7 TERMINALS

The outgoing terminals and neutral link shall be brought out to a cable alley suitably located and accessible from the panel front. The current transformers for instruments metering shall be mounted on the terminal blocks. No direct connection of incoming or outgoing cables to internal components of the Panels/Distribution board is permitted only one conductor may be connected in one terminal.

7.3.1.8 WIREWAYS

A horizontal PVC wire way with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical sections.

7.3.1.9 CABLE COMPARTMENTS

Cable compartments of adequate size shall be provided in the Panels/Distribution Boards for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate supports shall be provided in the cable compartments to support cables. All outgoing and incoming feeder terminals shall be brought out to terminal blocks in the cable compartment.

7.3.1.10 EARTHING

GI earth bars of suitable size but not less than 25 mm x 3 mm shall be provided in the Panels/Distribution Boards for the entire length of the panel. The frame work of the Panels/Distribution board shall be connected to this earth bar. Provision shall be made for connection from this earth bar to the main earthing bar coming from the earth pit on both sides of the Panels/Distribution board and to take tapping to the outgoing earthing strips to connect to the main distribution boards.

The earth continuity conductor of each incoming and outgoing feeder shall be connected to this earth bar. The armour shall be properly connected with earthing clamp, and the clamp shall be ultimately bonded with the earth bar. CT earthing also shall be connected to this earth bar.

7.3.1.11 LABELS

Engraved PVC labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside the Panels/DBs shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet.

7.3.1.12 INTERNAL COMPONENTS

The Panels/ Distribution boards shall be equipped complete with all type of required number of circuit breakers, contactors, relays, fuses, meters, instruments, indicating lamps, push buttons, equipment, fittings, busbars, cable boxes, cable glands etc., and all the necessary internal connections /wiring as required and as indicated on relevant drawings. Components necessary for proper complete functioning of the Panels/Distribution boards, but not indicated on the drawings shall be supplied and installed on the distribution boards.

All parts of the Panel/Distribution boards carrying current including the components, connections, joints and instruments shall be capable of carrying their specified rated current continuously, without temperature rise exceeding the permissible values as per the relevant specifications at any part of the Panel/Distribution boards.

All units of the same rating and specifications shall be fully interchangeable.

7.3.1.13 VENTILATION

Ventilation louvers with removable type welded wire mesh are to be provided on sides of panel, backside covers of busbar chamber doors. Also on PCC at top of busbar chamber welded wire mesh protected ventilation duct with canopy of sheet shall be provided for proper cooling & to ensure temperature rise within limits as per standards. 3/4" size propellar fan should be fixed on opening at both ends in all panels including main panel & floor mounted distribution boards.

7.3.1.14 HARDWARE/MISCELLANEOUS ITEMS:

The hardware to be used in panels shall be zink plated & all joints & connections shall be made with galvanized zink passivated or cadmium plated high tensile strength steel bolts/nuts/spring washers etc.. The make of hardware items shall be approved make All control wires shall be of 1.1KV grade flexible copper of approved make with approved make copper /Al type lugs. The control fuses /control MCB of approved make shall be provided with ferrules for identification of wires. PVC gray casing for wires shall be provided in cubicles. All wire shall be suitably tied with PVC button straps. Appropriate rubber bushes, clamps are to be crossover of control wiring in cubicles etc.

7.3.2 MCB DISTRIBUTION BOARDS:

7.3.2.1 SCOPE

This section relates to specifications for design supply, assembly, installation, connection, testing and commissioning of lighting and power distribution boards (LPDBs), using Miniature Circuit Breaker (MCB), Earth Leakage Circuit breaker (ELCB), Contactor, Neutral link, Earthing terminals, control switch terminals, cubicle of CRCA sheet steel housing and complete the item installation.

7.3.2.2 SYSTEM

The MCB distribution boards shall be suitable for operation on 400/440 volt, 3 phase, 4 wire, 50 Hz A.C. supply system or 220/250 volt, 1 phase, 2 wire, 50 Hz A.C. supply system.

7.3.2.3 CONSTRUCTION

a) The DB's shall be factory made and preferably of those manufacturers whose MCBs, ELCB's are to be used. General arrangement layout of the DB's shall be approved by the Construction manager/Consultant before manufacture.

b) The DB shall be metal clad duly fabricated from 2mm (14/16 SWG) thick high quality CRCA sheet.

- c) The DB shall be cubicle, compartmentalized, wall/floor mounted and dead front operated.
- d) The DB shall be totally enclosed and made dust, vermin and weather proof such that it meets IP 54 of IS 2147 protection classification.
- e) A detachable cover plate of 2mm thick CRCA sheet to be provided on front of the board such that all live parts of the electrical accessories mounted on the board can be accessible only on removal of the said cover plate.

Further, the cover plate shall also, have suitable cut out so that dolly of the MCB's can be operated even if the cover plate is in position. A transparent plastic protection cover shall be provided on the cut out portion of the cover plate.

The cover plate shall also provide right above the respective cut outs a suitable arrangement to label the electrical circuit details of the MCB's mounted on it as well as to affix a danger plate in legible manner.

The cover plate shall be fixed to the board with adequate size zinc passivated machine screws.

Above the detachable cover plate, one additional hinged door of 2mm thick CRCA sheet covering the MCB's etc., shall be provided with a suitable locking arrangement.

The hinged door shall be provided with a suitable gasket capable of withstanding corrosive & humid atmosphere and to meet degree of enclosure protection IP 54 as per IS : 2147. The DB's shall undergo the process of painting as described under cubicle type main/submain distribution boards.

- f) The DB shall have top/bottom entry arrangement for incoming and outgoing cables/conduits.
- g) All hardware to be used in manufacture of the DB shall either be of mild steel zinc passivated or otherwise be treated to prevent corrosion due to humid atmosphere.
- h) All internal electrical connections shall be carried out using 1100 volt grade, PVC insulated, Copper conductor of ISI approved make, having rated current carrying capacity to carry continuous full current of respective switch/MCB rating at operating conditions prevailing at the project site.
- i) The DB internals shall be earthed with use of copper strips running through out the length. Size of the earthing strip shall be as shown in the respective drawing.
- j) The earthing strip shall be brought out on two sides of the DB's with bolted type earth terminating arrangement, for connecting to the building earthing grid. The earth terminal shall be of either brass or zinc passivated mild steel.
- k) All non current carrying metal surfaces of the DB's shall be adequately treated with seven tank pretreatment process to render it free from grease, oil, oxide, dirt, etc., to make them ready to receive and hold coats of zinc chromate primer.
- l) The DB's shall be provided with electric components and accessories as per the details shown in the drawing/BOQ for the respective electric distribution board.

7.4 INSPECTION:

7.4.1 The DB's shall be inspected and checked as per inspection manual of the DB manufacturer.

7.4.2 Various electrical components and accessories of the DB's shall be checked as per drawing for the respective DB's.

7.4.3 The DB's shall be checked for rigid mounting, earthing connection, proper rating & size of components, internal wiring etc.,

7.4.4 All mechanical fasteners and electrical connections shall be checked and tightened before installation.

7.5 INSTALLATION:

7.5.1 The DB's shall be assembled and aligned together and be installed at site as per installation manual/ instruction of the DB manufacturer.

The installation shall conform to relevant Indian Standard specification and requirement of local site conditions.

7.5.2 The DB shall be installed in surface/concealed manner at the location as shown in the respective drawings.

7.5.3 All minor electrical and mechanical work required to be attended to on the DB shall be completed in an approved manner after installation but before energizing the DB's.

7.6 TEST:

Prior to commissioning of the DB's following tests shall be carried out.

7.6.1 Mechanical endurance test shall be carried out by closing and opening of all the MCB's, switches etc.

7.6.2 Insulation resistance test shall be carried out between phases and between phase to earth bus, keeping the isolating switch in open position. Similar test shall be carried out keeping the isolating switch in closed position.

7.6.3 All the interlocks, controls and tripping mechanisms of the switch gears shall be tested for their proper functioning.

7.6.4 Each panel shall be provided with a thermostatically controlled space heater of adequate rating and single phase plug point and cubicle illumination lamp with switch operated at 240V AC, 50 Hz. Heaters shall have individual ON-OFF switches.

7.7 COMPONENTS:

7.7.1 GENERAL

The type, size and rating of the components shall be as indicated on the relevant drawings.

While selection of the capacity of the components resulting from the prevailing conditions like room temperature shall be allowed for the thermal and magnetic trip rating shall be compensated for the ambient temperature.

The rating indicated on the drawings are ratings anticipated at prevailing site condition.

7.7.2 AIR CIRCUIT BREAKERS:

The air circuit breaker shall comply with the requirements of IS: 13947-2 (1993) and shall have:

- i) A service short circuit breaking capacity shall be as specified and equal to short circuit withstand values. All short circuit ratings shall be Ics values.
- ii) A short circuit making capacity of 105 KA.
- iii) A short time withstand capacity of 75 KA for 1 second.

iv) Mechanical and electrical endurance for 2000 operating cycles out of which 100 cycles should be for electrical endurance.

v) Electrical overload performance at 6 times the rated current, 110% of the rated voltage as recovery voltage and 0.5 power factor.

vi) Dielectric test of 2.5 KV applied for one minute on main circuits. Test evidence from a recognised independent laboratory/institution shall be furnished for compliance of the breakers with the above requirements.

vii) Each pole of the ACB's shall be equipped with an inverse time delay thermal over current trip device and an electro magnetic instantaneous over current trip device. The ACB's shall be equipped with under voltage trip relay. The trip devices shall be direct acting. ACB shall be capable of providing short circuit overload and earthfault protection (in absolute values) if required, thru microprocessor based control unit sensing the true RMS values to ensure accurate measurement meeting the EMI/EMS requirement as per the standard.

viii) Disconnecting devices of approved type shall be provided to facilitate the removal of the circuit breakers from the housing for test and maintenance purposes.

ix) The ACB's shall be fitted with detachable type arc quenching device on each pole. The ACB's shall have auxiliary contacts for signaling, interlocking etc. The ACB's shall have slow close facilities for checking contact operation and contact gap adjustment.

x) All contacts subject to arcing shall be tipped with arc resisting material. Main contacts shall be silver plated to ensure reliability in service.

xi) Isolating contacts shall be of the silver plated, multifinger, spring loaded type. Facilities shall be provided to isolate the circuit breaker for inspection purpose. Feature of contact wear inspection indicating the life of contacts shall be provided. The ACB shall have double insulation (class-II) with moving and fixed contacts totally enclosed for enhanced safety and inaccessibility to live parts. The breaker shall have three distinct positions with in the cassette as follows:

a) `Service Position' - with main and auxiliary contacts connected.

b) `Test Position' - with power contacts fully disconnected and control circuit contacts connected.

c) `Isolated position' - With both power and control circuit contacts fully disconnected.

xii) Interlocks shall be provided to :

a) Prevent the breaker from being isolated unless it is in the OFF position.

b) Prevent the breaker from being racked into the service position unless it is in the OFF position.

c) Prevent the breaker from being accidentally pulled completely OFF the guide rail.

xiii) Safety shutters of an insulation material shall be provided to prevent access to all live contacts, when the breaker is in the inspection position or completely withdrawn.

xiv) Facilities for pad locking the safety shutters when breaker is completely withdrawn shall be provided.

Facilities shall be provided for earthing the circuit breaker.

xv) Air circuit breaker shall be capable of clearing the maximum fault current which can occur.

xvi) All electrical closing of breaker should be with Electrical motor wound stored energy spring closing mechanism with Mechanical indicator to provide ON/OFF status of ACB.

For all ACBs the operating handle should be provided for charging the spring in continuous action. The spring shall be released with ON/OFF push button command in one operation at the correct speed independent of operator speed. A direct mechanical coupling should indicate the ACB in ON to OFF position thus qualifying to disconnection as per the IS/IEC indicating the true position of all the contacts. One set of NO/NC potential free contacts to be provided for operation on building management system. All accessories like shunt, undervoltage motorised mechanism etc shall be front mounted and can be fitted at site.

7.7.3 MOULDED CASE CIRCUIT BREAKERS (MCCB):

MCCBs shall satisfy the requirements of IS-13947 Part (II) and shall be of current limiting type. MCCB shall provide type 'C' protection to the contactors as per IEC 158-1B. MCCBs shall be quick make, quick break, independent manual type with trip free feature with mechanical ON, OFF, and TRIP indications. A trip button shall be provided for tripping the breaker.

MCCB shall have electro-magnetic, under voltage and earth fault releases.

Alarm and auxiliary contacts, terminal shrouds, sliding type front operation kit with facility for door interlocking and pad locking shall be provided (ICS=ICU).

7.7.4 FUSE SWITCH UNITS

The fuse switch units shall be 3-pole double break type suitable for load break duty, quick make and break action. Separate neutral link shall be provided in the switch. All fuse switch units shall be provided with hinged doors duly interlocked with operating mechanism so as to prevent opening of the door when the switch is in "ON" position and also prevent closing of the switch when the door is not properly secured. All contacts shall be silver plated and all live parts shall be shrouded. The incoming and outgoing terminals of switch shall be adequately sized to receive proper size of cables. High rupturing capacity (HRC) fuse links shall be provided with switch fuse units and shall be in accordance with IS: 2208-1962 and having rupturing capacity of not less than 35 MVA at 415 volts. HRC fuse links shall be provided with visible indicators to show that they have operated. The switch fuse unit shall be manufactured in accordance with IS:4047-1967 as amended to date.

7.7.5 MINIATURE CIRCUIT BREAKER

Miniature circuit breakers shall be quick make and break type and conform to IS: 8828. The housing of MCBs shall be heat resistant and having a high impact strength. The fault current of MCBs shall not be less than 9000 amps, at 230 volts. The MCBs shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical "ON" and "OFF" indications.

The circuit breaker dollies shall be of the trip free pattern to prevent closing the breaker on a faulty circuit.

The MCB contacts shall be silver nickel and silver graphite alloy and tip coated with silver. Proper arc chutes shall be provided to quench the arc immediately. MCB's shall be provided with magnetic fluid plunger release for over current and short circuit protection.

The over load or short circuit devices shall have a common trip bar in the case of DP and TPN Miniature Circuit Breakers. All the MCB's shall be tested and certified as per Indian Standards, prior to installation.

6.7.6 FUSE:

Fuses shall be of high rupturing capacity (HRC) fuse links and shall be in accordance with relevant ISS and having rupturing capacity of not less than 35 MVA at 415 volts. The back up fuse rating for each motor/equipment shall be so chosen that the fuse does not operate on starting of motors/equipment.

7.7.7 EARTH LEAKAGE CB/RESIDUAL CURRENT CB :

The ELCB/RCCB shall comply with IS:12640-1988/IEC:1008. The ELCB/RCCB shall be current operated independent of the line voltage. ELCB/RCCB shall work on the principle of core balance transformer. The ELCB/RCCB shall be rated for current sensitivity of a min of 30mA and a max of 300 mA at 240/415 V AC. The terminals shall be protected against finger contact to IP:20 degree of protection. The ELCB/RCCB shall have a minimum of 20,000 electrical operations.

Testing Provision

A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the ELCB and the operating handle shall move to the "OFF" position.

7.7.8 CONTACTORS:

The contactors shall meet with the requirements of IS:2959.

The contactors shall be of MN series only

The contactors shall have minimum making and breaking capacity in accordance with utilization category AC3 and shall be suitable for minimum class II intermittent duty.

If the contactor forms part of a distribution board then a separate enclosure is not required, but the installation of the contactor shall be such that it is not possible to make an accidental contact with live parts.

7.7.9 VOLTMETER:

Voltmeter shall comply with IS-1248 (Latest edition) requirements. The dial of the meter shall be square in shape 96 x 96 Sq. size. The voltmeter shall be Network type, flush pattern, with dust and moisture proof enclosure.

The voltmeter selector switch shall be arranged to provide line to line voltage reading and line to neutral voltage reading.

7.7.10 AMMETER:

Ammeter shall comply with IS-1248 (Latest edition). The dial of the ammeter shall be square in shape of 96 x 96 Sq. mm size. The Ammeter shall be Network type, flush pattern with dust and moisture proof enclosure. The range of the ammeter shall be in accordance with 1 to 1.5 times the feeder full load current. Separate current transformer shall be provided for all ammeters. Three way ON and OFF selector switch shall be provided for measuring current in different phases.

7.7.11 CURRENT TRANSFORMER:

Where ammeters are called for C.T's shall be provided for current measuring. Each phase shall be provided with separate current transformer of accuracy class-I and suitable VA burden for operation of associated metering and controls. Current transformer shall be in accordance with IS:2705 as amended up to date.

7.7.12 ENERGY MANAGEMENT SYSTEM

The system monitor the energy consumption at the individual distribution boards for centralized billing. The requirements are as follows:

1. To monitor each supply breaker Line & Phase Voltage, Current, Power, Energy, reactive power, P.F., Frequency etc. the trend of consumption, maximum demand in KVA time plot with an accuracy class of 0.5 should be provided with RS 485 port option.

2. Should monitor Demand parameter (KVA or KW) instantaneous demand & maximum demand, Day, Date, Time of MD occurrence.

3. Each outgoing feeder shall be provided with electric 3 phase 4 wire/1 phase Energy meters to monitor energy parameter with tamper proof cover. Accuracy class 1.0.

4. Computer System

Data so collected from the incoming and outgoing shall be integrated and recorded in the PC Pentium-IV, 1.1 GHz, 256 MB RAM, 40 GB HDD, 3.5" FDD, CD Drive – 52X, serial port and parallel port, 17" colour monitor, mouse and standard keyboard. Windows-98 version & MS-OFFICE-97.

132 Column Dot Matrix printer, UPS (Min 2 KVA), High speed control and graphic low loss data communication cable including required software for demand representative of the same. The required window based software shall also be provided for having pre-configured with screens which show mimics, trends, history, alarms and shall generated MIS reports.

Required high speed data cable/control cable and other network accessories like data converter, repeaters etc shall also be included by the bidder.

7.8 BUS TRUNKING / DUCT :

Bus duct shall be aluminium conductor conventional design suitable for use on 415 volts, three phase four wire, 50 Hz. A.C. Supply system.

ENCLOSURE

The enclosure shall be made of sheet metal 2mm (14 SWG) M.S/GI sheet. The enclosures shall be reinforced by using suitable bracing material between the channels. The sheet metal structure shall be jig assembled to ensure that any one section can fit into other sections without any difficulty.

The sheet metal enclosure shall be of sufficient section, ventilated and designed such that the temperature rise does not exceed the prescribed limit above ambient of 45 °C. Proper ventilation shall be provided by means of louvres and covered by fine mesh to avoid the ingress of vermin.

The sheet metal work shall be pretreated in seven tank. Metal treatment plant for degreasing, derusting and phosphating the surface. After phosphating the surface shall be finished. The inside/outside surfaces of the enclosure shall be powder coated in shade to be specified later or galvanized.

Bus bars shall be of aluminium alloy conforming to IS.S. 5082 – 1969 grade E 91E – WP. The current density not to exceed 0.8A per Sq.mm or as per approved design calculations which ever is less. The bus bars shall be insulated with Class „F“ insulation material and ensure tight fitting on the conductors. The busbar surface shall be colour coded by applying Red, Yellow, Blue and Black indications to identify the phases.

The joints shall be bolted using electro galvanized high tensile (HT) M.S. bolts, complete with spring washers to avoid loosening in service.

Bus bars supports shall be of SMC/FRP and shall have sufficient strength to withstand the effect of a short circuit.

All joints shall be provided with links to ensure earth continuity between sections of bus trunking / ducts. Flexible joints made of copper shall be supplied as may be necessary for end termination at DG/Transformer and panel end. Flexible bellows shall also be provided for connection at D.G. end. The busduct / trunking shall be complete with expansion joints through panel, flexible connection, first barriers etc.

Note: The offer of busduct shall be complete with design calculation:

i) Busbar size required based on normal current carrying capacity considering various current derating factor.

- ii) Based on short circuit with-stand capacity.
- iii) For electro-mechanical stress analysis for busbars, busbar support and hardware.

In case of switchgears and panels issued by owner for erection the unit rate shall include Design, supply, inspection, receiving, storage, installation, field testing and commissioning activities including co-ordination with the suppliers of the switchgears. The rate shall be quoted per set of switchgears/panels as identified in the BOQ.

7.9 GENERAL :

INSPECTION:

The panels be inspected and checked as per inspection manual of the PANEL manufacturer.

Various electrical components and accessories of the PANEL's shall be checked as per drawing for the respective panels

The PANEL's shall be checked for rigid mounting, earthing connection, proper rating & size of components, internal wiring etc.,

All mechanical fasteners and electrical connections shall be checked and tightened before installation.

7.10 INSTALLATION:

The PANEL's shall be assembled and aligned together and be installed at site as per installation manual/ instruction of the PANEL manufacturer.

The installation shall conform to relevant Indian Standard specification and requirement of local site conditions.

The PANEL shall be installed in surface/concealed manner at the location as shown in the respective drawings.

All minor electrical and mechanical work required to be attended to on the PANEL shall be completed in an approved manner after installation but before energizing the PANEL's.

CABLES:

8.1 GENERAL SCOPE :

Supply , installation, storing, laying, fixing, jointing / termination, testing and commissioning of Medium Voltage XLPE insulated extruded PVC inner sheathed PVC overall Sheathed armoured aluminium/ copper conductor cables laid in built up trenches, directly buried underground, on cable trays, in pipes, clamped directly to wall or Structures etc. as called for in the drawing.

a) Type :

Medium voltage cables shall be circular, multicore annealed copper or aluminium conductor, XLPE insulated, PVC extended inner sheathed an PVC overall sheathed and steel wire armoured or steel tape armoured construction or unarmoured. The conductors of cable shall be stranded. Sector shaped stranded conductors shall be used for cables of 50 sqmm size and above. The cables shall conform to IS:1554 part-I in all respects.

MV power cables shall be 2, 3, 3.5 or 4 cores, as required and shall have conductors made from electrical purity aluminium conductors conforming to IS:8130-84.

Conductors shall be insulated with high quality PVC base compound. Insulation and outer sheathing compounds shall conform to IS:5831 - 84.

A common covering shall be applied over the laid-up cores by an extruded sheath of un-vulcanized rubber compound.

Armouring of galvanized round steel wires or galvanized flat steel strips shall be provided over the inner sheath.

Outer sheath of PVC shall be extruded over the armouring cables shall be manufactured and tested in accordance with IS 1554 Part I.

Unless otherwise specified, all control cables shall be multicore, 1100V grade PVC insulated, armoured and overall PVC sheathed with stranded copper conductors of 2.5 sq.mm, conforming to IS 1554 Part I. Cores shall be identified by colour scheme of PVC insulation.

b) Rating :

The cables shall be rated for a voltage of 1100 Volts.

c) Core Identifications :

Cores shall be provided with the following colour scheme of PVC insulation

1. Single Core : Green yellow for earthing.
2. Two Cores : Red and Black, Blue & Black, Yellow & Black.
3. Three Cores : Red, Yellow & Blue
4. Four Core : Red, Yellow, Blue & Black

d) Selection of Cable:

1. Cables sizes shall be selected considering the current carrying capacity, voltage drop, maximum short circuit duty and the period of short circuit to meet the present and future anticipated loads.

2. While deciding cable sizes, the derating factors for type and depth of laying, grouping, ambient temperature, ground temperature and soil resistivity shall be taken into account.

8.2 STANDARDS :

The following standards and rules shall be applicable.

IS 1554	└	PVC insulated (heavy duty) electric cables Part I for working voltages upto and including 1100 V.
IS 8130	└	Conductors for insulated electric cables and flexible cords.
IS 3961	└	Recommended current ratings for cables:(Part 2) PVC Insulated and PVC sheathed heavy duty cables.
IS 5831	└	PVC insulation and sheath of electric cables.

The individual cores shall have continuous numbering of the core all along its length and also be provided with identification ferrules at both ends. Individual control cables shall have 20% spare cores.

PVC / XLPE cables shall be used for all electrical works to prevent flame propagation, smoke reduction and to avoid toxic gas emission in the event of a fire. FRLSH compound shall be tested rigorously for oxygen index as

per ASTM D2863, acid gas generation to IEC 754-1, smoke density to ASTM D 2843 and flammability SS 424 1475 class F3, IEEE 383 and IEC 332-1.

Manufacturer's name, ISI Mark, cable size and type shall be clearly embossed at regular intervals on all cables.

8.3 INSPECTION :

All cables shall be tested inspected at manufacturers works. However upon receipt at site cables shall be checked for physical damages during transit.

8.4 JOINTS IN CABLES :

The contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoidance of straight cable jointing. This apportioning shall be got approved by the Construction manager/ Consultant before the cables are cut to lengths.

Where straight joints in cable are unavoidable, the use and location of such straight joints shall be got approved by Construction manager/Consultant.

8.5 JOINTING BOXES FOR CABLES :

Cable joint boxes shall be of appropriate size, suitable for PVC insulated armoured cables of particular voltage rating.

8.6 JOINTING OF CABLES :

All cable joints shall be made in suitable, approved cable joint boxes, jointing of cables in the joint boxes and the filling in of compound shall be done in accordance with manufacturer's instructions and in an approved manner. All straight joints shall be done in epoxy mould boxes with epoxy resin (Tropolin/M-Seal resin or approved equal). All jointing accessories shall be of CCI/INCAB or approved equal. All terminal leads of conductors shall be heavy soldered upto at least 50mm length.

All cables shall be joined colour to colour and tested for continuity and insulation resistance before jointing commences. The seals of cables shall not be removed until preparations for jointing are completed. Joints shall be finished on the same day as commenced and sufficient protection from the weather shall be arranged. The conductors shall be efficiently insulated with high voltage insulating tape and by using spreaders of approved size and pattern. The joints shall be completely filled with epoxy compound and tapped so as to ensure that the box is properly filled.

Epoxy compound shall be filled as follows :

Equal quantities of resin and hardener shall be mixed thoroughly by hand until the mixture is free from white patches and has uniform colour. No water, oil or any other liquid shall be added to the mixture to make it soft as this will affect the properties of the compound. The mixture shall be used within 30-40 minutes of mixing. The surface on which epoxy compound is to be used, shall be free from dust, rust, oil, grease and shall be dry. The joint shall neither be disturbed nor moved till the epoxy compound is completely hardened. A smooth surface can be made by rubbing a damp cloth smoothly on the compound before it sets. The joints shall be painted after it has completely hardened.

Alternatively, ready mix of epoxy cable jointing compound may also be used.

8.7 CABLE MARKERS/CABLE TAGS :

Cable Markers:

All underground cables and cable joints shall be marked on the surface by markers generally manufactured and tested to the requirements of relevant ISS. Approved CI cable markers shall be provided at every 30m along

the route of the cables and at both ends of road crossing, indicating cable joints and cables as applicable. Special CI markers shall be provided at all buried cable joints indicating "Electrical Cable Joints". CI plates duly engraved with the size of the cable and the place it serves shall be tied to the cable at regular intervals of 5m for easy identification of cables.

Cable Tags:

Cable tags shall be made out of 2 mm thick aluminium sheets, each tag 32 mm in dia with one hole of 2.5 mm dia. 6 mm below the periphery shall be provided for clamping the same with cables.

Cable designation are to be punched with letter/number punches and the tags are to be tied to cables with piano wires of approved quality and size. Tags shall be tied inside the panels beyond the glands as well as below the glands at cable entires. Along trays, tags are to be tied at all bends on straight lengths, tags shall be provided at every 5 meter.

8.8 TERMINATION OF CABLES :

Cable termination shall be done in terminal box or cable end box or distribution boards, or apparatus/equipments. Terminations are to be made with mechanical gland and of the tinned nickel plated, anti- corrosive, three piece improved pattern which is to grip inner and outer PVC sheaths as well as the armour of the cable. The cable ends or the core conductor are to be connected by solderless lugs or sockets using crimping tool of approved make for all cables.

All terminations of cable conductors and base conductors shall be mechanically and electrically sound and shall comply with the requirements of relevant Standards and Indian electricity regulations.

The connectors or connecting sockets are to have such dimensions so as to limit temperature rise.

When required the water tightness of the terminal boxes may be obtained by filling with a compound preferably plastic flame retarding and non-dripping type within the normal range of temperatures.

When the cable is cut during the course of installation the open ends are to be sealed immediately by means of self-adhesive non hygroscopic tape over a wax water seal to make an air and watertight joint.

8.9 INSTALLATION OF CABLES:

Cable shall be laid in a manner as indicated on the drawings. Generally cables are laid in the following manner.

- i. In the underground masonry trench.
- ii. On the cable tray/or on cable ladders.
- iii. Buried underground.
- iv. Through pipe sleeves.

Various installation methods are discussed in the following paragraphs.

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before unwinding the cable. The cable drums shall be rotated in a direction as indicated by the manufacturer. Care shall be exercised in laying cables to avoid forming kinks. The drums shall be unrolled and cables run over wooden rollers, placed at intervals not exceeding 2 meters.

General

All cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of service.

When cable pass through holes in metal work, precautions shall be taken to prevent abrasion of the cables on any sharp edges.

In every vertical cable ladders, channel or duct or trunking or cable trench containing cables and exceeding three meters in length, internal barriers shall be provided so as to prevent the air at the top of the unit from attaining an excessively high temperature. In every vertical cable shaft, cable trench or any passage of cable through wall, ceiling, floor barriers against spread of fire and smoke shall be provided for compliance with IEE regulations. `Viper' CABLEMASTIC fr 903 fire resistant painting shall be applied on all power cables.

Where cable passes through walls, ceiling, floor, it shall run through sleeve of PVC pipes or hume pipes of adequate diameter. After pulling the cable through sleeve, both the ends of the sleeve shall be sealed water tight with fire resistance material to prevent spread of fire and seepage of water.

Generally along each cable route either in trench or in cable trays/ladders or in pipe separate Two Nos. of earth strips/wires shall run exposed.

Where an installation comprises medium voltage cables as well as extra low voltage circuits, precaution shall be taken in accordance with relevant regulations and shall be physically separated by minimum of 300mm distance.

Metal sheaths and armour of all cables, metal conduits, ducts, trunking, and bare earth continuity conductors associated with such cables, which might otherwise come into fortuitous contact with other fixed metal work shall be effectively bonded there to earth so as to prevent appreciable potential difference at such possible points of contact.

Underground Installations

The cables shall be laid in an excavated trench. The depth of the trench shall be minimum 750 mm below the final ground level but shall be decided on the number of cables to be laid in the trench so that the vertical distance between two adjacent layers of cables shall not be less than 350mm. The width of the trench shall be decided on the number of cables to be laid in the trench so that the distance between two adjacent cables shall not be less than one cable diameter.

a) Width of Trench:

- i) The minimum width of trench for laying single cable shall be 350 mm.
- ii) Where more than one cable is to be laid in the same trench in horizontal formation, the width of trench shall be increased such that the inter axial spacing between the cables, except whether otherwise specified shall be at least 200 mm.
- iii) There shall be clearance of at least 150 mm between axis of the end cables and the sides of the trench.

b) Depth of Trench:

- i) Where cables are laid in single tier formation, the total depth of the trench shall not be less than 750 mm.
- ii) When more than one tier of cables is unavoidable and vertical formation of laying adopted, depth of trench in (i) above shall be increased by 300 mm for each additional tier to be formed.

In addition to above, where gradients and changes in depth are unavoidable, these shall be gradual. The cables shall be protected by placing precast concrete tiles or burnt bricks over the cables on top layer of sand and for the full length of underground cables. Where more than one cable is running in the same trench, the concrete tiles/bricks shall cover all the cables and shall project a minimum of 150mm on either side of the cables.

In any case the top layer of the cables shall be minimum 600 mm below the finished level of the ground.

The top of the cable trench shall be well compacted till the finished level of the ground and shall be approved by the Construction Manager/Consultant. If required a laboratory compaction test shall be carried out in presence of the Construction Manager/Consultant.

H.V., M.V., cables shall not be laid in the same trench/cable tray and/or along side of water main.

Cables under road crossings and any surfaces subjected to heavy traffic shall be protected by running them through Hume pipes of suitable size.

Where cables cross one another, the cables of higher voltages shall be laid at lower level than the cable of lower voltage.

The relative position of the cables laid in the same trench shall be preserved and the cables shall not cross each other as far as possible. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius of bend not less than 15 times the diameter of the cable. Minimum 3 meters long loop shall be provided at both sides of every straight joint and 5 meters at each end of the cable. Distinguishing marks shall be made at the cable ends for identification.

Proximity to Communication Cables:

MV Cables and communication cables shall as per as possible cross at right angles where power cables are laid in proximity to communication cables the horizontal and vertical clearance shall not normally be less than 600 mm.

Insulation tapes of appropriate voltage and in red, yellow, and blue colors shall be wrapped just below the sockets for phase identification.

All the excavation and back fill including timbering, shoring, and pumping required for the installation of the cables shall be carried out as indicated on the drawing and as per requirements laid down elsewhere or as per Construction manager/Consultant direction. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layers not exceeding 150mm. At each layer compaction test shall be carried out in presence of Construction manager/Consultant Each layer shall be properly rammed and consolidated before laying the next layer. The contractor shall restore all surfaces, roadways, side walls, curbs, walls, landscaping or other works cut for excavation to their original condition, the satisfaction of the Construction manager/Consultant. Suitable approved type cable markers shall be installed along the cable route & wherever change of direction takes place.

Cables Installed Inside the Building

The cables inside the building shall be installed in one of the following manner, as indicated in the drawing and approved by the Construction manager/Consultant.

Installed in Built-up Trench

The cables laid on the bottom of the structural trenches shall not lay freely upon the trench bottom. They shall be raised to prevent the possibility of their coming into contact with deleterious materials.

The cables laid in the trench shall be laid on angle iron brackets/cable tray/cable ladder/cable troughs/cable racks as indicated on the drawings, and as approved by the Construction manager/Consultant. Where cables are clamped to the wall a minimum clearance of 100mm shall be maintained between wall and cable and minimum 150mm vertical clearance shall be maintained between two cables. Where cables are laid on brackets the brackets shall not be fixed more than 500mm apart to avoid sag in the cables. Where the cables are laid on cable tray/ladder/troughs /racks, minimum 300mm distance shall be observed between adjacent tier of tray/ladder/ troughs/racks, and cable shall be fixed minimum 25mm away from the wall, and minimum of one

cable diameter distance shall be observed between two adjacent cables. Cables shall be properly fixed with the tray/ ladder/ troughs/ racks with cable tie or saddles or straps.

Cables on Cable Trays/Ladders under the Ceiling or on Wall

Where cables are installed under above suspended ceiling or below ceiling or on wall, they shall be laid on a ladder/perforated G.I. cable tray and shall be run in such positions that they are not liable to be damaged by contact with the floor or the ceiling or other fixtures.

The ladder/perforated cable tray shall be properly fixed with channels, angles, tie rod, flats to the ceiling. The metal inserts for fixing channels, angles, tie rod, flats shall be put in place while casting the slab. If insert plates are not placed in position, Anchor fasteners shall be used to support cable trays if required. The cable tray route shall be co-ordinated with other services to avoid crisscross of all the services. While laying the cables on the tray minimum one cable diameter distance shall be observed between two adjacent cables about 20% space shall be kept spare for any future installation.

Cables Installed in the Mechanical Room

The cable reaching the motors in the mechanical room or plant room or machines room or service area shall be laid on cable tray except where indicated in masonry underground trenches.

The cable reaching the motors shall be protected by rigid galvanized conduits up to a height of 300mm above the floor. Above that height, the cable shall be protected by means of oil tight flexible metallic G.I. conduits to the terminal box of the motor. The connection between the rigid conduit and the flexible conduit shall be done by a screwed coupling of an approved type. The flexible conduit shall be properly fixed with the terminal box of the motor by means of double hexagonal check nut.

TESTS ON CABLE:

ROUTINE TESTS

The following tests constitute Routine Tests , which are carried out on each and every length of cable before it leaves the factory .

A. Conductor Resistance Test

This test ensures that conductor resistance is within the specified limit , thereby verifying that the continuity of conductor is maintained throughout the cable length and that the conductor has the required electrical section . D.C. resistance is measured at room temperature and is then corrected to standard reference temperature of 20 dg C .

B. High Voltage Test

This test ensures that insulation will safely withstand the rated voltage with permissible variation in normal operation.

TYPE TESTS

These tests are carried out on samples taken from each production lot. They are carried out to prove conformity as regards the general qualities and design to the specification of particular type of cables.

ACCEPTANCE TEST

These tests are again carried out in the presence of the concerned inspecting authority for testing , approval and release of material offered for inspection.

The above tests must be conducted at site in presence of Consultant's/Client's representative. Test certificates of the above tests shall be approved by Client/Consultant. The test results shall be recorded on prescribed

forms. The test certificates for the test carried out at site shall be submitted in six copies to the Construction manager/Consultants for approval.

H.T. CABLES GENERAL

HT 33 KV XLPE cables shall in all respects conform to IS 7098 part II. Storage handling, installation / method of laying testing loops mechanical protection jointing and termination etc. shall be as per CPWD General Specifications for Electrical Works (Part II External) 1995.

The cables shall be tested and commissioned in accordance with Drawings, Specifications, Indian Standard Specification IS : 1255 – 1967 and cable manufacturers instructions. The cables shall of reputed make.

The recommendations of the cable manufacturer with regard to jointing and sealing shall be strictly followed. The installation of cable shall be done by an approved, qualified and experienced person in this trade.

MATERIAL:

The H.T. cables shall be 33 KV, aluminum conductor CROSS LINKED POLYETHYLENE steel tape armoured cable laid underground and or in RCC hume pipes as shown on Drawings. The conductor shall be made of Electrical purity aluminum wires and stranded together and compacted. The cable shall be 3 Core type. The insulation shall be of high quality cross linked polyethylene applied by extrusion process. Both conductor and the insulator are provided with shielding made of same Conducting compound. Armoring is applied over inner sheath and shall be of flat steel strips. The outer sheath shall be of heat resisting Tropodur (PVC) compound. This shall be black colour.

CABLE TERMINATIONS:

Cable termination shall be done in terminal cable box using cable glands and the cable ends sealed with sealing compound. The cable boxes of transformers shall be filled with bituminous compound of approved make.

LAYING OF CABLES:

H.T. cables shall be laid either buried directly underground or RCC pipes. The cable buried underground shall be at minimum depth of 1.2 mtr. from the ground level. Sand cushion of not less than 80mm shall be provided both above and below the cable with a protective concrete slab on the top of the sand layer. The cable trench shall be back filled and compacted.

PROTECTION OF CABLES:

The cable shall be protected by placing precast reinforced 50mm, thick (1:2:4) concrete slabs 200mm wide on the top layer of sand for the length of the cable. Where more than one cable is running in the same trench the concrete blocks shall be cover all the cables and shall project minimum 80mm on either side of the cables.

Cables under road crossing and any surface subjected to heavy traffic, shall be protected by running them huge pipes of suitable size.

TEST ON CABLES:

The cable shall be type tested and routine tested in accordance with IS-7098 (Part – II) 1985.

The following tests shall be carried out as routine tests on every length of cables

- a) Conductor resistance test
- b) Partial discharge test
- c) High Voltage test

TEST VOLTAGES

The test voltage shall be applied between conductor and screen/armoured.

VOLTAGE RATING OF CABLES

TEST VOLTAGE

19/33 KV (E) cable

48 KV (rms) for 5 Minutes

The above tests must be conducted at site in presence of Consultant's/Client's representative. Test certificates of the above tests shall be approved by Client/Consultant. The test results shall be recorded on prescribed forms. The test certificates for the test carried out at site shall be submitted in six copies to the Construction manager/Consultants for approval.

G.- CABLE TRAY SPECIFICATION :

The trays shall be made of 2mm thick (upto 500mm width) & 3mm thick(above 500mm width) perforated sheet having minimum 75 mm depth. The width of perforation shall be maximum 10mm spaced at maximum 20mm distance. The width of the cable tray shall be selected so as to accommodate required number of cables to be laid on it, with minimum separation of minimum one cable diameter between two adjacent cables. The cables shall be tied with the cable tray with nylon strip/ Aluminium clamps/GI clamps. The cable trays shall be GI perforated / powder coated(thickness of powder coating shall be up to 50 microns).

All steel work shall be treated in accordance with the following procedure and in accordance with IS : 6005 "Code of Practice for Phosphating Iron and Steel".

After completion of fabrication work, complete fabricated structure shall be thoroughly cleaned to remove traces of grease, rust, scale and dust. The seven tank process for treatment of fabricated structure shall be used. After preparation of fabricated surfaces, the panel shall be powder coated with synthetic enamel paint up to 50 microns thickness.

The finished panels shall be dried in storing ovens in dust free atmosphere to ensure fine quality finish. The paint shall be Berger Luxol Higlloss, with siemens gray color for inside outside .

Finish powder coated surface of steel shall present an aesthetically pleasing appearance free from uneven surface.

The finish powder coating shall be as per ISS or as approved by consultants.

GI PERFORATED / LADDER TYPE CABLE TRAY –

The cable tray shall be fabricated out of slotted/perforated MS sheets as channel sections, single or double bended. The channel sections shall be supplied in convenient lengths and assembled at side to the desired lengths. These may be galvanised or powder coated to the desired lengths. Alternatively, where specified, the cable tray may be fabricated by two angle irons of 50mm x 50mm x 6mm as two longitudinal members, with crosses bracings between them by 50mm x 5mm flats welded/bolted to the angles at 1 m spacing. 2mm thick MS perforated sheet shall be suitably welded/bolted to the base as well as on the two sides.

Typically, the dimensions, fabrication details etc. are shown in CPWD General Specification for Electrical Works - Part II -External, 1994.

The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scraped and removed before the installation.

The maximum permissible uniformly distributed load for various sizes of cables trays and for different supported span are as per CPWD General Specification of Electrical Work Part II -1994. The sizes shall be specified considering the same.

GENERAL

The width of the cable tray shall be chosen so as to accommodate all the cable in one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100mm. The overall width of one cable tray shall be limited to 800mm.

Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice. (Details are typically shown in figure3) of CPWD General Specification of Electrical Work Part II -1994. The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

The cable tray shall be suspended from the ceiling slab with the help of 10mm dia MS rounds or 25mm x 5mm flats at specified spacing as per of CPWD General Specification of Electrical Work Part II -1994. Flat type suspenders may be used for channels upto 450mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angles 50mm x 50mm x 5mm at the bottom end as specified. These shall be grouted to the ceiling slab at the other end through an effective means, as approved by the Engineer, to take the weight of the cable tray with the cables.

The entire tray (except in the case of galvanised / powder coated type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

The cable tray shall be bonded to the earth Terminal of the switch bonds at both ends.

The cable trays shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross joints, etc, and paid for accordingly.

STATUTORY APPROVALS

All statutory approvals from electrical inspectorate, MP regulatory board and MPEB are to be obtained by the electrical contractor for which no extra cost will be payable. However the contractor shall be reimbursed with all required deposits made in the govt. treasury for the said purpose against production of treasury challans . The work also includes getting MPEB connection sanctioned of up to 4000KVA from MPEB .

IS SPECIFICATIONS

The following Indian Standard Specifications revised as on date will apply to the equipment and contract.

a. Switch fuse units on cubicle switch boards	IS 4047	1967
b. Switchgears Bus Bars	IS 375	1963
c. Distribution boards	IS 2675	1966
d. Enclosure for low voltage switchgears	IS 2147	1962
e. PVC cables	IS 1554	1964
f. tubular filament lamps	IS 2410	1963
g. Tungsten filament lamps	IS 415	1963
h. Ceiling fans	IS 374	1966
i. Industrial light fittings	IS 1771	1961
j. Water tight electric light fittings	IS 3553	1966
k. Steel boxes for enclosure of electrical accessories	IS 5133	1966
l. Fittings for rigid conduits	IS 2667	1964

m. Rigid steel conduits for electrical wiring	IS 9537	1984
n. Accessories for rigid steel conduits for electrical wiring	IS 3873	1966
o. Switch socket outlet	IS 4615	1968
p. Three pin plugs and socket outlet	IS 1293	1967
q. Switches for domestic and similar purpose	IS 3854	1966
r. PVC wires	IS 694	1964
s. Call bell and buzzers	IS 2268	1966
t. Earthing	IS 3043	1966
u. Electrical wiring installation	IS 732	1963
v. Switchgears	IS 3072	1965
w. Lighting protection	IS 2309	1969

Indian electricity rule 1956 amended as on date

INSTRUCTIONS FOR CARRYING OUT ELECTRICAL INSTALLATIONS

1. The Contractor will have to bring all the necessary and proper tools and tackles for carrying out the work.
2. The work is to be carried out alongwith the progress of civil works .
3. All jumpers and connections of ACSR conductor or aluminium busbar are to be taken out by means of Proper clamps ,tees , lugs only.
4. Jointing of copper strips shall be done by brazing or by way of butt jointing, bolt, nut, washer used for jointing shall be either of brass/GI. The size of bolt shall be approved by Engineer-in-charge / Architect.
5. All precautions during slab works shall be taken by contractor to safeguard electrical pipes.
6. Interlocking, interlocking between air break switch and respective LT breaker shall be done both electrically or mechanically as required, Contractor shall include the case of interlocking in installation of HT VCB ,isolators, AB switch and LT A.C.B./O.C.B./M.C.C.B
7. All material to be supplied by the Contractor must be from approved quality , make and must be got/approved by Engineer-in-charge/Architect before use.
8. The Contractor shall follow all the rules and regulations like factory act, workmen compensation act and shall be responsible for any injury or accident to persons working at site.
9. The work is to be carried out as per the Indian Electricity Rules &Standard code of practice and other relevant specifications. Workmanship shall be to the satisfaction of the Engineer-in-charge/Architect. Preference to the work/items shall be given as per requirement of Employer and site situations.
- 10.a: The installation shall have to be approved by Electrical Inspector/M.P.E.B./MP regulatory board and/or any other local authorities, if required and such approval shall have to be arranged by Contractor. Any alterations, additions suggested by them shall have to be incorporated by the Contractor ,cost of which shall be considered included in scope of this tender.
- b: After getting permission of charging from Electrical Inspector's office it is duty of Contractor to follow-up for installing energy meter and getting line charged from MPEB as early as possible. All follow-up expenses shall be considered included in offer.
11. The Contractor shall keep at site of work one engineer having bachelors degree in electrical engineering from recognized university for receiving instruction and shall have to give satisfactory progress of work .The contractor will have to obtain prior approval of EIC by submitting the credentials of the

electrical engineer he propose to appoint on site of work .Even during execution if EIC/Architect feels that the said engineer appointed by contractor has failed to perform his duties satisfactorily ,they can instruct the contractor to appoint another engineer and contractor will have to comply it immediately.

12. If any part or whole of the work or any item is not executed to the entire satisfaction of the Engineer-in-charge/Architect. The Contractor shall have to demolish and do the same work again with out any extra cost if so ordered by the Engineer-in-charge/Architect.

13. The place after any work is completed should be cleaned by the Contractor. Breaking of walls, slabs, roads etc. necessary for laying cables, conduits drawing of cables/wires etc. and making them good to original position will have to be done by the Contractor through skilled workers.

14. The measurement will be taken jointly in presence of Consultants/AKVN authorized representative at site.

15. No joint shall be allowed in I-section, MS channel.

16. Whatever material/equipments supplied by the Contractor, he has to supply 4 sets of test certificates from the manufacturers ,like lightning arrestor, AB switch, DO fuse, electrical control panel, sub distribution boards, ACB, OCB, MCB, MCCB, earth fault relay/earth leakage relay, ELCB, transformers, wires, cables and other item etc.

17. The quantities as shown in the Tender are for guidelines .

18. On the completion of the work the Contractor shall supply free of charges, completion plan in triplicate, in blue prints and also in original drawing on tracing cloth. Insulation and earth test report of the Internal and External electrification installation shall be supplied in 3 copies. These shall be handed over to the Consultant in good condition by the Contractor before the finalization of his final bill.

19. Meter connection , MPEB's approval for sanction of power and DG set ,Electrical Inspector's approval for HT yard and DG set ,MP regulatory boards approval for DG sets is included in scope of contract and all such work shall be completed by contractor within time without any extra cost however all legal fees deposited by him shall be reimbursed by employer against production of treasury challans.

20 All materials brought at site shall be as approved by Consultant and if desired so contractor shall arrange for testing of materials at laboratory (ERDA, Baroda)for any electrical parameter checking. All such expenses shall be borne by contractor and are included in quoted rates.

21 General repairs should be done before completion of work.

22 Preparation of final drawing of DG sets, transformer /HT yard layout based on drawings given by consultants and getting approval from state electricity board and office of chief electrical inspectors office to charge transformer is included in scope of contractor. work also include obtaining complete permission /approval including site visits of officials . All work to be arranged by contractor and liasioning charges/expenses for above work shall be included in tender cost .Final permission without pending work remark shall be submitted to Employer .Calibration of meters / CTs from state electricity board will also be responsibility of contractor and no extra payment for these works shall be payable. Only those Challans/bills (which are submitted in treasury) for Electrical Inspectors office, MPEB office will be reimbursed by employer against production of original challans to employer.

TESTING AND COMMISSIONING

Before the lighting/power installation is made alive the Contractor shall carry out tests enumerated below in presence of Engineer-in-charge or his authorized representative. All testing equipments necessary to carry out the tests shall be arranged by Contractor and the tests results recorded on approved proforma. Nothing extra shall be payable for testing.

1. Before energizing, measure insulation resistance of the cable from phase to phase and that from phase to ground, Insulation resistance of the busbars at the lighting panel from phase to phase and from phase to ground shall be measured before energizing the panel and should comply latest IS.

2. Current and voltage of all phase shall be measured at the lighting panel busbars with all circuits on with fixture and also in all switchboard.

3. Check the earth continuity for all sockets outlets. A fixed relative position of the phase and neutral connection inside the socket shall be established for sockets.

4. The earth electrodes shall be tested for earth resistance by means of standard earth tester. The resistance between the earthing system and the general mass of earth shall not be greater than 1 ohm.

5. While crossing the expansion joints in building conduits shall be provided with flexible pipe shall not be more than 250 mm, at both the ends of conduit proper flexible couplings shall be provided and earth wire shall be properly connected to earthing terminal of coupling.

6. Contractor should quote after site visit only. In case for cable trench, street light pole pit, earthing pit etc. or any place where Contractor has to dig the earth in hard strata or rock he has to do so at quoted rates only for item. No blasting shall be allowed for such digging.

7. For earthing of street light tubular pole 8 SWG GI wire as per standard specification is used.

8. Testing / Commissioning Of Conduit Wiring

Before the lighting /power installation is made alive the contractor shall carry out tests enumerated below in presence of Engineer – in – Charge or his authorized representative . All testing equipments necessary to carry out the tests shall be arranged by contractor/the tests results recorded on approved proforma . Nothing extra shall be payable for testing.

- a. Measure insulation resistance of each circuit without lamps being in place / it should not be less than 5 megaohms to earth.
- b. Current / voltage of all phase shall be measured at the lighting panel busbar with all circuits on with fixture /also in all switchboard.
- c. Check the earth continuity for all sockets outlets. A fixed relative position of the phase /neutral connection inside the socket shall be established for sockets.
- d. Load Balancing – Balancing of circuits in three phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.
- e. Fall of potential – The drop in pressure between the main switch terminals and the farthest current consuming apparatus will not exceed 2% with all devices switched ON. The number of points controlled per circuit shall be as per I.E . Rules if not specified particularly.
- f. Ratings : For purpose of determining sizes of sub mains and controlling switches , the following ratings for points shall be assumed.

- | | |
|----------------------------|--------------|
| i) Ceiling Light Point | - 100 Watts. |
| ii) Conveyance plug points | - 100 watts. |
| iii) Fan Points | - 60 watts. |
| iv) Domestic power plug | - 250 watts. |

Cable Identifications : For multicore cables , PVC ferrule type indicators or tags shall be provided at both ends for core identification. For phase identification pf 2,3,3 ½ cables coloured PVC tags shall be used at both ends.

All cables shall be provided with aluminium tags of approved design , spaced not less than 10 meter apart and these shall contain the following information.

Feeder no.

Size

No. of cores.

h. Under ground cables : Cables shall be so laid that they will not interfere with other underground structure. All water pipes , sewage line or other structures , which become exposed by the excavation ,shall be properly supported and protected from injury until the filling has been rammed solidly in places under and around the . Any telephone other cables coming in the they are to be properly shieled as directed by the Clients . Hume pipe for crossing shall have to be sealed at both ends after cable laying and testing is completed .

TECHNICAL SPECIFICATIONS

(CCTV SYSTEM)

CLOSED CIRCUIT MONITORING SYSTEM

GENERAL SYSTEM REQUIREMENTS:

The scope of work shall include supply, installation, testing and commissioning of all indoor and outdoor IP cameras, NVRs and control panels with all inter connection as required. The scope includes supply and laying of video coaxial / Cat 6 computer cables, power and control wiring.

GENERAL SYSTEM DISCRIPTION:

The CCTV is required to supply the operator with the following information and facilities:

Display of images on monitors through commands given by the operators keyboard.

Automatic camera selection, positioning and display to pre-set positions

Remote camera, monitor and recording selection

Display of single and/or quadruplicated images on any selectable monitor.

Recording driven by Network Video Recorders

TECHNICAL BRIF:

1. Network Video Recorder –

- The Network recorder shall be a 16/32-channel Analog input disk Network recorder. The Network recorder shall have the capability to carry 2 drive bays, and thus it shall have the capability to carry up to 4TB with the optional hard disk drives.
- The Network recorder shall have the capability to record 25fps per channel @ CIF resolutions and should be capable to record @Half D1 and D1 Resolutions.
- The Network recorder should support the latest compression technology H.264 algorithm.
- The Network video recorder should be capable of pentaplex functions.
- The Network recorder shall have field recording. The Network recorder shall have 4 different recording modes – 1. Normal recording, 2. Alarm recording, 3. Pre-alarm recording and Instant.
- The Network recorder shall have the ability to provide backup of the recorded images through USB, eSATA & network and should have min 1xeSATA.
- The Network recorder shall have built-in coaxial and RS-485/422 telemetry allowing control of PTZ cameras .
- The Network recorder shall have the following play back functions FF, GO to First, Go to Last and frame Advance.
- The Network recorder shall have 4 audio inputs and 1 audio output and should have two way audio supports.
- The Network recorder shall have a built-in LAN terminal. The Network recorder shall have the capability to connect to any PC over a LAN, and it shall have the capability to monitor and setup the Network recorder through network. Also, video and audio recordings shall be downloaded to a networked PC.
- The Network video recorder should have separated recording/network Dual Streaming feature for transferring the data online with less bandwidth consumption and Frame rate can be adjustable.
- The recording device should have remote management software CMS.
- The Network recorder shall offer the following search modes:
 - Date/Time search
 - Calendar
 - Event

- The Network recorder shall operate on AC Free 100 to 240 V, 50 / 60Hz with the operating temperature of 0degree to 40 degree C
- The Network recorder shall be CE, FCC, and UL-ETL.

Video Input	16ch Composite (BNC)
Video Output	Main Output (Simultaneous) : VGA, Composite,
	Spot Output : Composite (up to 16channels division)
Operating System	Embedded Linux
Compression	H.264 Hardware Codec
Multiplex Function	Pentaplex (Live, Recording, Playback, Network,Backup)
Recording FPS	D1, Half D1, CIF
Frame Rate	480fps (NTSC),400fps (PAL) at CIF Resolution
Recording Mode	Continuous, Alarm, Motion, Instant
Playback Mode	Calendar, Date/Time, Event (Motion, Alarm), Bookmark
Display Mode	1, 4, 9, 16, 1+5, 1+7, 1+12
Audio	4 lines Input / 1 line Output
Two-way Communication	Two-way audio support
Sensor Input / Alarm Out	8 Line (NC/NO Selectable) / 4 Line(NC/NO Selectable)
Storage	1 SATA / e-SATA HDD
Backup	USB Memory Network, Internal ODD,External USB ODD
Export	USB Storage, Network,Internal/External ODD
Network	10/100/1000 base Ethernet, DDNS,
	TCP/IP, ADSL/VDSL, DHCP
Data retention	Support (Auto Delete setting on Setup)
NTP	Support
Health Check	Support
Watchdog	Support
Operation Control	Front Key, Mouse and Remote Controller
Firmware Update	USB Memory, Network

2. Dome camera Indoor -

- The colour camera shall incorporate 1.3 & 2 mega pixel CMOS image 3.6mm Lens(2.8mm/6mm optional). The colour video camera shall produce H.264 & MJPEG dual-stream encoding. produce max 15fps@1.3M(1280x960)&25/30fps@720P(1280x720 a picture. The CCTV camera shall have the ability to switch from colour mode to black & white mode automatically in Low light conditions. The video camera shall have a minimum light requirement of 0.05 Lux @ F2.0.The video camera shall have a video signal to noise ratio of more than 48dB.
- The video output level shall be 1.0 Vp-p (75 ohms composite) with a BNC type connection.
- The video camera shall have advanced intelligence to eliminate light hunting and picture distortions caused by colour/black and white switching. The video camera should be Day & Night Camera.
- The video camera shall have options for back light compensation in the form of Network WDR / AGC / BLC / HSBLC.
- The video camera shall have 3D-Network Noise Reduction.
- The camera shall have internal sync system capabilities.
- The Camera Electronic shutter min speed should be 1/50~1/100,000.
- Power requirements for the video camera shall be 12V DCand shall consume approx. 1.15 W.
- The camera should have a multi Language OSD including English.
- The video camera shall be CE, FCC, and UL-ETL Listed.

Imaging Sensor	6.0mm (1/3 Type) Super Had CCD II
ISP	Network Signal Processor
Lens Type	3.6mm Fixed Lens (LD120N/P-C1) / Option: 2.5mm Fixed Lens (LD120N/P-A1)
Sync. System	Internal / Line Lock (Option)
Scanning Frequency (H/V)	
Horizontal Resolution	
S/N Ratio	48dB
Minimum Illumination (F1.2, 30IRE)	0.05 Lux @ F2.0
Video Output Signal	1Vp-p Composite (75Ω)
Day & Night	Network (Auto / Day / Night)
Backlight Compensation	Network WDR / AGC / BLC / HSBLC
Exposure	ELC
Auto Gain Control	Auto
Electronic Shutter Speed	
White Balance	ATW (1700-11000K)
Multi OSD Language	2 Languages
Power Source	DC 12V
Power Consumption	1.15 W
Operating Temperature / Humidity	-10°C ~ 50°C / 0% ~ 80%RH (Non-Condensing)

Storage Temperature / Humidity	-20°C ~ 60°C / 0% ~ 85%RH (Non-Condensing)
Certifications	FCC, CE, UL
Dimension (Ø x H)	Ø 88 x 67.5 mm
Weight	0.17 g

PUBLIC ADDRESS SYSTEM

GENERAL SYSTEM REQUIREMENTS:

The voice alarm system shall be the integrated solution for BGM and EVAC. The voice alarm system shall be designed for public address and emergency evacuation. All the essential EVAC functionality – such as system supervision, spare amplifier switching, loudspeaker line surveillance, Network message management and a fireman's panel interface – shall be combined.

The system shall provide for emergency call (EMG), business call and BGM audio, up to 60 zones, 8 call stations and two remote control panels.

The voice alarm system shall be a one channel/two channel system. It shall be compatible with BGM sources and 100 V booster amplifiers. It shall be capable of connecting to EVAC compliant loudspeakers and accessories for an integrated public address and voice alarm solution.

The system shall be fully IEC 60849 compliant.

It shall have full system supervision, loudspeaker line impedance supervision, a supervised emergency microphone on the front panel and a supervised message manager for at least 200 pre-recorded messages and chimes.

It shall be possible to merge messages to allow even more flexible use of pre-recorded announcements and evacuation messages. It shall be possible for each message to have any length within the total available capacity.

The memory shall have a capacity of 16 MB. It shall be possible to upload from a PC via USB into the memory, after which the unit shall operate without PC connection.

The standard WAV-format shall be used for the messages and sample rates of 8kHz up to 24kHz with 16-bit word length (linear PCM) shall be supported.

Volume override relay contacts shall be provided for each zone separately for overriding local loudspeaker volume controls. All current override schemes shall be supported (3-wire and 4-wire override schemes i.e. standard 24V and failsafe). Upon a call or an activated trigger input these contacts shall be activated for the appropriate zones, together with an additional voltage free contact (Call Active) for control purposes.

A 24Vdc output shall be available to supply power to external relays, so no external power supply shall be required for that purpose. A LED VU-meter shall allow for monitoring of the master output.

The maximum allowed total cable length between the controller and the last router in the chain shall be 1000 meters.

The maximum allowed total cable length between the controller and the last call station in the chain shall be 1000 meters.

The maximum allowed total cable length between the controller and the RC panel shall be 1000 meters.

The controller and each connected router shall have 12 trigger inputs to start business and emergency messages. Each shall be configurable for a message consisting of a sequence of up to 8 wave files.

It shall be possible for wave files to be used in different combinations with other messages, optimizing flexibility and used storage space.

The messages shall be merge able to allow even more flexible use of pre-recorded announcements and evacuation messages. The system will be configured for 24 zones, expandable to up to 60 zones using additional six zone routers. Up to 8 call stations shall be connectable. Interconnections shall be made using standard RJ45 connectors and CAT5 cable.

It shall be possible to connect 1000 watts booster amplifier per router. The audio output shall use standard analog audio 100 V line switching for full compatibility with public address equipment and EVAC-compliant loudspeakers. The system shall be configured using DIP switches for basic functionality and a PC for more advanced functions. It shall be possible to specify 16 priority levels.

A built-in 240 W booster amplifier shall provide the power for the emergency call channel and BGM. It shall be possible to add additional booster amplifiers as spare, to provide two-channel operation or if the total power requirement exceeds 240 W (maximum 1000 W per 6 zones).

The maximum/rated output power of the internal booster shall be 360 W / 240 W. max mains inrush current shall be 8A @ 230 Vac / 16A @ 115 Vac

All control equipments should operate on Mains voltage which will be either 230Vac or 115Vac, $\pm 15\%$, 50 / 60Hz (selectable)

The power supply voltage range shall be 18 – 24V with a current consumption of less than 50 mA.

Power consumption of the Central Control Unit shall not exceed 600 Watts, and that of the Matrix shall not exceed 50Watts.

In case of Power failure Battery backup facility should be available and the battery voltage shall be 24Vdc, $+20\%$ / -10% .

The nominal sensitivity shall be 85 dB SPL (gain preset 0dB).

The nominal output level shall be 700 mV.

The maximum allowable sound pressure level shall be 110 dBSPL.

The microphone shall have a limiter. The distortion shall be less than 0.6% at maximum input.

The equivalent input noise level shall be no more than 30 dB SPL. The frequency range shall be 100Hz – 16kHz.

The speech filter shall be a 315 Hz, high-pass, 6 dB/oct filter. The output impedance shall be 200 Ohms. The stem length with microphone shall be 390 mm.

All low level connections and volume override shall be on MC1,5/XX-ST-3,5 type connector blocks.

All high level connections except mains shall be on MSTB 2,5 /XX-ST.

The input contact shall have supervision based on a series and parallel resistor.

All control equipments shall be rack mountable with removable rack mounts. The matrix shall be not higher than 2U. The controller shall be not higher than 3U. The rack mounting kit shall be included.

The operating temperature range shall be -10°C to $+55^{\circ}\text{C}$. The storage temperature range shall be -40°C to $+70^{\circ}\text{C}$.

The system shall comply to the following standards:

EVAC compliance	acc. to IEC 60849
EMC emission	acc. to EN 55103-1
EMC immunity	acc. to EN 55103-2
Safety	acc. to EN 60065

CENTRAL CONTROL UNIT SPECIFICATION

- As the basis of the voice alarm system, the Central control unit shall have all the essential functionality for compliance with IEC 60849 standard, including full system supervision, loudspeaker line impedance supervision, a supervised emergency microphone on the front panel and a supervised message manager
- Frequency response shall be 60 Hz – 18 kHz (+1/-3 dB, @ -10 dB ref. rated output. The distortion shall not exceed 1% at the rated output, 1 kHz.
- Control unit shall have tone controls to allow for adjustment of the BGM sound.
- It shall have separate bass and treble controls.
- The controller shall have two BGM source inputs and a mic/line input with configurable priority, speech filter, phantom power and selectable VOX activation.
- It shall be possible to select 16 priority levels for microphone, call stations and trigger inputs for optimum system flexibility. It shall have two connectors to connect call stations. It shall have 12 input triggers with 6 supervised trigger inputs.
- Furthermore it shall have one record output on cinch connectors.
- The trigger outputs shall be on floating relays with a rating of 250V @ 7A.
- The controller shall have an emergency active relay, a fault relay and two general purpose relays, for control purposes. The fault relay shall be failsafe.
- The output section shall have six transformer-isolated 100 V constant voltage outputs for driving 100 V-loudspeakers in six separate zones.
- All zones shall be individually selectable from the front panel and the BGM output level in each zone shall be individually settable in 6 steps.
- The BGM output shall be connected to the 70V line, thus it shall be possible to connect a total load of 480 Watts in a two channel system combined with a 480 Watt booster.
- The output of the booster shall be also available as a separate output on 100V and 70 V. A separate 100 V Call Only output shall be provided for addressing an area where BGM is not required but where evacuation announcements are. Six configurable volume override output contacts shall be available for overriding local volume controls during priority calls. A LED VU-meter shall monitor the output.

MATRIX SPECIFICATION:

- The Matrix shall be an expansion unit adding 6 zones as well as 12 input- and 8 output contacts to the voice alarm system.
- It shall be able to use the booster built in the central control unit.
- It shall provide outputs and inputs for one or two boosters in a multi amplifier for one- or two-channel system.
- It shall provide dual channel operation for calls and BGM simultaneously to a maximum of six different zones, using two booster amplifiers.
- Also single channel operation shall be possible with only one booster.
- The matrix shall have a set of relays for zone-switching the power amplifier output(s) to different loudspeaker groups.
- Each of the zones shall be switched between the call channel (upon call-station selection or all-call microphone or emergency activation), the BGM channel (upon front panel selection), or off.
- The zone power handling capacity of the matrix shall be 1000 Watts.
- The router shall also have 12 input triggers. 6 triggers shall be supervised for EMG purposes.

PAGING STATION SPECIFICATION:

- The 6-zone paging station shall be a stylish high quality call station with a stable metal base, a flexible microphone stem and a unidirectional condenser microphone.
- It shall be intended for making calls to selected zones.
- The special design shall allow for neatly flush mounting in desk tops.
- Using dip switches on the bottom of the call station, the call station ID shall be selectable. The call station shall have selectable gain, speech filter and limiter for improved intelligibility.
- On each call station it shall be possible to select 6 zones with the possibility to connect a paging station keypad to increase the number of zones or zone groups that can be selected.
- It shall have LED indications for zone selection, fault and emergency state.
- The call station extension shall provide seven additional zone and zone group keys
- On each paging station shall be possible to select 6 zones with the possibility to connect up to 8 call station keypads to increase the number of zones or zone groups that can be selected. Selected zones are indicated with LEDs on the call station, three additional LEDs give visible feedback on the active state of the microphone and the system. Green indicates microphone active, amber indicates that the system has detected a fault (IEC 80649) and red indicates that the system shall be in the emergency state.

LOUD SPEAKER CEILING MOUNT:

- Recess mount speaker with metal grill, designed in accordance with IEC268-5 Power handling capacity standards. CE conformity. Safety according to EN60065. Ball-proof according to DIN 18032-3. Complete with metal fire dome, with following specifications:
 - Maximum power : 9 watts
 - RMS: 6 watts. Tappings at 6/3/1.5w
 - SPL: 99dB
 - At 6w/1watt (1kHz at 1 mtr)
 - Rated impedance: 1667 ohm
 - 2 pole push-in terminal block

SURFACE MOUNT SPEAKER:

- Suitable for speech and music reproduction. Metal enclosure designed to mount on surface or for recess mount. Conforming to CE and safety according to EN60065 and Evacuation compliance to BS5839-8 complete with back box with following specifications:
 - Maximum power: 9 watts
 - RMS: 6 watts with tapping at 6/3/1.5/0.75 watts.
 - SPL: 102dB at 6 watts /1w (1kHz, 1mtr)
 - Frequency: 150 Hz to 20kHz.
 - Impedance: 1667 ohm with 3 pole screw connector.

AMPLIFIER:

- 19 inch rack mounting 2U high metal housing with dual priority switching.
- Inputs for 100 volts slave operation.
- Level controls for input 1 and 2.
- 240 watts RMS
- Frequency range: 50Hz to 20kHz
- Distortion: <1% at rated output power, 1kHz
- Inputs and outputs available at 100volts.
- Direct output : 100 volts / 70 volts and 8 ohm.
- Operation: 230 volts AC and 24VDC

BGM SOURCE:

- Back ground music source consisting of DVD/CD/MP3 player with USB input and a separate FM player.
- Simultaneous operation of player and FM set

2 CORE CABLE

- 2 core 1 Sq mm Multi Stranded Overall PVC Cable of any Standard Make
- This will be laid in the Pre-laid Conduits

FIRE ALARM SYSTEM

PART 1 - GENERAL

DESCRIPTION:

A. The work shall consist of furnishing, installation, testing & commissioning of a complete high quality advanced technology early detection Intelligent Analogue Soft Addressable fire alarm system as shown on the drawings and specified herein.

1.01 REFERENCES FOR INSTALLATION:

German Standards VDE (Verband Deutscher Electrotechniker)

DIN VDE14675 and VDE 0833 Fire Alarm Systems

NFPA- National Fire Protection Association
NFPA 72

British Standard Institute / European Standards
All Applicable codes and standards including BS EN 54

1.03 SUBMITTALS:

A. Product data for fire alarm system components including dimensioned plans, sections, and elevations showing minimum clearances, installed features and devices, and list of materials and data.

B. Shop drawings.

C. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs. Description shall cover this specific project.

D. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with any one of the referenced standards, completely with specifications and Vds approval or equal.

1.04 TRANSPORTATION, HANDLING AND STORAGE:

A. All the components of fire alarm system shall be provided in manufacturer's original new and unopened packing bearing manufacturer's name and label.

B. Store materials, not in actual use, in covered and well ventilated area and protect them from dirt, dust, moisture, direct sunlight and extreme temperatures.

C. For further requirements follow manufacturer's written instructions regarding storage and handling.

1.05 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fire alarm systems and components, whose products have been in satisfactory use in similar services for not less than 3 years period, and be subject to approval of engineer.

B. Installer Qualifications: An experienced specialist sub-contractor who is authorized by the system manufacturer, and subject to approval of the engineer.

C. All the components and installations shall comply with the requirements of DIN VDE 14675 & VDE 0833 for design & installation.

D. Provide system and components specified in this section that are listed and approved by Vds, UL & confirm to equivalent DIN/EN standards.

E. Single source responsibility: All components and accessories shall be product of single manufacturer.

PART 2 – PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. The fire detection and alarm system shall comprise of Automatic Soft Addressable Modular design main fire alarm control panels, Dual optical smoke & heat MULTI Sensors , Blue LED Optical Smoke & Heat MULTI Sensors, Optical Smoke / Heat/ CO Gas MULTI sensors, Loop powered Dual Optical Smoke/Heat sensor with integral Sounder / Flasher / Speech units, manual call points, electronic wall mounted Alarm sounder/flasher/speech combined devices, Transponder interface units, each with its own short circuit built-in isolators. All loop cabling and any other components and accessories deemed necessary for a safe, reliable and satisfactory system shall conform to the relevant and applicable requirements and recommendations of DIN EN 54. The system shall be fully programmed to accommodate fire alarm zones. The system shall be configured to allow on site modifications with the minimum of disruption using the PC based software to facilitate future changes or alterations to existing buildings/network on site.

B. The fire alarm and detection system shall provide the following facilities as a minimum:
The system shall be intelligent in operation with advanced decentralised intelligence technology. Each detector shall have its own processor with algorithms built in the device to take a fire or fault decision. System with centralised intelligence by providing signal levels to the control panel are not acceptable.

The system will be capable of providing fire, fault disablement and supervisory monitoring facilities as required by DIN EN 54 Pt 2. All devices on a loop shall have built in SHORT CIRCUIT LINE ISOLATORS for wiring fault isolation to protect the system. "Group Circuit Monitors" which isolate/protect sections of a loop circuit, i.e. a group of field devices are not acceptable. In event of manufacturer not providing in built isolators, style 7 wiring as per NFPA shall be strictly complied with.

All system components and devices shall be connected to two-wire loop circuits (as shown in the typical schematics) with each component having its own individual built-in isolator, should have sensors with integrated sounder in a same unit and no extra cabling should require to power up the sounder. Removal or disconnection of any component from the loop shall not affect the functioning and performance of other components and the system. Please note that the group isolators, which are used to isolate a section of a loop in case of fault, are not acceptable.

System shall be of automatically addressable type i.e. all the devices on the loops of the FACP shall be allocated addresses automatically from the PC / panel at the time of system power. The loop devices shall also be able to commission by using PC interface without the need of FACP.

And also given an address during commissioning, the value of which shall be stored in non-volatile memory, within the electronics module of the outstation. This value shall be read during loop allocation and provided it is valid shall be used to setup the outstations primary address.

Automatic Addressing shall cover the benefits of Soft Addressing and also overcome the limitations of Hard Addressing. This means that If the devices are inserted or removed all the existing devices shall keep the same address and programmed activations and use labels remain unchanged. The panel with PC shall allocate the address to ensure that it is impossible for two devices to have the same address. Fire Detection and Alarm Systems, which rely only on Coding , Programmer or hard addressing techniques are not acceptable.

Facilities shall be provided to constantly monitor and check the following circuits and fault conditions:

- The power supply to the loop /s;
- For open-circuit, short-circuit, earth fault and any other fault condition in the loop wiring;
- For communication failure and errors in all cards and loops

- For faults in keyboard and printer circuits
- All devices, etc. shall be installed on the same loop.

All devices shall be assigned a maximum of 25 character or 2 lines of max. 30 characters each with a ¼ VGA Display. In case of fire, fault or warning, the label of device sensing threshold shall appear on visual display unit of the panel.

Any event i.e. Fire, fault or warning shall be recorded with time, date and place of occurrence in the memory of FACP. These events can either be displayed on normal or ¼ VGA Display of the FACP or printed, as required. Provision shall be done at the fire alarm control panels to silence the loop powered alarm sounders but the visual indication shall remain until the system is reset. The detectors shall have auto learn sensitivity adjustments. The main fire alarm control panels shall be located as shown on the schematics and the floor drawings.

2.02 GENERAL

A. All major component of fire alarm system shall be product of a single manufacturer and shall conform to the requirement of EN54, Vds approved and be designed acc. to DIN VDE14675 and VDE 0833 Fire Alarm Systems CODE OF PRACTICE FOR SYSTEM DESIGN, INSTALLATION AND SERVICING.

B. The power supply breakers for FDA system shall be marked “ DO NOT DISCONNECT. FIRE ALARM SUPPLY”

2.03 ANALOGUE ADDRESSABLE FIRE ALARM CONTROL PANEL (FACP)

B. In the event of a fire being reported from the smoke/heat Detectors, activation of manual call points or sprinkler operation the sequence of alarm operation shall be as follows: If a fire condition is reported from a smoke detector then the evacuation will be done initially by the local integral sounder. Then after a certain delay (to be agreed at the time of commissioning) the evacuation message shall be announced on that fire zone only. If after 3 minutes the alarm has not been acknowledged, the evacuation message shall also be announced on the other adjacent zones. All other zones shall be given the Alert message. The evacuation of the building shall be staged in phases to allow orderly movement of people.

C. If a Manual Break Glass Unit is activated or a sprinkler flow switch is operated, then the evacuation shall be transmitted immediately to the affected fire zone plus the adjacent zones.

D. Activation of the fire alarm system shall directly initiate some or all of the following to be agreed as a part of the overall engineering policy.

- Signal to all elevator machine rooms indicating fire status (to control lifts)
- Release doors normally locked by magnetic devices.
- Release doors normally held open by magnetic devices
- Shutdown mechanical equipment ventilation plant
- Shutdown general exhaust fans
- Start up smoke extract fans
- Start up exhaust make up fans
- Start up stair vestibule pressurization fans
- Automatically operate fire dampers
- Initiate alert signals to panels in the adjacent office tower.
- Sprinkler valves, flow switches and other monitored valves shall be directly supervised by the fire alarm systems.

These shall include but not limited to the following:

- Building automation system via Graphic Supervisor or Hard wired integration if chosen.
- Emergency lighting system
- Security system.

2.04 SYSTEM COMPONENTS AND DEVICES

FIRE ALARM CONTROL PANEL:

A. The panel shall be modular Multifunctional computer controlled using **32 bit processor**. De-centralised control and monitoring functions to be realised on the loop and spur.. The panel shall be complete with, but not limited to, the following elements:

- 1) Visual display unit capable of displaying 8 lines 40 characters backlit display / ¼ VGA display as optional.
- 2) Built-in optional 40 character internal protocol thermal printer or external.
- 3) Built-in full numeric keyboard with function keys.
- 4) 64 Single Zone Indicator expandable upto 192 SZI
- 5) USB Port
- 6) SMART Card media slot.
- 7) Key switch to prevent unauthorised operation of keypad.
- 8) Integral sealed lead acid battery and charger, with 24 hour back up in the event of supply mains failure.
- 9) Essential controls – Delay, panel reset, Audible alarm off, Disconnect master box, additional messages, verify/cancel fault buzzer. Fire, Pre-Alarm, Trouble, Disconnection lamps. Each lamp shall also have appropriate indication (Releasing Systems activated, Master box, Delay , Verify, CPU failure, Inoperation normal condition & failure of powersupply / battery) Simple menu driven function keys with password protection shall allow users to an extensive range of software based features such as:

- Overview
- Service
- Time functions
- Informations
- Last 10000 system events
- Current fault and warning logs.
- Interrogation of sensor cleanliness
- On/Off, Enable/ disable sensors, zones, sounders, interface unit channels.
- Status of detectors
- Alarm counters
- Printer on, off, line feed and test facilities.

10) All control buttons and keyboard shall be enclosed behind a lockable cover, Up to 127 device capacity per 3.5km loop and a TTY/ RS 485 communication option.

11) In addition to the above, all other necessary controls, elements and accessories shall be included to provide a complete and efficient panel conforming to the requirements of DIN EN 54.

12) LOOP PARAMETERS:

Individual loop circuits will be capable of accommodating the following.

- Up to a maximum of 127 addressable devices on 3.5 kms loop length
- Up to 32 loop powered IQ8 Alarm addressable Sounders.
- Up to 32 loop powered IQ8 Alarm electronic Strobes.

- Up to 32 loop powered combined electronic sounders and strobes
- Up to 80 sensors with integral alarm sounder
- The detection loop shall have the ability to support both sensors and sounders connected on the same 2 core loop circuit.
- Up to 127 loop powered input modules.
- Should have the ability to spur off the detection loop without using „T“ breaker devices, without any degradation.

2.06 SYSTEM EVENT PRINTER

A. The system printer shall be 40 character thermal printer optional in-built on the main control panel, and shall log all events, change of status, alarm and fault messages along with time of the day and date. An external 80 column dot matrix printer along with system PC can also be considered.

The printer shall provide the following:

- Hard copy of every event occurring
- Status read out of every addressable point
- Devices tested on a walk test
- Contaminated detectors needing replacement
- Single point scan printout of analogue values
- Hard copy of historic log.

2.07 FIELD DETECTION DEVICES

GENERAL: ANALOGUE DETECTORS & BASES

All analogue detectors and bases shall be provided by the same manufacturer of the control system. No other make of detectors will be permissible.

All analogue detectors shall have real intelligence itself. This means even without control panel the detector can make decision, adapt to different environmental condition and diagnose itself. They shall have decentralised intelligence, automatic function self test, CPU failure mode, alarm and operating data memory and integrated short circuit line isolators. The detector bases for interfacing between the loop wiring and the detector head shall be manufactured by means of injection moulded ABS plastic coloured white and shall not contain any electronics for addressing. The base fixings should be suitable for any industry standard BESA or conduit boxes. All bases shall include the option to provide a programmable relay output for interfacing, providing a dry contact for third party.

All bases shall be provided with a plastic removable dust cover for protection during site construction as well as an IP rated sealing gasket to prevent dirt and moisture from entering through from the fixing surface. Each base shall include a lock and removal of locked detectors shall be achievable only through the use of the appropriate removal tools as specified by the manufacturer of the detectors. Detectors removal tools are to be handed over on completion of the contract as part of the spare parts to the client.

Removal of a detector from its associated base shall not affect the continuity of the detection loop.

The Fire alarm manufacturer shall have the complete range of following analogue

ADDRESSABLE detectors with decentralised intelligence as standard so as to meet the

specific applications of the site.

- a) Heat Detectors (fixed & ROR temperature)
- b) Optical Smoke Detector
- c) Optical Smoke & Heat Detector

- d) Dual angle Optical/Heat Detector
- e) Blue Light Optical / Heat Smoke Detector
- f) Optical Smoke, Heat & CO gas Detector
- g) Optical Smoke detector with integral Sounder
- h) Dual angle Optical/Heat detector with integral Flasher
- i) Dual angle Optical/Heat detector with integral Sounder
- j) Dual angle Optical/Heat detector with integral Speech Sounder
- k) Dual angle Optical/Heat detector with integral Flasher and integral speech sounder
- l) Duct mounted sensor
- m) Radio Frequency wireless analogue detectors
- n) Manual Call Points

All of the above shall be compatible with the aforementioned base providing inter-changeability between detector heads, without the requirement for switch settings. All detectors shall also have an integral short circuit isolator, which in the event of a single cable fault will isolate the “culprit” piece of cable and retain all devices on the loop operationally.

Each detector shall possess two integral LED giving a red flashing indication for fire and green for normal operation. For remote locations, each detector shall be capable of connection to a remote LED unit by means of 2 core wire connection.

Detectors shall be white in colour and manufactured from ABS plastic. All electronics and associated sensing elements will be housed within this unit, these components being hermitically sealed to prevent their operation from being impaired by dust, dirt and humidity.

The sensitivity of all detectors shall be adjustable from a software. It shall be possible to programme detector sensor sensitivity directly on the loop using interface with a laptop PC and appropriate programming software from manufacturer.

For MULTI SENSOR detectors, disablement of each sensor element shall be possible individually or for whole loop. Also this disablement feature shall be possible to have manually or time / event controlled.

All detectors shall be provided with a plastic removable dust cover for protection during site construction.

A semi-flush recessing kit for analogue detectors shall be available for each detector type incorporating the standard detector base.

2.07 (a) HEAT DETECTORS

Install as shown in the drawings. These shall comply with the requirements of EN 54: Part 5 and shall be VdS approved. This shall be a dedicated heat only detector to provide fixed temperature heat as well as rate of rise sensing. It should be fully compliant with EN54 part 5

to provide grades of A1.

2.07 (b) OPTICAL SMOKE DETECTOR:

Install as shown in the drawings. Analogue Addressable Optical Smoke Detectors. These shall be of Automatic addressable Optical type with inbuilt isolator in a single head. The optical element shall detect visible smoke from slow smoldering fires. Smoke sensing design shall comply with EN 54 part 7 and shall be VdS approved. It shall have microprocessors, short-circuit isolators and all electronic components and circuitry suitable for an Analogue addressable system. The detectors shall also have 360 degree viewing LED fire indicator. Detectors mounted in the false ceilings shall be provided with semi flush mounting kits.

2.07 (c) OPTICAL SMOKE /HEAT DETECTOR

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 5 & 7 and shall be VdS approved. These detectors shall have combined two individual sensing elements to provide excellent cover for both types of fires (slow smoldering & fast free burning fires). These detectors shall be of Automatic addressable Combined Optical/Heat type with inbuilt isolator in a single head.

Optical sensing shall be carried out by means of an Infra-red LED transmitting a pulse of light across an obtuse angled chamber & heat sensing shall be carried out by a thermistor, sampling the surrounding environmental temperature.

2.07 (d) DUAL ANGLE OPTICAL/HEAT DETECTOR

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 5 & 7 and shall be VdS approved. This device shall combine two individual sensing elements to provide excellent cover for both "types" of fires. (Slow smoldering and fast free burning).

OPTICAL SENSING: Shall be carried out by 2 infra-red LED transmitters across 2 separate Optical detection angles. This sensor shall process both the forward and backward scattered Light caused by entering the detection chamber of device, allowing the detector to Differentiate between real smoke and non-smoke particles e.g. Steam & Dust.

HEAT SENSING: Shall be carried out by a thermistor, sampling the surrounding environmental temperature.

2.07 (e) Blue-light OPTICAL SMOKE / HEAT DETECTOR

Install as shown in the drawings. These shall comply with the requirements of EN 54: Part 5 & 7. The optical measurement chamber shall be provided with latest developed blue LED sensor technology , enabling the detection of open fire, smoldering fires and fires with high heat generation (Invisible smoke sensing). These detectors shall be capable of identifying the TF1 & TF6 test fires described in EN 54-9 specifications. These detectors shall be intelligent with time related signal analysis, signal correlation of sensor data & decentralised HEAT SENSING: Shall be carried out by a thermistor, sampling the surrounding environmental temperature.

2.07 (f) OPTICAL SMOKE DETECTOR WITH INTEGRAL SOUNDER

Install as shown in the drawings (Hotel guest rooms / suits).These shall comply with the requirements of EN 54: Part 3 & 7.

The sensor element of the optical detector sounder shall be as per the specification for the optical smoke detector, however the device shall incorporate an internal electronic sounder.

The internal electronic sounder shall be an integral part of the detection device comprising of a piezo sounder output device providing the low and high frequency output.

The combined detector sounder shall provide a sound pressure level of 92dBA at 1 metre. The audible volume levels shall be individually selectable for each device and there should also be a configurable soft start feature that ramps up the volume gradually rather than

switching on at full level.

It shall be possible to connect a maximum of 80 combined detector sounders to a detection loop.

A minimum of 19 Different tone types are stored in the detector sounders. Upto 4 different tone types shall be combined in a signal set and activated in case of alarm. Individual detector sounder volume levels shall be adjustable at the main control panel or via the use of the remote programmer unit coupled with a laptop PC and appropriate programming software from the manufacturer.

Activation of the sounder shall be independent of the detection of a fire condition by the sensing element. All sounder outputs shall be synchronised with all other loop powered detector sounder devices and other loop powered audible visual units on the panel.

Each sounder shall have its own microcomputer to handle loop communications, which along with all other associated electronic components will be hermetically sealed to provide protection from hostile operating environments.

2.07 (g) DUAL ANGLE OPTICAL/HEAT DETECTOR WITH FLASHER

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 5 & 7.

The sensor element of the dual angle optical/heat detector flasher shall be as per the specification for the dual angle optical/heat detector.

The integral flasher element shall utilise a high power red LED for strobe effect. LED pulsing shall be synchronised with all other loop powered audible visual units located on the fire alarm and detection panel.

The flasher LED shall be fault monitored for working operation.

It shall be possible to connect a maximum of 48 combined dual angle optical/heat detector flasher to a detection loop.

Activation of the flashers shall be independent of the detection of a fire condition by the sensing element.

Each flasher shall have its own microcomputer to handle loop communications, which along with all other associated electronic components will be hermetically sealed to provide protection from hostile operating environments.

2.07 (h) DUAL ANGLE OPTICAL/HEAT DETECTOR WITH INTEGRAL SOUNDER

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 3,5 & 7.

The sensor element of the dual angle optical/heat detector sounder shall be as per the specification for the dual angle optical/heat detector.

The sounder element of the dual angle optical/heat detector shall be as per the specification for the optical smoke detector with integral sounder.

It shall be possible to connect a maximum of 80 combined dual angle optical/heat detector sounder to a detection loop.

2.07 (i) DUAL ANGLE OPTICAL/HEAT DETECTOR WITH INTEGRAL SPEECH SOUNDER.

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 3,5 & 7.

The sensor element of the dual angle optical/heat detector with speech shall be as per the specification for the dual angle optical/heat detector.

The speech function shall be provided by stored messages on a non-volatile flash memory component. Output from the flash memory processor shall be up to 25 seconds of speech. Additionally there shall be the capability to provide complex tones, such as bell and DIN tones. Each device shall include 5 standard messages in 5 languages within the flash memory component. At least 4 signal parts (consisting of tones and speech) shall be set into one signal-set. At least 2 signal sets can be programmed for 2 different events, e.g. evacuation and alert.

In addition to the voice messages above, an 8 Inch solenoid bell recording shall be provided as a standard complex tone.

All speech outputs shall be synchronized with all other loop powered sensor speech devices and other loop powered audible visual units on the panel.

It shall be possible to connect a maximum of 32 combined dual angle optical/heat detector strobes with sounder speech to a detection loop.

2.07 (j) DUAL ANGLE OPTICAL/HEAT DETECTOR WITH INTEGRAL FLASHER AND SPEECH SOUNDER.

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 3,5 & 7.

The sensor element of the dual angle optical/heat detector with Flasher and Speech sounder shall be as per the specification for the dual angle optical/heat sensor.

The sounder element of the dual angle optical/heat detector with Flasher and Speech sounder shall be as per the specification for the dual angel optical/heat sensor sounder.

The integral strobe element of the dual angle optical/heat detector with Flasher and Speech sounder shall be as per the specification for the dual angel optical/heat sensor strobe.

The speech function shall be provided by stored messages on a non-volatile flash memory component. Output from the flash memory processor shall be up to 25 seconds of speech.

Additionally there shall be the capability to provide complex tones, such as bell and DIN tones. Each device shall include 5 standard messages in 5 languages within the flash memory component. At least 4 signal parts (consisting of tones and speech) can be set into one signal-set. At least 2 signal sets can be programmed for 2 different events, e.g. evacuation and alert.

As standard, the microprocessor shall contain the following messages:

Evacuation:Alarm Message 1 (Voice) "This is a fire alarm. Please leave the building immediately by nearest available exit"

Evacuation: (Voice) "Attention please"

Evacuation Alarm Message 2: (Voice) "This is an emergency. Please leave the building immediately by the nearest available exit"

Alert Message " An incident has been reported in the building. Please await further instructions"

Clear Message: (Voice) "The emergency is now cancelled. We apologise for any inconvenience"

Test Message "This is a test message, no action is required"

All the voice messages shall be synchronised across the detection loops by means of a regular synchronisation signal generated by the fire alarm control panel.

In addition to the voice messages above, an 8 Inch solenoid bell recording shall be provided as a standard complex tone.

All speech outputs shall be synchronised with all other loop powered sensor speech devices and other loop powered audible visual units on the panel.

It shall be possible to connect a maximum of 32 combined dual angle optical/heat detector strobes with sounder speech to a detection loop.

2.07 (k) DUCT MOUNTED SENSORS

Venturi principle air duct detector kit shall be used. The kit with IP 54 protection ABS plastic with filters shall be mounted outside airducts. The venturi tube dips into the airduct. The airspeed in the duct shall not exceed 1 m/s to max 20 m/s. This device shall employ the aforementioned Optical/Heat detector to provide environmental information. Probes are fitted to pick up smoke in ventilation ducts. This unit is particularly suitable for sensing smoke particles in ducting which is likely to be in large quantity and flowing fairly quickly,

2.07 (i) MANUAL CALL POINTS

Install as shown in the drawings. The manual initiation devices shall be electrically compatible with all of the aforementioned detector types and shall be complete with all-electronic components and circuitry for an automatic safe addressable device. The manual call point shall have an inbuilt short circuit isolator and an inbuilt microprocessor to ensure a response time of less than 1 second.

The MCP unit shall also handle all communication to the control panel. All electronic devices contained within the MCP shall be hermetically sealed so as to prevent damage from hostile environment conditions: e.g dust with minimum rating of IP43.

The MCP operating voltage shall be 8-42 volts DC, RED similar to RAL 3020. If the MCP are

located in public areas a transparent cover shall be provided as a protection to prevent inadvertent activation. MCP shall be available in two designs Large & small for aesthetic

purposes to architects.

The MCP shall have an input facility to connect conventional devices. It should have an option of using either frangible glass allowing for complete removal upon operation or plastic pane resettable function. There shall be no text but SYMBOLS on the MCP (burning house /

press to break).

The device can be tested functionally without the need to either remove the front cover and/or breaking the glass, with a special test key (supplied as standard). The key shall insert the underside of the MCP ensuring easy access of the key at all times.

These devices will comply fully with EN 54 part 1.

2.07 (j) Linear Heat Detector Module & sensor cable

Line heat detector module enable early detection of fires & over heating. This should be specifically designed in narrow rooms, cable alleys & rough ambient condition. This should consist of evaluation unit & sensor cable. The sensor cable shall be connected into evaluation unit.

Maximum sensor cable length connected to evaluation unit shall be 300 mtrs . Unit shall monitor the resistance of sensor cable. The operating voltage of the unit shall be 9-30V. The evaluation unit need to be connected with main fire Panel. It should be Vds approved as per EN 54-5A1.

2.08 FIELD ALARM DEVICES

Electronic sounders, combined sounder/strobe and standalone strobes shall be loop powered for direct connection to the 2 core detection loop shall be electrically compatible with all initiation devices. These wall mounted units shall be available in red or white and suitable for both indoor and outdoor applications with an ingress protection rating of IP31 and IP65 respectively.

All electronic sounders, sounder/strobe and strobe only versions shall have alarm signals synchronised across all the detection loops of the fire alarm control panel.

All alarm devices shall have a short circuit isolation device provided as an integral component of the device.

All sounders shall have a „soft start“ feature controlled by the fire alarm panel, whereby a low initial volume can be set and then increased at a defined rate upto a maximum volume setting.

All alarm devices shall be provided by the same manufacturer of the control system. No other make of detectors will be permissible. The Fire alarm manufacturer shall have the complete range of following alarm devices with built in short circuit line isolators so as to meet the specific applications of the site.

2.08 (a) ADDRESSABLE SOUNDER / FLASHER

A combined electronic sounder and flasher shall be capable of providing a minimum sound level of 97dBA \pm 2dBA @ 1 metre.

The sounder shall be capable of providing 4 different sound signals which are selected/configured from 19 tone types store in the device.

The unit shall have its own microprocessor to handle loop communications and monitoring of the internal flasher element for faults in both the quiescent and alarm conditions. The microprocessor shall also monitor the sound producing element during an alarm condition to ensure that faulty devices can be automatically identified during the weekly test procedure.

All associated electronic components shall be hermetically sealed to provide protection from hostile operating environments.

The frequency of the electronic flasher light output shall be 1Hz

The unit shall be manufactured from ABS plastic with a polycarbonate lens. Body and lens colour shall be Red body / red lens.

These devices shall allow for direct connection to the detection loop. It shall be possible to connect upto 32 combined electronic sounder/flasher to each detection loop of the fire alarm

control panel.

2.09 FIELD INTERFACE TRANSPONDERS

These devices shall be directly connected to the loop, four variants shall be available as standard, these being:

- (i) 4 In / 2 Out interface unit
- (ii) 1 In interface unit
- (iii) 32 LED output interface unit
- (iv) 12 Relay output Interface unit.

These units shall be self-contained wall mountable units, similar in finish to the main control panel.

(i) 4 In / 2 Out interface unit

Interface units shall be capable of accepting 4 input signals, 2 output signals. Dependent upon the specific application, input signals may be interpreted by the system as any of the following:

- Fire signal input
- Fault signal input
- Supervisory signal input
- Event signal input

The exact nature of which shall be selected by means of the commissioning software. These units will accept and or supply clean contact signals either normally open or normally closed (configurable) OR switched voltage inputs from conventional detectors or MCPs.

The output contacts shall be rated at 30V / 1 amp. DC output of the unit shall be provided with single pole change over contacts for control of plant, door release units or power output to drive conventional bells, sounders etc. Both the outputs on the interface shall be individually programmable. External power supply 12V / 24 VDC shall be provided to this unit

As with other outstations previously mentioned, interface units will contain local processing in order to handle all signaling and loop communications. Product shall be approved by VdS.

(iv) 12-Relay output interface units

These interface units contain 12 clean relays which are individually programmable with the commissioning software. All relays can be configured as NO or NC.

As with other outstations previously mentioned, interface units will contain local processing in order to handle all signaling and loop communications.

2.10 NETWORKING OF CONTROL PANELS

It shall be possible to network connect up to 31 controls as a secure network connection. All messages from a panel should be transmitted in both direction on the ring structure. Any wire-break or short-circuit on the ring shall not effect data transmission. The network shall be configurable so that single panels, groups of panels or all panels on the network operate the same site configured cause and effect fire plan.

The network shall also be configured to allow master control from any one of the control panels on the network. To cover longer distance repeaters or fibre optical cable and converters can be used between two panels.

The network shall be able to accommodate intruder alarm panels.

There shall be extensive diagnostic functions on the panel to be used to localize faults caused by interference or wiring, Networking shall be capable of carrying out using a data cable e. g IBM type 1 or CAT5. The distance between each panel shall be standard 1000 meters and capable of extending up to 3000 meters using booster repeaters.

2.11 NETWORKED LCD OPERATING PANELS / REPEATER PANELS

The Repeat Panel shall be sited at the Rear Entrance, guard house or location where it is manned 24 hrs.. It shall provide system repeat facilities to repeat all of the liquid crystal display messages as well as the common indications. Repeat panel shall be interfaced for network fire alarm control panels, designed for standardised display and operation as per DIN EN 54 part 2 and DIN VDE 0833 part 2. Installation and connection to FACP shall be via the short circuit and open circuit resistant essernet. System network. RS 485 interface or TTY interface for connecting remote printers, and fire brigade shall be available. The repeaters shall have minimum three common relays freely programmable, monitored, potential free upto 24 VDC.

2.12 BATTERIES :

Batteries shall be provided and shall be the dry sealed lead-acid type. The batteries shall have ample capacity. With primary power disconnected, to operate the fire alarm system for a period of 24 hours with an optional 72 hours battery backup. Following this period of operation via batteries. The batteries shall have ample capacity to operate all components of the system, including all alarm signaling devices in the total alarm mode for a minimum period of 30 minutes.

2.13 WIRING

All cables associated with Fire Alarm installation shall be of fire resistant 2 core 1.5 sq. mm twisted pair . Cables shall comply with BS 6207 Part 1. The cable is to BS 6207: Part 1 having, Typically no more than 2 cores each core having 1.5 sq. mm cross sectional area, A red cover sheath (preferred for alarm applications), Having continuous metal sheath encapsulation, Fire resistant tested to BS6387 categories CWZ.

3.0 PART 3 - EXECUTION

3.01 INSTALLATIONS

The entire fire alarm system shall be installed in accordance with DIN / BS EN54/NFPA Standards and manufacturer's approved shop drawings, written instructions and recommendations.

3.02 TESTING

Fire alarm system shall be tested in accordance to Local Civil Defense regulations and put into operation by the manufacturer or his authorized representative in the presence of engineer. Fault and alarm conditions shall be simulated and all data and alarm indicators checked with full events recorded on system printer according to the testing procedure.

TECHNICAL SPECIFICATION OF EXTERNAL ELECTRICALWORK FOR NON SOR ITEMS

H. - EARTHING:

4.1 SCOPE:

All the non-current carrying metal parts of electrical installation shall be earthed as per IS: 3043. All equipment, metal conduits, rising main cable armour, switch gear, distribution boards, meters, all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to earth electrodes. Earthing shall be in conformity with the provisions of Rules 32, 61, 62, 67 and 68 of IER 1956.

4.2 G.I.PIPE EARTH STATION:

G.I. pipe shall be of medium class, 40 mm dia and 4.5 m length. Galvanising shall conform to relevant Indian Standards. G.I. pipe electrode shall be cut tapered at the bottom and provided with holes of 12 mm dia drilled not less than 7.5 cm from each other up to 2 M of length from bottom. The pipe electrode shall be as far as practicable embedded below permanent moisture level. Except where rock is encountered, pipes shall be driven to a depth of at least 4.5 mtr. Where rock is encountered at a depth of less than 2.5mtr the electrode may be buried inclined to the vertical and the inclinations shall not be more than 30 deg from the vertical. The pipe electrode shall be made of one piece. Earth leads to the electrode shall be laid in a heavy duty GI pipe and connected to the pipe electrode with brass bolts, nuts and washers. GI pipe shall be terminated in a wire meshed funnel. The funnel shall be enclosed in a masonry chamber of 450 mm x 450 mm dimensions. The chamber shall be provided with C.I. frame and CI inspection cover. The earth station shall also be provided with a suitable permanent identification label tag. The earth electrode shall conform to IS:3043 latest edition. The soil around the earthing electrode shall be treated to reduce the resistivity of the soil by filling the complete depth of electrode with alternative layers of charcoal and salt.

4.3 PLATE EARTH STATION:

Plate electrodes shall be made of G.I./copper (CU) plate of 6mm/3mm thick and 600 x 600mm size. The plate shall be buried vertically in ground at a depth of not less than 4.5 meters to the top of the plate, the plate being encased in charcoal to a thickness of 300 mm all round. It is preferable to bury the electrode to a depth where subsoil water is present. Earth leads to the electrode shall be laid in a heavy duty GI pipe and connected to the plate electrode with brass bolts, nuts and washers. A GI pipe of not less than 20 mm dia shall be clamped with bolts vertically to the plate and terminated in a wire meshed funnel. The funnel shall be enclosed in a masonry chamber of 450 mm x 450 mm dimensions. The chamber shall be provided with GI frame and CI inspection cover. The earth station shall also be provided with a suitable permanent identifications label tag. The earth electrode shall conform w

ELECTRODE EARTHING :

The earthing electrode (AS per IS 3043 : 1987) has to be installed by doing bore of size 300mm up to a depth of 3000mm., then throw handful of compound (2 bag of betonite powder compound) soil mix into pit. After removing plastic sleeve carefully from electrode place electrode at center after this start refilling space around electrode with backfill compound in small quantity. Then pour some water and poke the pit with a long wooden rod to allow trapped air to escape .In this manner gradually continue refilling process till the electrode is buried in bore up to the green patch painted on top portion of electrode. Ensure that pit is not watery. Pack electrode nicely and tightly so that it stands firmly in pit. Pour a few bucket of water in and around pit . **In hard soil condition , do not mix compound with dug out soil.** Test earth electrode resistivity .If result is not satisfactory give some time to electrode system to set in soil. After this connect it with equipment through suitable size down conductor (GI/CU strip) as specified .After this the PCC in 1:2:4 is to be applied in an area of 300mmx300mm and brick masonry chamber(thickness of chamber wall 200 mm) has the chamber cover and frame of 300mmx300mm of CI shall be supplied and grouted in brick masonry. The chamber cover shall have lifting hook and shall have space in frame for proper placement. The watering fennel, is to be installed over watering pipe. The test link between earthing electrode and running earthing strip is to be provided for testing . After completion of work, resistance of earthpit has to be measured by 4 pin method and results shall be recorded /handed over to Employer /consultant in 1 sets.

4.4 EARTHING CONDUCTORS :

The scope of work includes supply of hot dipped galvanized iron strips/wire as per details and drawings . The GI Strip supplied for purpose shall be continuous (minimum single length acceptable in 10 mtr.) The strip has to be straightened without damaging galvanizing. The strip has to be welded by overlapping and three side continuous welding joint. These joint shall then be cleaned and jute covering has to be provided (wherever strip is buried in ground). After this black bituminous anti corrosive paint has to be applied on all joints. Same process has to be adapted for all tapings also In case if earth wire is required to be connected on strip with the help of bolt, GI bolts, nuts are to be used along with covering and painting. The earthing strip wherever indicated in drawing, has to be supplied in ground at a depth specified in dwg. The earthing strip shall be covered with black soil and in no case sand has to be used around strip.

All earthing conductors shall be of high conductivity copper/or GI as specified and shall be protected against mechanical damage and corrosion. The connection of earth electrodes shall be strong secure and sound and shall be easily accessible. The earth conductors shall be rigidly fixed to the walls, cable trenches, cable tunnel, conduits and cables by using suitable clamps.

Main earth bus shall be taken from the main medium voltage panel to the earth electrodes. The number of electrodes required shall be arrived at taking into consideration the anticipated fault on the medium voltage net work.

Earthing conductors for equipment shall be run from the exposed metal surface of the equipment & connected to a suitable point on the sub main or main earthing bus. All switch boards, distribution boards and isolators disconnect switches shall be connected to the earth bus. Earthing conductors shall be terminated at the equipment using suitable lugs, bolts, washers and nuts.

All conduits cable armouring etc., shall be connected to the earth all along their run by earthing conductors of suitable cross sectional area. The electrical resistance of earthing conductors shall be low enough to permit the passage of fault current necessary to operate a fuse/ protective device or a circuit breaker and shall not exceed 2 Ohms.

4.5 LOCATION FOR EARTH ELECTRODE:

Normally an earth electrode shall not be situated less than 2 M from any building. Care shall be taken that excavation for earth electrode may not affect the column footings or foundation of the building. Further the location shall be such where the soil has reasonable chance of retaining moisture as far as possible. Entrances, pavements and roadways are definitely to be avoided for locating the earth electrode.

4.6 EARTHING SYSTEM :

Main earthing grid shall be of 50 x 6 GI strip laid in a grid formation. All other equipments shall be earthed to this strip. All panels, equipments and non current carrying conductor shall be earthed through the strip/wire of suitable size.

Main panels	- 35 x 5
Main panels to sub panels	- 25 x 5
Sub panel to DB	- 25 x 3
DBs to sub DBs	- 8 SWG G.I.

Earthing system shall be mechanically robust and the joints shall be capable of retaining low resistance even after subjection to fault currents.

Joints shall be tinned, soldered and/or double rivetted. All the joints shall be mechanically and electrically continuous and effective. Joints shall be protected against corrosion.

4.7 TESTING :

On the completion of the entire installation, the following tests shall be conducted :

- i) Earth resistance of electrodes.
- ii) Impedance of earth continuity conductors.
- iii) Effectiveness of earthing.

All meters, instruments and labour required for the tests shall be provided by the contractor. The test results shall be submitted in the prescribed tabulated form in triplicate to the consultants for approval.

M. - LIGHTNING PROTECTION SYSTEM:

SCOPE:

The scope of work under this section covers the specifications for supply, installation, connection, testing and commissioning of lightning protection system consisting of the following :

Air termination network.

Roof conductors.

Down conductors.

Testing joint

Earth termination network.

STANDARDS:

The lightning protection system shall comply with IS: 2309/ 1989 and Indian Electricity Act and Rules.

SYSTEM :

- a) The lightning protection system shall be installed as indicated on the drawings or in case such is not available the contractor shall prepare one as per IS-2309/1989 and get the same approved by Construction manager/Consultant.
- b) As air terminals shall be installed on the highest roof of the building, the air terminals shall be joined to horizontal roof conductor by means of rivets/clamps.
- c) Roof conductor shall be laid horizontally on the roof as indicated on the drawing.
- d) Down conductor shall be installed on the vertical surface of the building. The down conductor shall be joined with roof conductors in the method as prescribed by the code. A test joint shall be provided in the down conductor 1000 mm above the ground level at a place which is easily accessible for testing.
- e) The down conductor shall be joined with earth termination network or to the earthing station as indicated on the drawing.
- f) The earthing station and the earthing conductor shall be as per section under heading "EARTHING".

4.9 COMPONENT PART :

Air Terminals and Roof Conductors

- a) An air termination shall consist of vertical conductor or a system of horizontal conductors and shall be installed along the outer perimeter of the roof.
- b) No part of the roof shall be more than 9 m from the nearest horizontal protective conductor.
- c) All metallic projections, chimneys, ducts, vent pipe, railings, gutters etc., on or above the main surface of the roof of the structure shall be bonded to and form part of the air termination network. The method and nature of the fixing shall be simple, solid and permanent.
- d) The minimum dimension of the air termination network shall be as follows :

Above Ground Below Ground

Galvanised iron strip 20 x 3 mm 32 mm x 6 mm

- e) The Air terminal shall be installed vertical on the highest point of the roof and shall be clamped firmly with the structure. The roof conductor shall be laid horizontally above the finishing of the roof surface.

Down Conductor :

- a) The number of down conductors shall be as follows :
 - 1) A structure having a base area not exceeding 100 sq.m shall have only one down conductor.
 - 2) For a structure having a base area exceeding 100 sq.m, the number of down conductors shall equal to smaller of the following :

One, for first 100 Sqmtr plus one more for every 300 sq.m or part thereof in excess of the first 100 sq.m or one for every 30 m of perimeter.
- b) The down conductor shall be distributed around the outside wall of the structure.
- c) Any external metal running vertically through the structure shall be bonded to the down conductor at the top and bottom.
- d) A down conductor shall follow the most direct path possible between the air terminals and the earth termination.
- e) The size of the down conductor shall be similar to roof conductor/air termination network.

f) Each down conductor shall be provided with a testing joint in such a position that, it is convenient for testing. (about 1000 mm above Ground level)

Joints and Bonds

a) The lightning protection system shall have as few joints as possible. Joints and bonds shall be mechanically and electrically effective eg. clamped, screwed, bolted, riveted or welded. With overlapping joint, the length of overlapping shall not be less than 25mm for all types of conductor. Contact surfaces shall be first cleaned, then inhibited from oxidation with a suitable non-corrosive compound. Joints of dissimilar metals shall be protected from moisture by an inert, tenacious material.

b) The lightning conductor shall be secured at not more than 2 M apart for horizontal run and 1.0 M for vertical run by fasteners resistive to corrosion.

4.10 Earth Resistance:

The resistance from any part of the lightning protection system to earth shall not exceed 10 Ohm before any bonding has been effected to metal in or on a structure or to services below ground. If the value obtained exceeds the specified 10 Ohm it shall be reduced by adding to the number of earth electrode.

In addition the resistance from the earth electrode to the nearest test clamps shall not exceed 0.2 Ohm.

4.11 Method of Measurement:

The complete earth conductor shall be measured and paid per unit length, including air termination network, down conductor, test joints and earthing termination network.

C.11 TRANSFORMERS:

6.1 SUPPLY, INSTALLATION, TESTING & COMMISSIONING:

TRANSFORMER:

This specification generally describes the power transformers and associated auxiliary equipment for use on the electrical power distribution system suitable for outdoor installation and covers the design manufacture testing at works supply and delivery site erection, testing and commissioning aspect of the same. The details are given in the data sheet.

SPECIFICATION FOR 33 KV / 415 V Oil TYPE TRANSFORMER □ S

1.0 SCOPE:

This Specification covers the designing, manufacturing, testing and supplying of Oil Type ONAN, Dyn-11 Transformer.

1.1 SITE CONDITIONS:

Ambient Temperature 43 Deg. C. (Maximum)

Altitude Less than 100 M above MSL.

Humidity 80% (Maximum)

1.2 POWER SUPPLY DETAILS:

Supply Voltage 3 Phase, 33 KV, +/- 7.5% variation.

Frequency 50 Hz + 3% Variation.

Fault Level 800 MVA at 33 KV.

1.3 STANDARDS:

Transformer complete with all accessories shall conform to the latest editions of the following Indian Standards: -

- IS 2026 Power Transformers
- IS 3639 Fittings and accessories for Power transformers.
- IS 2099 High voltage Porcelain Bushings
- IS 1271 Insulating Materials.
- IS 3347 Porcelain and metal parts of bushing.
- IS 1666 Copper Conductors for winding.

Transformer shall also meet the requirements of Indian Electricity Rules, Fire Insurance Association and the Electrical Inspector.

1.4 RATING:

Transformers shall be of Air Natural cooled, Core type.

Transformers having no load voltage ratio of 33 KV / 0.415 KV, Vector Group Dyn.11, 0.415 KV Secondary winding neutral shall be solidly, grounded.

It shall be possible to operate transformers as per loading guide IS 6600 upto overloads of 150% and there shall be no limitations imposed by bushings, top chargers, auxiliary equipment etc., to meet this requirements.

1.5 TEMPERATURE RISE:

Windings Temperature rise measured by resistance method shall not exceed 45 Degrees C over an ambient of 45 Degrees C .

1.6 CONDITION OF INSTALLATION:

Transformers shall be located indoor in ventilated room.

1.7 NO LOAD TAPS:

Transformer shall be provided with tapping on the respective H.V. side at 7.5% to -7.5%, in steps of 2.5% . Arrangement shall be provided for locking the tap charger in any desired tap position.

1.8 GENERAL REQUIRMENTS:

Transformer housing shall be fabricated from Mild Steel plates of adequate thickness welded together.

Material for insulation and construction of cores and windings shall be such

as to withstand mechanical, electrical and thermal stresses under full load and short circuit conditions without impairing the performance of the transformer.

Cores shall be with cold rolled grain oriented Silicon steel having very low iron loss

Both HV and LV winding shall be of copper.

Noise and vibration levels shall be limited to low level i.e. 70 dB @ 1 mtr. distance.

After manufacture all the surfaces shall be thoroughly cleaned and degreased and the exposed surfaces given a priming coat of rust resisting paint followed by two finishing coats of epoxy paint/powder coating with min 10 micron thickness.

Material of gaskets shall be cork-neoprene or approved equivalent.

1.9 PRIMARY WINDING AND HT CABLE BOX:

Primary or high tension side of transformer shall be delta connected and suitable to connect 33KV HT CABLE..

1.10 SECONDARY WINDING & CABLE BOX:

Secondary or low tension side of transformer shall be connected in star.

Secondary voltage shall be 415 V, 3 Phase with neutral, 50 Hz, having terminal box suitable for terminating 4x3.5cx300 sqmm Al Ar XLPE cable . Terminal box shall have earthing terminal Neutral shall be brought out to a separate bushing. Disconnecting chambers shall be provided with inspection covers.

1.11 ACCESSORIES:

Each Transformer shall be provided with all necessary accessories including the following:

2 Nos. Earthing terminals with lugs.

4 Nos. Bi-directional rollers-roller assembly shall be such that for changing the direction, rollers need not be removed.

4 Nos. lifting lugs for body and core.

1 No. Rating and diagram plate, preferably of stainless steel/brass, etched or engraved.

1 No. Tapping changer switch operating handle with indicator & locking device.

1 Set Thermograph with display ,alarm and trip contacts for winding temp.

1 Set. Inspection covers.

All control wiring from the dial type thermometer/thermograph, etc., shall be brought to a terminal strip of Marshalling box and provision for cable entry for outgoing cables shall be made with necessary double compression cable glands and terminals.

1.12 TRANSFORMER TESTS:

The following tests shall be performed on the transformer and reading shall be recorded in the presence of the Owner's Engineer / representative.

Ratio (on all tapping), polarity and check of voltage vector relationship.

No load test at service voltage and normal frequency to give open circuit loss at service voltage & magnetizing current value.

Short circuit test give full load copper losses and impedance voltage at rated current & normal frequency.

Induced high voltage test to test inter turn and inter layer insulation strength.

Separate source voltage withstands.

Measurement of insulation resistance.

Measurement of Acoustic Noise Level.

1.13 TEST CERTIFICATES:

Six (6) copies of test certificates shall be required for all the tests performed on the transformer.

1.14 INSPECTION:

Before delivery of the transformer, Owner/Owner's representatives may insist on witnessing any/all tests and final inspection of the transformer. Vendor shall give at least fifteen (15) days notice before the transformer is ready for testing and inspection purposes. Stage wise inspection shall be carried out.

1.15 DRAWING AND PERFORMANCE DATA:

After the order is placed, vendor shall give within one (1) week, four (4) prints of certified drawings showing outline dimensions, height of L.T. and H.T. cable box, roller width and distance between rollers, net weight

with and without oil, list of accessories, wiring diagram for control circuit for approval.

One (1) print of each drawing will be returned to Vendor, after marking all the necessary corrections, changes and clarifications required. Vendor shall then incorporate these and send within fifteen (7) days, six (6) prints and one (1) transparency of each drawing marked "Certified " for record and use. Vendor shall give six (6) copies of instruction manual on installation, maintenance and operation of transformer and control device mounted on the transformer.

1.16 PACKING AND DESPATCH:

The transformer shall be packed, before dispatch to facilitate transportation and installation.

TRANSFORMER DATA SHEET

S.No.	Description	Rating
		1600 KVA
1.0	GENERAL	
1.1	Application	Light , General Power & air conditioning
1.2	Quantity Required	1 Nos.
1.3	Installation	outdoor
2.0	RATINGS	
2.1	Rating KVA	1600 KVA
2.2	Number of phases & Frequency	3 Phase, 50 Hz
2.3	Type of cooling	ONAN
2.4	No. Load Voltage	
	HV	33000V
	LV	415V
2.5	Vector Group	Dyn11
3.0	Percentage Impedance	(As per IS 2026)
3.1	Nominal System Voltage	
	HV	33000V
	LV	415V
3.2	Highest System Voltage	
	HV	36000V
	LV	650 V
4.0	TAP CHANGING GEAR	

4.1	TAPS ON LOAD	OFF LOAD
4.2	Tapping on windings HV/LV	HV
4.3	Total Tapping range	FOR OFF LOAD –7.5% TO +7.5%
4.4	Steps	2.5% FOR Off LOAD
5.0	TEMPERATURE RISE	
5.3	Winding by Resistance °C	55 Degree
6.0	INSULATION WITHSTAND	
6.1	Impulse (1.2x50 micro second wave):	170 KV
6.2	Power Frequency (Dry & Wet)	
a)	HV	70 KV
b)	LV	2.3 KV
7.0	NEUTRAL EARTHING	
7.1	SYSTEM NEUTRAL Effectively Earthed/Resonant Non effectively Earthed / Isolated	Effectively Earthed
7.2	TRANSFORMER NETURAL	Effectively Earthed
7.3	Neutral CT.	-

5.0 DRAWINGS

The following drawing shall be submitted for the EIC/Clients approval in the stipulated time. Weeks after award Of contract General outline drawing showing plan, front elevation, rear elevation, cable boxes/disconnecting chamber section views, locating dimensions of cable entries terminals foundation floor fixing details and weights. 1.

Bushings/Cable Box : plan, elevation terminals details., mounting details make and type number, current and voltage rating, creepage distances and principal characteristics. 1.
Rating and diagram plate. 1.
Marshalling boxes connections wiring diagram 2.

5.1 TEST REPORTS

Test result shall be corrected to a reference temperature of 75 dig C.

Two copies of test results shall be submitted for the Owner's / Consultants approval before dispatch of transformer.

Additional bound copies, as required by the Owners/Consultant contract, of complete test result including all tests on transformer, bushing, current, transformer (if provided). Shall be furnished with the transformer.

D. - LT SWITCHGEARS MAIN L.T. PANELS & DISTRIBUTION BOARDS:

7.1 SCOPE :

This section shall cover supply, assembly, installation, connection, testing and commissioning of medium voltage cubicle type MV Switchgear, Main LT Panel and Distribution boards as described in these specifications, drawings and schedule of quantities. The distribution boards are designated as:

Main LT Panels, Sub LT Panels

Floor Panels, Distribution Board

The unit rate per item shall include design supply, assembly, installation, connection, testing and commissioning of MV Assembly Distribution boards, with all the components in place, internal wiring, as specified in this specification, and shown on the drawing, and load schedule complete with supply and fixing of M.S. channel/ angle iron support on wall/floor etc.

In case of switchgears and panels issued by owner for erection the unit rate shall include inspection, receiving, storage, installation, field testing and commissioning activities including co- ordination with the suppliers of the switchgears. The rate shall be quoted per set of switchgears/panels as identified in the BOQ. The details of design/Constructional features of these switchgears are specified here below.

7.2 GENERAL :

7.2.1 SYSTEM DETAILS :

All the Main Panels/Motor control centers Distribution boards, Sub-Main Distribution boards, shall be suitable for operation on three phase/ single phase, 415/230 volts, 50 Hz neutral solidly grounded at transformer and short circuit level not less than 415 Volts at 25KA or as specified elsewhere.

The Distribution boards shall be designed to withstand tropical condition at site, with maximum expected ambient temperature of 45°C and 100 percent humidity and dusty weather.

Enclosure of the switchboard shall have IP 52 protection for Indoor and IP 55 for outdoor.

7.2.2 STANDARDS AND CODES:

The Distribution boards shall comply with the latest edition of relevant Indian Standards and Indian Electricity Rules and Regulations. The following Indian Standards shall be complied with :

IS 1394 -	L.V. switchgear and control gear Part-I - 1993 General rules
IS 5578-85	Guide for marking of insulated conductors.
IS 11353-85	Guide for uniform system of marking and identification of conductors and apparatus terminals.
IS 2147-62	Degree of protection provided by enclosures for low voltage switch gear and control gears.
IS 2675-83	Enclosed distribution fuse boards and cutouts for Voltages not Exceeding 1000 V.
IS 2551-82	Danger notice plates.
IS13947-1993	Circuit breakers.(Part-II)

IS13947-1993	Switches, Disconnectors, switch disconnector (Part - III) and fuse Combination units.
IS 1818-72	Alternating current isolators (disconnectors) and earthing switches.
IS 8623-77	Factory built assemblies of switchgear and control gear for voltages upto and including 1000 V AC & 1200 V DC.
IS 8828	Miniature air break circuit breakers for voltages not exceeding 1000 V.
IS 9926	Fuse wires used in rewirable type Electric fuses upto 1100 Volts.
IS 2208	HRC fuse links
IS 2705	Current Transformers(Part- I,II & III)
IS 3156	Voltage Transformers(Part- I,II & III)
IS 1248	Indicating Instruments
IS 722	Integrating Instruments
IS 13947-93	Control devices and switching elements.(Part - 5)Section-1
IS 13947-93	Contactors and motor starter section 1 (Part - 4) Electromechanical. Section - 1 Section-1
IS 3231	Relays
IS 375	Marking and arrangement of busbars Indian Electricity Act and Rules.

7.2.3 SHOP DRAWINGS:

Prior to fabrication of the Switchgears, Distribution boards, the contractor shall submit for Clients/Consultants approval the shop drawing, and design calculations, indicating type, size, short circuit rating of all the electrical components used, details & schedule of components & model Nos. type, rating etc., busbar size, internal wiring size, Distribution board dimension, colour, mounting detail etc. The contractor shall submit manufacturer's catalogues of the electrical components installed in the distribution.

7.2.4 INSPECTION:

At all reasonable times during production and prior to transport of the distribution boards to site, the contractor shall arrange and provide all the facilities at their plant for inspection by Client/Consultant or authorised representative.

7.2.5 TESTS TO BE CONDUCTED ON PCCS ON PDBS

The Panel shall be subject to standard routine test as per IS-2026 1977 on amended up to date.

- c) 2.5 KV highpot test with leakage current measurement.
- d) Meggar test.
- c) Load test by primary injection test kit at 70% capacity of the incomer.
- d) Secondary injection test for relays, meters & CT's.
- e) Temperature rise test FOR MEP.
- f) Functional test.

The above tests must be conducted in the manufacture premises in presence of Consultant's/Client's representative. The bidder who are not having those testing facility are not entitled to participate in the bid. Protective relays are to be tested/calibrated at installation prior to commissioning. Test certificates of the above tests shall be approved by Client/Consultant. The test results shall be recorded on prescribed forms. The test certificates for the test carried out at factory or at site shall be submitted in six copies to the Construction manager/Consultants for approval.

7.2.6 TYPE TEST CERTIFICATES:

The bidder shall produce following type tests certificate of CPRI (certificates shall be between year 2000 to 2003).

- a) Short circuit test at 41.7 KA fault level.
- b) Temperature rise test.
- c) Degree of protection test-IP55/IP54
- d) H.V. test.

7.2.7 FIRE INSURANCE APPROVAL

The bidder shall have TAC approval from Tariff Advisory committee & copy of approval shall be enclosed with bid.

7.2.8 OPERATION MANUALS

Three sets of operation manuals with the technical leaflets of the components used in the CPC & PBS are to be provided after completion of job.

6.2.9 PERFORMANCE GUARANTEE

All the equipments shall be guaranteed for 12 months from the date of commissioning.

7.3 CONSTRUCTION :

7.3.1 CUBICLE TYPE MV SWITCHGEARS & DISTRIBUTION BOARDS:

7.3.1.1 STRUCTURE:

The MV Switchgears panels and Distribution boards shall be sheet steel enclosed cubicle pattern, floor mounted free standing, totally enclosed dead front, compartmentalised multitier formation design. The panels shall be both sides extensible type with provision for bus bar extensions. Generally all Switchgears, Panels, MDB's, SMDB's & DB's shall be of front access only & suitable for top entry of cables unless otherwise specifically specified for bottom entry.

All M.S. sheet steel used in the construction of Distribution boards shall be 2mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Sheet steel shrouds and partitions shall be of minimum 2 mm thickness. Joints of any kind in sheet steel shall be seam welded, all welding slag grounded off and welding pits wiped smooth with plumber metal. The height of the panels should not be more than 2200 mm. The operating levels shall not be more than 1800 mm. The operating level of the lower most cubicle shall not be less than 450 mm.

The Panels / Distribution boards shall be totally enclosed, completely dust and vermin proof. Synthetic rubber gaskets (neoprene/DPDM) between all adjacent units and beneath all covers shall be provided to render the joints dust proof. All doors and covers shall be fully gasketed and shall be lockable. Doors shall have concealed hinges. All the doors shall be suitably reinforced by channel to provide rigidity.

All panels and covers shall be properly fitted and secured with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with bolt and nuts. Self threading screws shall not be used in the construction of the panels/DBs etc.

A base channel of 75mm x 40mm x 5mm thick shall be provided at the bottom. A clearance of 300mm between the floor of the Panels/ Distribution Board and the bottom of the lower most unit shall be provided.

The Panels/ Distribution boards shall be preferably arranged in multitier formation. These shall be of adequate size with a provision of 20 Percent vacant space to accommodate future additional switch gear in addition to spare feeders presently provided. The size of the boards shall be designed in such a way that the internal space is sufficient for hot air movement, and the electrical component do not attain temperature rise more than 40 degree Celsius.

Knockout holes of appropriate size and number shall be provided in the gland plate of Panels/Distribution board in conformity with the number, and size of incoming and outgoing conduits/cables.

Alternatively the Panels/Distribution boards shall be provided with removable undrilled gland plates (3mm thick).

The switch boards shall be designed to facilitate easy inspection, maintenance and repair.

The Panels/Distribution boards shall be sufficiently rigid to support the equipment without distortion under normal and short circuit condition. They shall be suitably braced for short circuit duty. Provision shall be made for permanently earthing the frames and other non current carrying parts of the switchgear by two independent earth connections.

7.3.1.2 PROTECTION CLASS

All indoor Panels/Distribution boards shall have degree of protection conforming to class IP 42. While outdoor panels shall be weather proof dust and water tight IP-55.

7.3.1.3 METAL TREATMENT & FINISH

All sheet steel work used in the construction of switchboard shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating in seven tank metal treatment plant and shall be powder coated to the specified shade of IS.5 of approved colour. The total thickness of paint shall not be less than 50 microns. The finished panels shall be dried in storing ovens in dust free atmosphere to ensure fine quality finish. The paint shall be Berger Luxol Higliss, with siemens gray color for inside outside .

7.3.1.4 BUS BARS

The Bus bars shall be of three phases separate neutral and earth bar. The busbars, and interconnection between busbars and various components shall be of high conductivity, high strength aluminium alloy with current density 0.8A/sqmm complying with the requirement of grade E91E of IS 5082. The busbar shall be of rectangular cross section designed to withstand full load current for phase busbars and half rated current for neutral busbars unless specified otherwise and shall be extensible on both sides. The bus bar shall be rated for the rating of the main incoming breaker, but in any case not less than 200 Amp. capacity. The busbar shall have uniform cross section through out the length.

The busbars and interconnections shall be provided with heat resistant and colour coded sleeves. The busbars shall be supported on unbreakable, non hygroscopic insulated supports of SMC supports at sufficiently close intervals to prevent busbar sag and shall effectively withstand without damage electromagnetic stresses in the event of short circuit. The neutral as well as earth bar shall also be capable of withstanding the fault level.

The busbars shall be housed in a separate compartment. The busbar shall be shrouded with 3mm thick transparent sheet to avoid any accidental contact. All busbars connections shall be done by drilling holes in busbars and connecting by chromium plated high tensile M.S. bolts, spring washer and nuts. Additional cross section of bus bars shall be provided in all Panels/ Distribution boards to cover up the holes drilled in the busbars. Spring and flat washers shall be used for tightening the bolts.

All connections between busbars and circuit breakers/ switches and between circuit breakers/switches and cable terminals shall be through solid copper strips of proper size to carry full rated current. These strips shall be insulated with insulating heat resistant paint with colour coding.

7.3.1.5 CIRCUIT COMPARTMENTS

Each circuit breaker shall be housed in separate compartments and shall be enclosed on all sides. Sheet steel hinged lockable door shall be duly interlocked with the breaker units in "ON" and "OFF" positions. Safety interlocks shall be provided for air circuit breaker to prevent the breaker from being drawn-out when the breaker is in "ON" position.

The door shall not form an integral part of the drawout position of the circuit breaker. All instruments and indicating lamp shall be mounted on the compartment door. Sheet steel barrier shall be provided between the tiers in a vertical section.

7.3.1.6 INSTRUMENT COMPARTMENT

Separate and adequate compartment shall be provided for accommodating instruments, indicating lamps, control contactors/relays, and control fuses etc., these components shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker units, bus bars and connections.

7.3.1.7 TERMINALS

The outgoing terminals and neutral link shall be brought out to a cable alley suitably located and accessible from the panel front. The current transformers for instruments metering shall be mounted on the terminal blocks. No direct connection of incoming or outgoing cables to internal components of the Panels/Distribution board is permitted only one conductor may be connected in one terminal.

7.3.1.8 WIREWAYS

A horizontal PVC wire way with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical sections.

7.3.1.9 CABLE COMPARTMENTS

Cable compartments of adequate size shall be provided in the Panels/Distribution Boards for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate supports shall be provided in the cable compartments to support cables. All outgoing and incoming feeder terminals shall be brought out to terminal blocks in the cable compartment.

7.3.1.10 EARTHING

GI earth bars of suitable size but not less than 25 mm x 3 mm shall be provided in the Panels/Distribution Boards for the entire length of the panel. The frame work of the Panels/Distribution board shall be connected to this earth bar. Provision shall be made for connection from this earth bar to the main earthing bar coming from the earth pit on both sides of the Panels/Distribution board and to take tapping to the outgoing earthing strips to connect to the main distribution boards.

The earth continuity conductor of each incoming and outgoing feeder shall be connected to this earth bar. The armour shall be properly connected with earthing clamp, and the clamp shall be ultimately bonded with the earth bar. CT earthing also shall be connected to this earth bar.

7.3.1.11 LABELS

Engraved PVC labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside the Panels/DBs shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet.

7.3.1.12 INTERNAL COMPONENTS

The Panels/ Distribution boards shall be equipped complete with all type of required number of circuit breakers, contactors, relays, fuses, meters, instruments, indicating lamps, push buttons, equipment, fittings, busbars, cable boxes, cable glands etc., and all the necessary internal connections /wiring as required and as indicated on relevant drawings. Components necessary for proper complete functioning of the Panels/Distribution boards, but not indicated on the drawings shall be supplied and installed on the distribution boards.

All parts of the Panel/Distribution boards carrying current including the components, connections, joints and instruments shall be capable of carrying their specified rated current continuously, without temperature rise exceeding the permissible values as per the relevant specifications at any part of the Panel/Distribution boards.

All units of the same rating and specifications shall be fully interchangeable.

7.3.1.13 VENTILATION

Ventilation louvers with removable type welded wire mesh are to be provided on sides of panel, backside covers of busbar chamber doors. Also on PCC at top of busbar chamber welded wire mesh protected ventilation duct with canopy of sheet shall be provided for proper cooling & to ensure temperature rise within limits as per standards. 3/4" size propellar fan should be fixed on opening at both ends in all panels including main panel & floor mounted distribution boards.

7.3.1.14 HARDWARE/MISCELLANEOUS ITEMS:

The hardware to be used in panels shall be zink plated & all joints & connections shall be made with galvanized zink passivated or cadmium plated high tensile strength steel bolts/nuts/spring washers etc.. The make of hardware items shall be approved make All control wires shall be of 1.1KV grade flexible copper of approved make with approved make copper /Al type lugs. The control fuses /control MCB of approved make shall be provided with ferrules for identification of wires. PVC gray casing for wires shall be provided in cubicles. All wire shall be suitably tied with PVC button straps. Appropriate rubber bushes, clamps are to be crossover of control wiring in cubicles etc.

7.3.2 MCB DISTRIBUTION BOARDS:

7.3.2.1 SCOPE

This section relates to specifications for design supply, assembly, installation, connection, testing and commissioning of lighting and power distribution boards (LPDBs), using Miniature Circuit Breaker (MCB), Earth Leakage Circuit breaker (ELCB), Contactor, Neutral link, Earthing terminals, control switch terminals, cubicle of CRCA sheet steel housing and complete the item installation.

7.3.2.2 SYSTEM

The MCB distribution boards shall be suitable for operation on 400/440 volt, 3 phase, 4 wire, 50 Hz A.C. supply system or 220/250 volt, 1 phase, 2 wire, 50 Hz A.C. supply system.

7.3.2.3 CONSTRUCTION

- a) The DB's shall be factory made and preferably of those manufacturers whose MCBs, ELCB's are to be used. General arrangement layout of the DB's shall be approved by the Construction manager/Consultant before manufacture.
- b) The DB shall be metal clad duly fabricated from 2mm (14/16 SWG) thick high quality CRCA sheet.

- c) The DB shall be cubicle, compartmentalized, wall/floor mounted and dead front operated.
- d) The DB shall be totally enclosed and made dust, vermin and weather proof such that it meets IP 54 of IS 2147 protection classification.
- e) A detachable cover plate of 2mm thick CRCA sheet to be provided on front of the board such that all live parts of the electrical accessories mounted on the board can be accessible only on removal of the said cover plate.

Further, the cover plate shall also, have suitable cut out so that dolly of the MCB's can be operated even if the cover plate is in position. A transparent plastic protection cover shall be provided on the cut out portion of the cover plate.

The cover plate shall also provide right above the respective cut outs a suitable arrangement to label the electrical circuit details of the MCB's mounted on it as well as to affix a danger plate in legible manner.

The cover plate shall be fixed to the board with adequate size zinc passivated machine screws.

Above the detachable cover plate, one additional hinged door of 2mm thick CRCA sheet covering the MCB's etc., shall be provided with a suitable locking arrangement.

The hinged door shall be provided with a suitable gasket capable of withstanding corrosive & humid atmosphere and to meet degree of enclosure protection IP 54 as per IS : 2147. The DB's shall undergo the process of painting as described under cubicle type main/submain distribution boards.

- f) The DB shall have top/bottom entry arrangement for incoming and outgoing cables/conduits.
- g) All hardware to be used in manufacture of the DB shall either be of mild steel zinc passivated or otherwise be treated to prevent corrosion due to humid atmosphere.
- h) All internal electrical connections shall be carried out using 1100 volt grade, PVC insulated, Copper conductor of ISI approved make, having rated current carrying capacity to carry continuous full current of respective switch/MCB rating at operating conditions prevailing at the project site.
- i) The DB internals shall be earthed with use of copper strips running through out the length. Size of the earthing strip shall be as shown in the respective drawing.
- j) The earthing strip shall be brought out on two sides of the DB's with bolted type earth terminating arrangement, for connecting to the building earthing grid. The earth terminal shall be of either brass or zinc passivated mild steel.
- k) All non current carrying metal surfaces of the DB's shall be adequately treated with seven tank pretreatment process to render it free from grease, oil, oxide, dirt, etc., to make them ready to receive and hold coats of zinc chromate primer.
- l) The DB's shall be provided with electric components and accessories as per the details shown in the drawing/BOQ for the respective electric distribution board.

7.4 INSPECTION:

7.4.1 The DB's shall be inspected and checked as per inspection manual of the DB manufacturer.

7.4.2 Various electrical components and accessories of the DB's shall be checked as per drawing for the respective DB's.

7.4.3 The DB's shall be checked for rigid mounting, earthing connection, proper rating & size of components, internal wiring etc.,

7.4.4 All mechanical fasteners and electrical connections shall be checked and tightened before installation.

7.5 INSTALLATION:

7.5.1 The DB's shall be assembled and aligned together and be installed at site as per installation manual/instruction of the DB manufacturer.

The installation shall conform to relevant Indian Standard specification and requirement of local site conditions.

7.5.2 The DB shall be installed in surface/concealed manner at the location as shown in the respective drawings.

7.5.3 All minor electrical and mechanical work required to be attended to on the DB shall be completed in an approved manner after installation but before energizing the DB's.

7.6 TEST:

Prior to commissioning of the DB's following tests shall be carried out.

7.6.1 Mechanical endurance test shall be carried out by closing and opening of all the MCB's, switches etc.

7.6.2 Insulation resistance test shall be carried out between phases and between phase to earth bus, keeping the isolating switch in open position. Similar test shall be carried out keeping the isolating switch in closed position.

7.6.3 All the interlocks, controls and tripping mechanisms of the switch gears shall be tested for their proper functioning.

7.6.4 Each panel shall be provided with a thermostatically controlled space heater of adequate rating and single phase plug point and cubicle illumination lamp with switch operated at 240V AC, 50 Hz. Heaters shall have individual ON-OFF switches.

7.7 COMPONENTS:

7.7.1 GENERAL

The type, size and rating of the components shall be as indicated on the relevant drawings.

While selection of the capacity of the components resulting from the prevailing conditions like room temperature shall be allowed for the thermal and magnetic trip rating shall be compensated for the ambient temperature.

The rating indicated on the drawings are ratings anticipated at prevailing site condition.

7.7.2 AIR CIRCUIT BREAKERS:

The air circuit breaker shall comply with the requirements of IS: 13947-2 (1993) and shall have:

- i) A service short circuit breaking capacity shall be as specified and equal to short circuit withstand values. All short circuit ratings shall be lcs values.
- ii) A short circuit making capacity of 105 KA.
- iii) A short time withstand capacity of 75 KA for 1 second.
- iv) Mechanical and electrical endurance for 2000 operating cycles out of which 100 cycles should be for electrical endurance.
- vi) Electrical overload performance at 6 times the rated current, 110% of the rated voltage as recovery voltage and 0.5 power factor.

vi) Dielectric test of 2.5 KV applied for one minute on main circuits. Test evidence from a recognised independent laboratory/institution shall be furnished for compliance of the breakers with the above requirements.

vii) Each pole of the ACB's shall be equipped with an inverse time delay thermal over current trip device and an electro magnetic instantaneous over current trip device. The ACB's shall be equipped with under voltage trip relay. The trip devices shall be direct acting. ACB shall be capable of providing short circuit overload and earthfault protection (in absolute values) if required, thru microprocessor based control unit sensing the true RMS values to ensure accurate measurement meeting the EMI/EMS requirement as per the standard.

viii) Disconnecting devices of approved type shall be provided to facilitate the removal of the circuit breakers from the housing for test and maintenance purposes.

ix) The ACB's shall be fitted with detachable type arc quenching device on each pole. The ACB's shall have auxiliary contacts for signaling, interlocking etc. The ACB's shall have slow close facilities for checking contact operation and contact gap adjustment.

x) All contacts subject to arcing shall be tipped with arc resisting material. Main contacts shall be silver plated to ensure reliability in service.

xi) Isolating contacts shall be of the silver plated, multifinger, spring loaded type. Facilities shall be provided to isolate the circuit breaker for inspection purpose. Feature of contact wear inspection indicating the life of contacts shall be provided. The ACB shall have double insulation (class-II) with moving and fixed contacts totally enclosed for enhanced safety and inaccessibility to live parts. The breaker shall have three distinct positions with in the cassette as follows:

- a) 'Service Position' - with main and auxiliary contacts connected.
- b) 'Test Position' - with power contacts fully disconnected and control circuit contacts connected.
- c) 'Isolated position' - With both power and control circuit contacts fully disconnected.

xii) Interlocks shall be provided to :

- a) Prevent the breaker from being isolated unless it is in the OFF position.
- b) Prevent the breaker from being racked into the service position unless it is in the OFF position.
- c) Prevent the breaker from being accidentally pulled completely OFF the guide rail.

xiii) Safety shutters of an insulation material shall be provided to prevent access to all live contacts, when the breaker is in the inspection position or completely withdrawn.

xiv) Facilities for pad locking the safety shutters when breaker is completely withdrawn shall be provided.

Facilities shall be provided for earthing the circuit breaker.

xv) Air circuit breaker shall be capable of clearing the maximum fault current which can occur.

xvii) All electrical closing of breaker should be with Electrical motor wound stored energy spring closing mechanism with Mechanical indicator to provide ON/OFF status of ACB.

For all ACBs the operating handle should be provided for charging the spring in continuous action. The spring shall be released with ON/OFF push button command in one operation at the correct speed independent of operator speed. A direct mechanical coupling should indicate the ACB in ON to OFF position thus qualifying to disconnection as per the IS/IEC indicating the true position of all the contacts. One set of NO/NC potential free contacts to be provided for operation on building management system. All accessories like shunt, undervoltage motorised mechanism etc shall be front mounted and can be fitted at site.

7.7.3 MOULDED CASE CIRCUIT BREAKERS (MCCB):

MCCBs shall satisfy the requirements of IS-13947 Part (II) and shall be of current limiting type. MCCB shall provide type 'C' protection to the contactors as per IEC 158-1B. MCCBs shall be quick make, quick break, independent manual type with trip free feature with mechanical ON, OFF, and TRIP indications. A trip button shall be provided for tripping the breaker.

MCCB shall have electro-magnetic, under voltage and earth fault releases.

Alarm and auxiliary contacts, terminal shrouds, sliding type front operation kit with facility for door interlocking and pad locking shall be provided (ICS=ICU).

7.7.4 FUSE SWITCH UNITS

The fuse switch units shall be 3-pole double break type suitable for load break duty, quick make and break action. Separate neutral link shall be provided in the switch. All fuse switch units shall be provided with hinged doors duly interlocked with operating mechanism so as to prevent opening of the door when the switch is in "ON" position and also prevent closing of the switch when the door is not properly secured. All contacts shall be silver plated and all live parts shall be shrouded. The incoming and outgoing terminals of switch shall be adequately sized to receive proper size of cables. High rupturing capacity (HRC) fuse links shall be provided with switch fuse units and shall be in accordance with IS: 2208-1962 and having rupturing capacity of not less than 35 MVA at 415 volts. HRC fuse links shall be provided with visible indicators to show that they have operated. The switch fuse unit shall be manufactured in accordance with IS:4047-1967 as amended to date.

7.7.5 MINIATURE CIRCUIT BREAKER

Miniature circuit breakers shall be quick make and break type and conform to IS: 8828. The housing of MCBs shall be heat resistant and having a high impact strength. The fault current of MCBs shall not be less than 9000 amps, at 230 volts. The MCBs shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical "ON" and "OFF" indications.

The circuit breaker dollies shall be of the trip free pattern to prevent closing the breaker on a faulty circuit.

The MCB contacts shall be silver nickel and silver graphite alloy and tip coated with silver. Proper arc chutes shall be provided to quench the arc immediately. MCB's shall be provided with magnetic fluid plunger release for over current and short circuit protection.

The over load or short circuit devices shall have a common trip bar in the case of DP and TPN Miniature Circuit Breakers. All the MCB's shall be tested and certified as per Indian Standards, prior to installation.

6.7.6 FUSE:

Fuses shall be of high rupturing capacity (HRC) fuse links and shall be in accordance with relevant ISS and having rupturing capacity of not less than 35 MVA at 415 volts. The back up fuse rating for each motor/equipment shall be so chosen that the fuse does not operate on starting of motors/equipment.

7.7.7 EARTH LEAKAGE CB/RESIDUAL CURRENT CB :

The ELCB/RCCB shall comply with IS:12640-1988/IEC:1008. The ELCB/RCCB shall be current operated independent of the line voltage. ELCB/RCCB shall work on the principle of core balance transformer. The ELCB/RCCB shall be rated for current sensitivity of a min of 30mA and a max of 300 mA at 240/415 V AC. The terminals shall be protected against finger contact to IP:20 degree of protection. The ELCB/RCCB shall have a minimum of 20,000 electrical operations.

Testing Provision

A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the ELCB and the operating handle shall move to the "OFF" position.

7.7.8 CONTACTORS:

The contactors shall meet with the requirements of IS:2959.

The contactors shall be of MN series only

The contactors shall have minimum making and breaking capacity in accordance with utilization category AC3 and shall be suitable for minimum class II intermittent duty.

If the contactor forms part of a distribution board then a separate enclosure is not required, but the installation of the contactor shall be such that it is not possible to make an accidental contact with live parts.

7.7.9 VOLTMETER:

Voltmeter shall comply with IS-1248 (Latest edition) requirements. The dial of the meter shall be square in shape 96 x 96 Sq. size. The voltmeter shall be digital type, flush pattern, with dust and moisture proof enclosure.

The voltmeter selector switch shall be arranged to provide line to line voltage reading and line to neutral voltage reading.

7.7.10 AMMETER:

Ammeter shall comply with IS-1248 (Latest edition). The dial of the ammeter shall be square in shape of 96 x 96 Sq. mm size. The Ammeter shall be digital type, flush pattern with dust and moisture proof enclosure. The range of the ammeter shall be in accordance with 1 to 1.5 times the feeder full load current. Separate current transformer shall be provided for all ammeters. Three way ON and OFF selector switch shall be provided for measuring current in different phases.

7.7.11 CURRENT TRANSFORMER:

Where ammeters are called for C.T's shall be provided for current measuring. Each phase shall be provided with separate current transformer of accuracy class-I and suitable VA burden for operation of associated metering and controls. Current transformer shall be in accordance with IS:2705 as amended up to date.

7.7.12 ENERGY MANAGEMENT SYSTEM

The system monitor the energy consumption at the individual distribution boards for centralized billing. The requirements are as follows:

1. To monitor each supply breaker Line & Phase Voltage, Current, Power, Energy, reactive power, P.F., Frequency etc. the trend of consumption, maximum demand in KVA time plot with an accuracy class of 0.5 should be provided with RS 485 port option.
2. Should monitor Demand parameter (KVA or KW) instantaneous demand & maximum demand, Day, Date, Time of MD occurrence.
3. Each outgoing feeder shall be provided with electric 3 phase 4 wire/1 phase Energy meters to monitor energy parameter with tamper proof cover. Accuracy class 1.0.

4. Computer System

Data so collected from the incoming and outgoing shall be integrated and recorded in the PC Pentium-IV, 1.1 GHz, 256 MB RAM, 40 GB HDD, 3.5" FDD, CD Drive – 52X, serial port and parallel port, 17" colour monitor, mouse and standard keyboard. Windows-98 version & MS-OFFICE-97.

132 Column Dot Matrix printer, UPS (Min 2 KVA), High speed control and graphic low loss data communication cable including required software for demand representative of the same. The required window based software shall also be provided for having pre-configured with screens which show mimics, trends, history, alarms and shall generated MIS reports.

Required high speed data cable/control cable and other network accessories like data converter, repeaters etc shall also be included by the bidder.

7.8 BUS TRUNKING / DUCT :

Bus duct shall be aluminium conductor conventional design suitable for use on 415 volts, three phase four wire, 50 Hz. A.C. Supply system.

ENCLOSURE

The enclosure shall be made of sheet metal 2mm (14 SWG) M.S/GI sheet. The enclosures shall be reinforced by using suitable bracing material between the channels. The sheet metal structure shall be jig assembled to ensure that any one section can fit into other sections without any difficulty.

The sheet metal enclosure shall be of sufficient section, ventilated and designed such that the temperature rise does not exceed the prescribed limit above ambient of 45 °C. Proper ventilation shall be provided by means of louvres and covered by fine mesh to avoid the ingress of vermin.

The sheet metal work shall be pretreated in seven tank. Metal treatment plant for degreasing, derusting and phosphating the surface. After phosphating the surface shall be finished. The inside/outside surfaces of the enclosure shall be powder coated in shade to be specified later or galvanised.

Bus bars shall be of aluminium alloy conforming to IS.S. 5082 – 1969 grade E 91E – WP. The current density not to exceed 0.8A per Sq.mm or as per approved design calculations which ever is less. The bus bars shall be insulated with Class „F“ insulation material and ensure tight fitting on the conductors. The busbar surface shall be colour coded by applying Red, Yellow, Blue and Black indications to identify the phases.

The joints shall be bolted using electro galvanized high tensile (HT) M.S. bolts, complete with spring washers to avoid loosening in service.

Bus bars supports shall be of SMC/FRP and shall have sufficient strength to withstand the effect of a short circuit.

All joints shall be provided with links to ensure earth continuity between sections of bus trunking / ducts. Flexible joints made of copper shall be supplied as may be necessary for end termination at DG/Transformer and panel end. Flexible bellows shall also be provided for connection at D.G. end. The busduct / trunking shall be complete with expansion joints through panel, flexible connection, first barriers etc.

Note: The offer of busduct shall be complete with design calculation:

- i) Busbar size required based on normal current carrying capacity considering various current derating factor.
- ii) Based on short circuit with-stand capacity.
- iii) For electro-mechanical stress analysis for busbars, busbar support and hardware.

In case of switchgears and panels issued by owner for erection the unit rate shall include Design, supply, inspection, receiving, storage, installation, field testing and commissioning activities including co-ordination with the suppliers of the switchgears. The rate shall be quoted per set of switchgears/panels as identified in the BOQ.

7.9 GENERAL :

INSPECTION:

The panels be inspected and checked as per inspection manual of the PANEL manufacturer.

Various electrical components and accessories of the PANEL's shall be checked as per drawing for the respective panels

The PANEL's shall be checked for rigid mounting, earthing connection, proper rating & size of components, internal wiring etc.,

All mechanical fasteners and electrical connections shall be checked and tightened before installation.

7.10 INSTALLATION:

The PANEL's shall be assembled and aligned together and be installed at site as per installation manual/instruction of the PANEL manufacturer.

The installation shall conform to relevant Indian Standard specification and requirement of local site conditions.

The PANEL shall be installed in surface/concealed manner at the location as shown in the respective drawings.

All minor electrical and mechanical work required to be attended to on the PANEL shall be completed in an approved manner after installation but before energizing the PANEL's.

- CABLES :

8.1 GENERAL SCOPE :

Supply , installation, storing, laying, fixing, jointing / termination, testing and commissioning of Medium Voltage XLPE insulated extruded PVC inner sheathed PVC overall Sheathed armoured aluminium/ copper conductor cables laid in built up trenches, directly buried underground, on cable trays, in pipes, clamped directly to wall or Structures etc. as called for in the drawing.

a) Type :

Medium voltage cables shall be circular, multicore annealed copper or aluminium conductor, XLPE insulated, PVC extended inner sheathed an PVC overall sheathed and steel wire armoured or steel tape armoured construction or unarmoured. The conductors of cable shall be stranded. Sector shaped stranded conductors shall be used for cables of 50 sqmm size and above. The cables shall conform to IS:1554 part-I in all respects.

MV power cables shall be 2, 3, 3.5 or 4 cores, as required and shall have conductors made from electrical purity aluminium conductors conforming to IS:8130-84.

Conductors shall be insulated with high quality PVC base compound. Insulation and outer sheathing compounds shall conform to IS:5831 - 84.

A common covering shall be applied over the laid-up cores by an extruded sheath of un-vulcanised rubber compound.

Armouring of galvanised round steel wires or galvanised flat steel strips shall be provided over the inner sheath.

Outer sheath of PVC shall be extruded over the armouring cables shall be manufactured and tested in accordance with IS 1554 Part I.

Unless otherwise specified, all control cables shall be multicore, 1100V grade PVC insulated, armoured and overall PVC sheathed with stranded copper conductors of 2.5 sq.mm, conforming to IS 1554 Part I. Cores shall be identified by colour scheme of PVC insulation.

b) Rating :

The cables shall be rated for a voltage of 1100 Volts.

c) Core Identifications :

Cores shall be provided with the following colour scheme of PVC insulation

1. Single Core : Green yellow for earthing.
2. Two Cores : Red and Black, Blue & Black, Yellow & Black.
3. Three Cores : Red, Yellow & Blue
4. Four Core : Red, Yellow, Blue & Black

e) Selection of Cable:

3. Cables sizes shall be selected considering the current carrying capacity, voltage drop, maximum short circuit duty and the period of short circuit to meet the present and future anticipated loads.

4. While deciding cable sizes, the derating factors for type and depth of laying, grouping, ambient temperature, ground temperature and soil resistivity shall be taken into account.

8.2 STANDARDS :

The following standards and rules shall be applicable.

IS 1554	└	PVC insulated (heavy duty) electric cables Part I for working voltages upto and including 1100 V.
IS 8130	└	Conductors for insulated electric cables and flexible cords.
IS 3961	└	Recommended current ratings for cables:(Part 2) PVC Insulated and PVC sheathed heavy duty cables.
IS 5831	└	PVC insulation and sheath of electric cables.

The individual cores shall have continuous numbering of the core all along its length and also be provided with identification ferrules at both ends. Individual control cables shall have 20% spare cores.

PVC / XLPE cables shall be used for all electrical works to prevent flame propagation, smoke reduction and to avoid toxic gas emission in the event of a fire. FRLSH compound shall be tested rigorously for oxygen index as per ASTM D2863, acid gas generation to IEC 754-1, smoke density to ASTM D 2843 and flammability SS 424 1475 class F3, IEEE 383 and IEC 332-1.

Manufacturer's name, ISI Mark, cable size and type shall be clearly embossed at regular intervals on all cables.

8.3 INSPECTION :

All cables shall be tested inspected at manufacturers works. However upon receipt at site cables shall be checked for physical damages during transit.

8.4 JOINTS IN CABLES :

The contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilisation and avoidance of straight cable jointing. This apportioning shall be got approved by the Construction manager/ Consultant before the cables are cut to lengths.

Where straight joints in cable are unavoidable, the use and location of such straight joints shall be got approved by Construction manager/Consultant.

8.5 JOINTING BOXES FOR CABLES :

Cable joint boxes shall be of appropriate size, suitable for PVC insulated armoured cables of particular voltage rating.

8.6 JOINTING OF CABLES :

All cable joints shall be made in suitable, approved cable joint boxes, jointing of cables in the joint boxes and the filling in of compound shall be done in accordance with manufacturer's instructions and in an approved manner. All straight joints shall be done in epoxy mould boxes with epoxy resin (Tropolin/M-Seal resin or approved equal). All jointing accessories shall be of CCI/INCAB or approved equal. All terminal leads of conductors shall be heavy soldered upto at least 50mm length.

All cables shall be joined colour to colour and tested for continuity and insulation resistance before jointing commences. The seals of cables shall not be removed until preparations for jointing are completed. Joints shall be finished on the same day as commenced and sufficient protection from the weather shall be arranged. The conductors shall be efficiently insulated with high voltage insulating tape and by using spreaders of approved size and pattern. The joints shall be completely filled with epoxy compound and tapped so as to ensure that the box is properly filled.

Epoxy compound shall be filled as follows :

Equal quantities of resin and hardener shall be mixed thoroughly by hand until the mixture is free from white patches and has uniform colour. No water, oil or any other liquid shall be added to the mixture to make it soft as this will affect the properties of the compound. The mixture shall be used within 30-40 minutes of mixing. The surface on which epoxy compound is to be used, shall be free from dust, rust, oil, grease and shall be dry. The joint shall neither be disturbed nor moved till the epoxy compound is completely hardened. A smooth surface can be made by rubbing a damp cloth smoothly on the compound before it sets. The joints shall be painted after it has completely hardened.

Alternatively, ready mix of epoxy cable jointing compound may also be used.

8.7 CABLE MARKERS/CABLE TAGS :

Cable Markers:

All underground cables and cable joints shall be marked on the surface by markers generally manufactured and tested to the requirements of relevant ISS. Approved CI cable markers shall be provided at every 30m along the route of the cables and at both ends of road crossing, indicating cable joints and cables as applicable. Special CI

markers shall be provided at all buried cable joints indicating "Electrical Cable Joints". CI plates duly engraved with the size of the cable and the place it serves shall be tied to the cable at regular intervals of 5m for easy identification of cables.

Cable Tags:

Cable tags shall be made out of 2 mm thick aluminium sheets, each tag 32 mm in dia with one hole of 2.5 mm dia. 6 mm below the periphery shall be provided for clamping the same with cables.

Cable designation are to be punched with letter/number punches and the tags are to be tied to cables with piano wires of approved quality and size. Tags shall be tied inside the panels beyond the glands as well as below the glands at cable entires. Along trays, tags are to be tied at all bends on straight lengths, tags shall be provided at every 5 meter.

8.8 TERMINATION OF CABLES :

Cable termination shall be done in terminal box or cable end box or distribution boards, or apparatus/equipments. Terminations are to be made with mechanical gland and of the tinned nickel plated, anti- corrosive, three piece improved pattern which is to grip inner and outer PVC sheaths as well as the armour of the cable. The cable ends or the core conductor are to be connected by solderless lugs or sockets using crimping tool of approved make for all cables.

All terminations of cable conductors and base conductors shall be mechanically and electrically sound and shall comply with the requirements of relevant Standards and Indian electricity regulations.

The connectors or connecting sockets are to have such dimensions so as to limit temperature rise.

When required the water tightness of the terminal boxes may be obtained by filling with a compound preferably plastic flame retarding and non-dripping type within the normal range of temperatures.

When the cable is cut during the course of installation the open ends are to be sealed immediately by means of self-adhesive non hygroscopic tape over a wax water seal to make an air and watertight joint.

8.9 INSTALLATION OF CABLES:

Cable shall be laid in a manner as indicated on the drawings. Generally cables are laid in the following manner.

- i. In the underground masonry trench.
- ii. On the cable tray/or on cable ladders.
- iii. Buried underground.
- iv. Through pipe sleeves.

Various installation methods are discussed in the following paragraphs.

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before unwinding the cable. The cable drums shall be rotated in a direction as indicated by the manufacturer. Care shall be exercised in laying cables to avoid forming kinks. The drums shall be unrolled and cables run over wooden rollers, placed at intervals not exceeding 2 meters.

General

All cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of service.

When cable pass through holes in metal work, precautions shall be taken to prevent abrasion of the cables on any sharp edges.

In every vertical cable ladders, channel or duct or trunking or cable trench containing cables and exceeding three meters in length, internal barriers shall be provided so as to prevent the air at the top of the unit from attaining an excessively high temperature. In every vertical cable shaft, cable trench or any passage of cable through wall, ceiling, floor barriers against spread of fire and smoke shall be provided for compliance with IEE regulations. `Viper' CABLEMASTIC fr 903 fire resistant painting shall be applied on all power cables.

Where cable passes through walls, ceiling, floor, it shall run through sleeve of PVC pipes or hume pipes of adequate diameter. After pulling the cable through sleeve, both the ends of the sleeve shall be sealed water tight with fire resistance material to prevent spread of fire and seepage of water.

Generally along each cable route either in trench or in cable trays/ladders or in pipe separate Two Nos. of earth strips/wires shall run exposed.

Where an installation comprises medium voltage cables as well as extra low voltage circuits, precaution shall be taken in accordance with relevant regulations and shall be physically separated by minimum of 300mm distance.

Metal sheaths and armour of all cables, metal conduits, ducts, trunking, and bare earth continuity conductors associated with such cables, which might otherwise come into fortuitous contact with other fixed metal work shall be effectively bonded there to earth so as to prevent appreciable potential difference at such possible points of contact.

Underground Installations

The cables shall be laid in an excavated trench. The depth of the trench shall be minimum 750 mm below the final ground level but shall be decided on the number of cables to be laid in the trench so that the vertical distance between two adjacent layers of cables shall not be less than 350mm. The width of the trench shall be decided on the number of cables to be laid in the trench so that the distance between two adjacent cables shall not be less than one cable diameter.

a) Width of Trench:

iv) The minimum width of trench for laying single cable shall be 350 mm.

v) Where more than one cable is to be laid in the same trench in horizontal formation, the width of trench shall be increased such that the inter axial spacing between the cables, except whether otherwise specified shall be at least 200 mm.

vi) There shall be clearance of at least 150 mm between axis of the end cables and the sides of the trench.

b) Depth of Trench:

iii) Where cables are laid in single tier formation, the total depth of the trench shall not be less than 750 mm.

iv) When more than one tier of cables is unavoidable and vertical formation of laying adopted, depth of trench in (i) above shall be increased by 300 mm for each additional tier to be formed.

In addition to above, where gradients and changes in depth are unavoidable, these shall be gradual. The cables shall be protected by placing precast concrete tiles or burnt bricks over the cables on top layer of sand and for the

full length of underground cables. Where more than one cable is running in the same trench, the concrete tiles/bricks shall cover all the cables and shall project a minimum of 150mm on either side of the cables.

In any case the top layer of the cables shall be minimum 600 mm below the finished level of the ground.

The top of the cable trench shall be well compacted till the finished level of the ground and shall be approved by the Construction Manager/Consultant. If required a laboratory compaction test shall be carried out in presence of the Construction Manager/Consultant.

H.V., M.V., cables shall not be laid in the same trench/cable tray and/or along side of water main.

Cables under road crossings and any surfaces subjected to heavy traffic shall be protected by running them through Hume pipes of suitable size.

Where cables cross one another, the cables of higher voltages shall be laid at lower level than the cable of lower voltage.

The relative position of the cables laid in the same trench shall be preserved and the cables shall not cross each other as far as possible. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius of bend not less than 15 times the diameter of the cable. Minimum 3 meters long loop shall be provided at both sides of every straight joint and 5 meters at each end of the cable. Distinguishing marks shall be made at the cable ends for identification.

Proximity to Communication Cables:

MV Cables and communication cables shall as per as possible cross at right angles where power cables are laid in proximity to communication cables the horizontal and vertical clearance shall not normally be less than 600 mm.

Insulation tapes of appropriate voltage and in red, yellow, and blue colors shall be wrapped just below the sockets for phase identification.

All the excavation and back fill including timbering, shoring, and pumping required for the installation of the cables shall be carried out as indicated on the drawing and as per requirements laid down elsewhere or as per Construction manager/Consultant direction. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layers not exceeding 150mm. At each layer compaction test shall be carried out in presence of Construction manager/Consultant Each layer shall be properly rammed and consolidated before laying the next layer. The contractor shall restore all surfaces, roadways, side walls, curbs, walls, landscaping or other works cut for excavation to their original condition, the satisfaction of the Construction manager/Consultant. Suitable approved type cable markers shall be installed along the cable route & wherever change of direction takes place.

Cables Installed Inside the Building

The cables inside the building shall be installed in one of the following manner, as indicated in the drawing and approved by the Construction manager/Consultant.

Installed in Built-up Trench

The cables laid on the bottom of the structural trenches shall not lay freely upon the trench bottom. They shall be raised to prevent the possibility of their coming into contact with deleterious materials.

The cables laid in the trench shall be laid on angle iron brackets/cable tray/cable ladder/cable troughs/cable racks as indicated on the drawings, and as approved by the Construction manager/Consultant. Where cables are clamped to the wall a minimum clearance of 100mm shall be maintained between wall and cable and minimum 150mm vertical clearance shall be maintained between two cables. Where cables are laid on brackets the brackets shall not be fixed more than 500mm apart to avoid sag in the cables. Where the cables are laid on cable

tray/ladder/troughs /racks, minimum 300mm distance shall be observed between adjacent tier of tray/ladder/troughs/racks, and cable shall be fixed minimum 25mm away from the wall, and minimum of one cable diameter distance shall be observed between two adjacent cables. Cables shall be properly fixed with the tray/ ladder/troughs/ racks with cable tie or saddles or straps.

Cables on Cable Trays/Ladders under the Ceiling or on Wall

Where cables are installed under above suspended ceiling or below ceiling or on wall, they shall be laid on a ladder/perforated G.I. cable tray and shall be run in such positions that they are not liable to be damaged by contact with the floor or the ceiling or other fixtures.

The ladder/perforated cable tray shall be properly fixed with channels, angles, tie rod, flats to the ceiling. The metal inserts for fixing channels, angles, tie rod, flats shall be put in place while casting the slab. If insert plates are not placed in position, Anchor fasteners shall be used to support cable trays if required. The cable tray route shall be co-ordinated with other services to avoid crisscross of all the services. While laying the cables on the tray minimum one cable diameter distance shall be observed between two adjacent cables about 20% space shall be kept spare for any future installation.

Cables Installed in the Mechanical Room

The cable reaching the motors in the mechanical room or plant room or machines room or service area shall be laid on cable tray except where indicated in masonry underground trenches.

The cable reaching the motors shall be protected by rigid galvanized conduits up to a height of 300mm above the floor. Above that height, the cable shall be protected by means of oil tight flexible metallic G.I. conduits to the terminal box of the motor. The connection between the rigid conduit and the flexible conduit shall be done by a screwed coupling of an approved type. The flexible conduit shall be properly fixed with the terminal box of the motor by means of double hexagonal check nut.

TESTS ON CABLE:

ROUTINE TESTS

The following tests constitute Routine Tests , which are carried out on each and every length of cable before it leaves the factory .

A. Conductor Resistance Test

This test ensures that conductor resistance is within the specified limit , thereby verifying that the continuity of conductor is maintained throughout the cable length and that the conductor has the required electrical section . D.C. resistance is measured at room temperature and is then corrected to standard reference temperature of 20 dg C .

B. High Voltage Test

This test ensures that insulation will safely withstand the rated voltage with permissible variation in normal operation.

TYPE TESTS

These tests are carried out on samples taken from each production lot. They are carried out to prove conformity as regards the general qualities and design to the specification of particular type of cables.

ACCEPTANCE TEST

These tests are again carried out in the presence of the concerned inspecting authority for testing , approval and release of material offered for inspection.

The above tests must be conducted at site in presence of Consultant's/Client's representative. Test certificates of the above tests shall be approved by Client/Consultant. The test results shall be recorded on prescribed forms. The test certificates for the test carried out at site shall be submitted in six copies to the Construction manager/Consultants for approval.

H.T. CABLES GENERAL

HT 33 KV XLPE cables shall in all respects conform to IS 7098 part II. Storage handling, installation / method of laying testing loops mechanical protection jointing and termination etc. shall be as per CPWD General Specifications for Electrical Works (Part II External) 1995.

The cables shall be tested and commissioned in accordance with Drawings, Specifications, Indian Standard Specification IS : 1255 – 1967 and cable manufacturers instructions. The cables shall of reputed make.

The recommendations of the cable manufacturer with regard to jointing and sealing shall be strictly followed. The installation of cable shall be done by an approved, qualified and experienced person in this trade.

MATERIAL:

The H.T. cables shall be 33 KV, aluminum conductor CROSS LINKED POL YETHYLENE steel tape armoured cable laid underground and or in RCC hume pipes as shown on Drawings. The conductor shall be made of Electrical purity aluminum wires and stranded together and compacted. The cable shall be 3 Core type. The insulation shall be of high quality cross linked polyethylene applied by extrusion process. Both conductor and the insulator are provided with shielding made of same Conducting compound. Armoring is applied over inner sheath and shall be of flat steel strips. The outer sheath shall be of heat resisting Tropodur (PVC) compound. This shall be black colour.

CABLE TERMINATINS :

Cable termination shall be done in terminal calve box using cable glands and the cable ends sealed with sealing compound. The cable boxes of transformers shall be filled with bituminous compound of approved make.

LAYING OF CABLES:

H.T. cables shall be laid either buried directly underground or RCC pipes. The cable buried underground shall be at minimum depth of 1.2 mtr. from the ground level. Sand cushion of not less than 80mm shall be provided both above and below the cable with a protective concrete slab on the top of the sand layer. The cable trench shall be back filled and compacted.

PROTECTION OF CABLES:

The cable shall be protected by placing precast reinforced 50mm, thick (1:2:4) concrete slabs 200mm wide on the top layer of sand for the length of the cable. Where more than one cable is running in the same trench the concrete blocks shall be cover all the cables and shall project minimum 80mm on either side of the cables.

Cables under road crossing and any surface subjected to heavy traffic, shall be protected by running them huge pipes of suitable size.

TEST ON CABLES:

The cable shall be type tested and routine tested in accordance with IS-7098 (Part – II) 1985.

The following tests shall be carried out as routine tests on every length of cables

- a) Conductor resistance test
- b) Partial discharge test
- c) High Voltage test

TEST VOLTAGES

The test voltage shall be applied between conductor and screen/armoured.

VOLTAGE RATING OF CABLES

TEST VOLTAGE

19/33 KV (E) cable

48 KV (rms) for 5 Minutes

The above tests must be conducted at site in presence of Consultant's/Client's representative. Test certificates of the above tests shall be approved by Client/Consultant. The test results shall be recorded on prescribed forms. The test certificates for the test carried out at site shall be submitted in six copies to the Construction manager/Consultants for approval.

G.- CABLE TRAY SPECIFICATION :

The trays shall be made of 2mm thick (upto 500mm width) & 3mm thick(above 500mm width) perforated sheet having minimum 75 mm depth. The width of perforation shall be maximum 10mm spaced at maximum 20mm distance. The width of the cable tray shall be selected so as to accommodate required number of cables to be laid on it, with minimum separation of minimum one cable diameter between two adjacent cables. The cables shall be tied with the cable tray with nylon strip/ Aluminium clamps/GI clamps. The cable trays shall be GI perforated / powder coated(thickness of powder coating shall be up to 50 microns).

All steel work shall be treated in accordance with the following procedure and in accordance with IS : 6005 "Code of Practice for Phosphating Iron and Steel".

After completion of fabrication work, complete fabricated structure shall be thoroughly cleaned to remove traces of grease, rust, scale and dust. The seven tank process for treatment of fabricated structure shall be used. After preparation of fabricated surfaces, the panel shall be powder coated with synthetic enamel paint up to 50 microns thickness.

The finished panels shall be dried in storing ovens in dust free atmosphere to ensure fine quality finish. The paint shall be Berger Luxol Higloss, with siemens gray color for inside outside .

Finish powder coated surface of steel shall present an aesthetically pleasing appearance free from uneven surface.

The finish powder coating shall be as per ISS or as approved by consultants.

GI PERFORATED / LADDER TYPE CABLE TRAY –

The cable tray shall be fabricated out of slotted/perforated MS sheets as channel sections, single or double bended. The channel sections shall be supplied in convenient lengths and assembled at side to the desired lengths. These may be galvanised or powder coated to the desired lengths. Alternatively, where specified, the cable tray may be fabricated by two angle irons of 50mm x 50mm x 6mm as two longitudinal members, with crosses bracings between them by 50mm x 5mm flats welded/bolted to the angles at 1 m spacing. 2mm thick MS perforated sheet shall be suitably welded/bolted to the base as well as on the two sides.

Typically, the dimensions, fabrication details etc. are shown in CPWD General Specification for Electrical Works - Part II -External, 1994.

The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scraped and removed before the installation.

The maximum permissible uniformly distributed load for various sizes of cables trays and for different supported span are as per CPWD General Specification of Electrical Work Part II -1994. The sizes shall be specified considering the same.

GENERAL

The width of the cable tray shall be chosen so as to accommodate all the cable in one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100mm. The overall width of one cable tray shall be limited to 800mm.

Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice. (Details are typically shown in figure3) of CPWD General Specification of Electrical Work Part II -1994. The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

The cable tray shall be suspended from the ceiling slab with the help of 10mm dia MS rounds or 25mm x 5mm flats at specified spacing as per of CPWD General Specification of Electrical Work Part II -1994. Flat type suspenders may be used for channels upto 450mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angles 50mm x 50mm x 5mm at the bottom end as specified. These shall be grouted to the ceiling slab at the other end through an effective means, as approved by the Engineer, to take the weight of the cable tray with the cables.

The entire tray (except in the case of galvanised / powder coated type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

The cable tray shall be bonded to the earth Terminal of the switch bonds at both ends.

The cable trays shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross joints, etc, and paid for accordingly.

STATUTORY APPROVALS

All statutory approvals from electrical inspectorate, MP regulatory board and MPEB are to be obtained by the electrical contractor for which no extra cost will be payable. However the contractor shall be reimbursed with all required deposits made in the govt. treasury for the said purpose against production of treasury challans . The work also includes getting MPEB connection sanctioned of up to 4000KVA from MPEB .

HT SUBSTATION ERECTION

a) OUTDOOR 33KV YARD

Complete outdoor type 33KV HT yard is required to be installed in premises. The preliminary details which are required to be taken care of by contractor are:

- i) Preliminary consent from MPEB for location of yard.
- ii) Preliminary consent for sanction of required KVA
- iii) Availability of necessary clearance with respect to adjacent building structures
- iv) Drawing details are in line with Electrical Inspectors/IE rules guidelines

Upon ensuring above, installation work HT yard shall be started as per following details:

a) The vertical member of HT yard shall be of JINDAL/SAIL make first quality, joint less 'H'-BEAM. These beams shall be straightened on ground first to ensure removal of all bends etc. A base plate of 500mmx500mmx10mm thick MS plate shall then be fully welded to the bottom of each beam. Each such plate shall also be supported by 4 nos gusset plates of 10mm thickness as per details given in drawing. These vertical members then shall be provided with MS angle 65mmx65mmx5mm supports welded at each location where horizontal channels are to be installed. Additional supports for GI earthing of structure and copper earthing of lightning arrester shall be provided on this vertical member.

b) The supports for installation of danger plate, anti climbing barrier are also to be welded on these 'H'-BEAM. On completion of above work complete derusting of beams are to be carried out. Two coats of red oxide paint are to be applied on complete area. The lower 2.5 mtr height including base plate etc is to be painted with 2 coats of black bitumen for ensuring corrosion resistance of parts which are to be buried in ground.

c) Each horizontal member of HT yard shall be ISMC 100 (channel) of TATA/SAIL first quality. All these channels shall be cut to size, made with holes for mounting of devices and clamps. On finishing of these jobs, each channel shall be grinded and painted with two coats of anticorrosive red oxide as per above details.

d) Mounting of channels on erected beams shall be done with help of MS clamps made out of flat 60mmx6mm. All such mountings shall be done with high accuracy to ensure proper grip of beams. All hardware used for above shall be Zink pacivated high strength GKW/UNBRACO make. All bolts are to be fixed with locking washers and double nuts.

e) The AB switch shall be fixed on horizontal/vertical manner as per drawing. Each pole shall be tested for meggar value prior to installing switch on structure. The contacts of AB switch shall be checked and gressed with conducting electrical grade grease. The AB switch shall then be installed to structure with all clamping accessories, hardware, operating rod, operating handle, padlock arrangement and limit switch for safety cutoff and earthing handle.

f) The lightning arrester also shall be pre tested for insulation resistance test and high voltage test. On passing these tests LA are to be installed on top of structure, laying and connecting of copper strips on insulation supports and connection of LA with line through jumpers shall be done as per drawing and specifications.

g) The pin insulators are to be provided as per details of drawing after checking insulation value

h) The DO fuse housings are to be checked for IR value and then to be installed. Each housing shall be provided with 1A fuse initially and on commissioning and successful charging with rated fuses.

- i) The ACSR conductor of specified size shall be installed through Disc insulator / AB switch / Pin insulator / Do fuse / Pin insulator / Transformer.
- j) The transformer shall be installed on prepared foundation and assembly of following accessories are to be done.
 - i) Conservator, breather, silica gel case, radiators, explosion vent diaphragm.
 - ii) Wiring of WTI/OTI/BUCHOLZ RELAY / any other safety device with main electrical panel
 - iii) Connection of neutral points with earth pits as per details.
 - iv) Connection of transformer body to earth pits as per details
 - v) Connection of power cable as per details
 - vi) On completion of installation following test shall be carried out :
 - Meggar value test with 1 KV meggar
 - Functional test
 - vii) Complete yard then shall be offered for inspection of electrical inspector and permission of charging shall be obtained on compliance of all points.

IS SPECIFICATIONS

The following Indian Standard Specifications revised as on date will apply to the equipment and contract.

a. Switch fuse units on cubicle switch boards	IS 4047	1967
b. Switchgears Bus Bars	IS 375	1963
c. Distribution boards	IS 2675	1966
d. Enclosure for low voltage switchgears	IS 2147	1962
e. PVC cables	IS 1554	1964
f. tubular filament lamps	IS 2410	1963
g. Tungsten filament lamps	IS 415	1963
h. Ceiling fans	IS 374	1966
i. Industrial light fittings	IS 1771	1961
j. Water tight electric light fittings	IS 3553	1966
k. Steel boxes for enclosure of electrical accessories	IS 5133	1966
l. Fittings for rigid conduits	IS 2667	1964
m. Rigid steel conduits for electrical wiring	IS 9537	1984
n. Accessories for rigid steel conduits for electrical wiring	IS 3873	1966
o. Switch socket outlet	IS 4615	1968
p. Three pin plugs and socket outlet	IS 1293	1967
q. Switches for domestic and similar purpose	IS 3854	1966
r. PVC wires	IS 694	1964
s. Call bell and buzzers	IS 2268	1966
t. Earthing	IS 3043	1966
u. Electrical wiring installation	IS 732	1963
v. Switchgears	IS 3072	1965
w. Lighting protection	IS 2309	1969

Indian electricity rule 1956 amended as on dat

INSTRUCTIONS FOR CARRYING OUT ELECTRICAL INSTALLATIONS

1. The Contractor will have to bring all the necessary and proper tools and tackles for carrying out the work.
2. The work is to be carried out alongwith the progress of civil works .
3. All jumpers and connections of ACSR conductor or aluminium busbar are to be taken out by means of Proper clamps ,tees , lugs only.

4. Jointing of copper strips shall be done by brazing or by way of butt jointing, bolt, nut, washer used for jointing shall be either of brass/GI. The size of bolt shall be approved by Engineer-in-charge / Architect.
5. All precautions during slab works shall be taken by contractor to safeguard electrical pipes.
6. Interlocking, interlocking between air break switch and respective LT breaker shall be done both electrically or mechanically as required, Contractor shall include the case of interlocking in installation of HT VCB, isolators, AB switch and LT A.C.B./O.C.B./M.C.C.B
7. All materials including civil materials required for electrical items are in the scope of this contract.
8. All material to be supplied by the Contractor must be from approved quality, make and must be got/approved by Engineer-in-charge/Architect before use.
9. The Contractor shall follow all the rules and regulations like factory act, workmen compensation act and shall be responsible for any injury or accident to persons working at site.
10. The work is to be carried out as per the Indian Electricity Rules & Standard code of practice and other relevant specifications. Workmanship shall be to the satisfaction of the Engineer-in-charge/Architect. Preference to the work/items shall be given as per requirement of Employer and site situations.
- 11.a: The installation shall have to be approved by Electrical Inspector/M.P.E.B./MP regulatory board and/or any other local authorities, if required and such approval shall have to be arranged by Contractor. Any alterations, additions suggested by them shall have to be incorporated by the Contractor, cost of which shall be considered included in scope of this tender.
- b: After getting permission of charging from Electrical Inspector's office it is duty of Contractor to follow-up for installing energy meter and getting line charged from MPEB as early as possible. All follow-up expenses shall be considered included in offer.
12. The Contractor shall keep at site of work one engineer having bachelors degree in electrical engineering from recognized university for receiving instruction and shall have to give satisfactory progress of work. The contractor will have to obtain prior approval of EIC by submitting the credentials of the electrical engineer he propose to appoint on site of work. Even during execution if EIC/Architect feels that the said engineer appointed by contractor has failed to perform his duties satisfactorily, they can instruct the contractor to appoint another engineer and contractor will have to comply it immediately.
13. If any part or whole of the work or any item is not executed to the entire satisfaction of the Engineer-in-charge/Architect. The Contractor shall have to demolish and do the same work again with out any extra cost if so ordered by the Engineer-in-charge/Architect.
14. The place after any work is completed should be cleaned by the Contractor. Breaking of walls, slabs, roads etc. necessary for laying cables, conduits drawing of cables/wires etc. and making them good to original position will have to be done by the Contractor through skilled workers.
15. The measurement will be taken jointly in presence of Consultants/AKVN authorized representative at site.
16. No joint shall be allowed in I-section, MS channel.
17. Whatever material/equipment's supplied by the Contractor, he has to supply 4 sets of test certificates from the manufacturers, like lightning arrestor, AB switch, DO fuse, electrical control panel, sub distribution boards, ACB, OCB, MCB, MCCB, earth fault relay/earth leakage relay, ELCB, transformers, wires, cables and other item etc.
18. The quantities as shown in the Tender are for guideline only.
19. On the completion of the work the Contractor shall supply free of charges, completion plan in triplicate, in blue prints and also in original drawing on tracing cloth. Insulation and earth test report of the Internal and

External electrification installation shall be supplied in 3 copies. These shall be handed over to the Consultant in good condition by the Contractor before the finalization of his final bill.

20. Meter connection, MPEB's approval for sanction of power and DG set, Electrical Inspector's approval for HT yard and DG set, MP regulatory boards approval for DG sets is included in scope of contract and all such work shall be completed by contractor within time without any extra cost however all legal fees deposited by him shall be reimbursed by employer against production of treasury challans.

21 All materials brought at site shall be as approved by Consultant and if desired so contractor shall arrange for testing of materials at laboratory (ERDA, Baroda) for any electrical parameter checking. All such expenses shall be borne by contractor and are included in quoted rates.

22 General repairs should be done before completion of work.

23 Guarantee period for all work/supply and complete installation (without tube light and lamp) will be of one year or more from date of completion of work as per manufacturer guarantee.

24 Preparation of final drawing of DG sets, transformer /HT yard layout based on drawings given by consultants and getting approval from state electricity board and office of chief electrical inspectors office to charge transformer is included in scope of contractor. work also include obtaining complete permission /approval including site visits of officials. All work to be arranged by contractor and liaisoning charges/expenses for above work shall be included in tender cost. Final permission without pending work remark shall be submitted to Employer. Calibration of meters / CTs from state electricity board will also be responsibility of contractor and no extra payment for these works shall be payable. Only those Challans/bills (which are submitted in treasury) for Electrical Inspectors office, MPEB office will be reimbursed by employer against production of original challans to employer.

TESTING AND COMMISSIONING

Before the lighting/power installation is made alive the Contractor shall carry out tests enumerated below in presence of Engineer-in-charge or his authorized representative. All testing equipments necessary to carry out the tests shall be arranged by Contractor and the tests results recorded on approved proforma. Nothing extra shall be payable for testing.

1. Before energizing, measure insulation resistance of the cable from phase to phase and that from phase to ground, Insulation resistance of the busbars at the lighting panel from phase to phase and from phase to ground shall be measured before energizing the panel and should comply latest IS.

2. Current and voltage of all phase shall be measured at the lighting panel busbars with all circuits on with fixture and also in all switchboard.

3. Check the earth continuity for all sockets outlets. A fixed relative position of the phase and neutral connection inside the socket shall be established for sockets.

4. The earth electrodes shall be tested for earth resistance by means of standard earth tester. The resistance between the earthing system and the general mass of earth shall not be greater than 1 ohm.

5. While crossing the expansion joints in building conduits shall be provided with flexible pipe shall not be more than 250 mm, at both the ends of conduit proper flexible couplings shall be provided and earth wire shall be properly connected to earthing terminal of coupling.

6. Contractor should quote after site visit only. In case for cable trench, street light pole pit, earthing pit etc. or any place where Contractor has to dig the earth in hard strata or rock he has to do so at quoted rates only for item. No blasting shall be allowed for such digging.

7. For earthing of street light tubular pole 8 SWG GI wire as per standard specification is used.

8. Testing / Commissioning Of Conduit Wiring

Before the lighting /power installation is made alive the contractor shall carry out tests enumerated below in presence of Engineer – in – Charge or his authorized representative. All testing equipments necessary to carry out

the tests shall be arranged by contractor/the tests results recorded on approved proforma . Nothing extra shall be payable for testing.

g. Measure insulation resistance of each circuit without lamps being in place / it should not be less than 5 megaohms to earth.

h. Current / voltage of all phase shall be measured at the lighting panel busbar with all circuits on with fixture /also in all switchboard.

i. Check the earth continuity for all sockets outlets. A fixed relative position of the phase /neutral connection inside the socket shall be established for sockets.

j. Load Balancing – Balancing of circuits in three phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

k. Fall of potential – The drop in pressure between the main switch terminals and the farthest current consuming apparatus will not exceed 2% with all devices switched ON. The number of points controlled per circuit shall be as per I.E . Rules if not specified particularly.

l. Ratings : For purpose of determining sizes of sub mains and controlling switches , the following ratings for points shall be assumed.

i) Ceiling Light Point - 100 Watts.

ii) Conveyance plug points - 100 watts.

iii) Fan Points - 60 watts.

iv) Domestic power plug - 250 watts.

Cable Identifications : For multicore cables , PVC ferrule type indicators or tags shall be provided at both ends for core identification. For phase identification pf 2,3,3 ½ cables coloured PVC tags shall be used at both ends.

All cables shall be provided with aluminium tags of approved design , spaced not less than 10 meter apart and these shall contain the following information.

Feeder no.

Size

No. of cores.

h. Under ground cables : Cables shall be so laid that they will not interfere with other underground structure. All water pipes , sewage line or other structures , which become exposed by the excavation ,shall be properly supported and protected from injury until the filling has been rammed solidly in places under and around the . Any telephone other cables coming in the they are to be properly shieled as directed by the Clients . Hume pipe for crossing shall have to be sealed at both ends after cable laying and testing is completed .

TECHNICAL SPECIFICATION FOR 750 KVA SIELENT TYPE DG SET

9.0 INTENT OF SPECIFICATION:

9.1 This specification covers the design, manufacture, assembly, shop testing, packing, dispatch, transportation, unloading and shifting , supply, erection, testing, commissioning, performance and guarantee testing of **Diesel Gen-Sets** at Site complete in all respects with all equipment, fitting and accessories for efficient and trouble free operation as specified here under.

9.2 SCOPE OF WORK:

9.2.1 Scope of Supply & Services:

General Scope of this work shall include but not limited to the following:-

- a) DG set including diesel engine complete with all auxiliary and accessories, separately excited Alternator directly coupled to the engine through flexible/ rigid coupling complete with all accessories for starting, regulation and control, including common base frame, interconnecting piping and accessories, power and control cable glands and lugs.
- b) DGs local (Engine mounted) control Panel complete with interfacing cables between Owners Local/Remote control panel and bidders local equipments including special cables if any. (for caterpillar engines EMCP , for Cummins PLC 3100)
- c) Equipments necessary for fuel storing and distribution including day oil tank, piping, valves, calibrated 990 liters MS tank along with level switch and float with 2 NO/ 2NC contacts for remote use.
- d) Flexible connections, Expansion joints, Residential type silencer, exhaust system including piping, support and thermal insulation for total exhaust system.
- e) Starting batteries with painted Teak wood battery stand, and battery charging equipment, including their connections as required along with tools & accessories for battery maintenance.
- f) Set of Anti Vibration Mountings pad etc.
- h) Properly machined common base frame with grouting bolts & Silent Canopy complying to CPCB norms.
- i) Operation and maintenance of DG set shall be undertaken by local authority.

Note : Item Nos. b), d), f), g) and h) shall be quoted as part of D.G. Sets and other separately.

- i) Preparing all related shop drawings for approval from client/consultant and statutory bodies. e.g. a) Permission for installation, b) Pollution control body, c) Electrical Inspectorate.
- j) Obtaining approval of the installation of Diesel Generators by Supply Authority, the Electrical Inspectorate and Pollution Control bodies and any other statutory bodies for operation of DG Sets.
- k) Minor civil works like chasing, grouting etc, for execution of jobs.
- l) Carrying out performance and guarantee test as required.

9.2.2 Specific Exclusions:

Following items of works are excluded from the scope of works under this specification:

- a) All major civil works relating to DG foundation etc.

9.3 CODES AND STANDARDS:

1.3.1 The equipment supplied under this specification shall conform to the latest issue of relevant standards, except where modified or supplemented by this specification.

IS: 5 : Colours for ready mixed paints.

IS: 1239

(Part-I & II) : Mild steel tubes and fittings.

IS: 1248	:	Specification for electrical indicating instruments.
IS: 1600	:	Code for type testing of constant speed IC engines for general purposes.
IS: 1601	:	Performance of constant speed IC engines for general purposes.
IS: 1651	:	Stationary cells and batteries lead acid type (with tubular positive plates).
IS: 2147	:	Degree of protection provided by enclosure for low voltage switchgear and control gear.
IS: 3231	:	Specification for Electrical relays for power system protection.
IS: 4540	:	Mono-crystalline semi-conductor rectifier assemblies and equipment.
IS: 4722	:	Rotating electrical machines.
IS: 7372	:	Lead acid storage batteries for motor vehicles.
IS: 10100	:	Methods of tests for internal combustion engines.
IS: 10102	:	Specifications for performance requirements for constant speed compression ignition (Diesel) engine for general purposes (above 20 KW)
IS: 12065	:	Permissible limits of noise level for rotating electrical machines.
IS: 12075	:	Mechanical vibration of rotating electrical machines.
IS: 13703	:	Low voltage fuse for voltage not exceeding 100V AC or 1500V DC.
IS: 13947	:	Low voltage switchgear & control gear.
BS: 5000 (Part –3)	:	Rotating electrical machines of particular type or for particular applications.
BS: 5514 (Part 1 to 6)	:	:Specification for reciprocating internal combustion engine.
ASME Power Test Code	:	Internal combustion engines.
PTC-17		

Codes of Diesel Engine Manufacturer's Association U.S.A.

9.3.2The installation work shall conform to Indian Electricity act and Indian Electricity Rules as amended upto date.

The fuel oil installation shall meet all statutory requirements of Explosive Department of Govt. of India as amended up to date. Any approval required from statutory authorities shall be obtained by the contractor. Nothing in this specification shall be construed to relieve the contractor of these responsibilities.

9.3.3The Indian standards mentioned above are available from:

Indian Standards Institution

Manak Bhavan

9, Bahadur Shah Zafar Marg,

New Delhi- 11 002, INDIA.

9.3.4The Indian Electricity Rules and the Electricity act mentioned above can be obtained from:

Kitab Mahal

State Emporium Building

Baba Kharak Singh Marg

New Delhi - 11 001, INDIA

9.3.5Equipment conforming to any other National/International Standard which ensures equal or better quality may be accepted. In such case the bidder shall furnish copies of the standards in English along with his bid and shall clearly bring out the salient features of comparison with corresponding listed standards.

9.3.6The equipments furnished under this specification have to operate in a tropical climate and shall be given tropical and fungicidal treatment as per relevant specification.

9.3.7Period of Operation/Duty Cycle:

The sets are intended to supply power upon non availability of grid power and shall be prime duty rated as standby supply and may be idle for long periods except for periodic routine checks once in a day. When there is a total failure of main power supply, the sets shall be required to operate continuously at full load for a period which at times may exceed even 24 hours.

9.4 ENGINE:

9.4.1Type:

The diesel engine shall be of stationary type four stroke with vertical in line or (V) type cylinder arrangement, Turbocharged, water cooled.

9.4.2Rating:

- a) Prime Power BHP rating of the engine shall be such that the DG set can continuously deliver the specified net electrical output while supplying power/driving all electrical and mechanical auxiliaries connected to alternator terminals and engine shaft at specified site conditions and ambient temperature of 45 deg C inside the DG room. Rating specified shall be Site rating.
- b) It shall also be capable of satisfactorily driving the alternator at 10% over load at the rated speed for one hour in any period of 12 hours of continuous running.

The successful contractor shall have to furnish :-

- i) Supporting calculations to arrive at diesel engine rating.
- ii) Short circuit calculation.
- iii) Back Pressure calculation.
- iv) Foundation details drawings.
- v) Fuel tank & piping layout.
- vi) Exhaust pipe layout up to chimney.

9.4.3Speed and Vibration Level:

- a) Speed shall be 1500 revolutions per minute. Speed governor/over speed protection shall be provided.
- b) At normal running conditions, speed shall be stabilized at plus or minus 2% nominal speed, regardless of load. At transient condition, engine speed shall vary not more than 10% plus or minus.
- c) The engine vibration / noise level shall not exceed 75 db when measured as specified in relevant specifications.

9.4.4 Lubrication System:

- a) The engine shall have a closed cycle forced & splash lubricating system with positive oil pressure and a crank chamber for collection/storage of the lubricating oil during circulation. No moving part shall require lubrication by hand or any other external source either prior to the starting of the engine or when it is in operation.
- b) The lubricating oil filter shall be suitable for replacement under normal operating conditions. The minimum operating life of filter shall be more than 250 hours without the necessity of its replacement or cleaning.
- c) In case lubricating oil coolers are required they shall be of the air cooled/water cooled type and shall be an integral part of the Diesel Generator Set.
- d) Necessary temperature and pressure gauges and other instruments shall be supplied and fitted on the lubrication system.
- e) A lubricating oil level dipstick suitably calibrated and shall be located in the accessible position.
- f) In case manufacturer recommends lube oil pump for intermittent priming, the same shall be provided by the bidder alongwith its controls.

9.4.5 Fuel System:

- a) The engine shall be capable of running and delivering rated load on all types of diesel normally available in India.
- b) The Guaranteed fuel consumption of the engine at full, three quarters and half of its rated power output shall be indicated by the Contractor in the bid. The guaranteed fuel consumption shall be established during acceptance load test at Site.
- c) A fuel day tank with 990 litres capacity shall be provided on a suitably fabricated steel platform. The tank shall be complete with level indicator marked in litres, filling inlet with removable screen, an outlet, a drain plug, an air vent and necessary piping. The fuel tank shall be painted with oil resistant paint. Fuel tank shall be provided with level controller with 2 NO and 2 NC contacts for alarm & trip shall also be provided by the bidder. All pipe joints should be brazed.
- d) A hand pump for pumping the fuel into the fuel day oil tank together with necessary pipes or tubing shall be provided. The inlet of the pump shall be provided with 15 metres long armoured hose with suitable filter.
- e) Fuel consumption should be observed in proportion with load and DG endor should offer guarantee while execution and during first 5 yrs of working.

9.4.6 Air Intake System:

The diesel engine shall be provided with special dry type air filters having low resistance to air passage, high dust retaining efficiency and provision for easy cleaning. Filters shall be suitable for achieving satisfactory engine operation and ensuring the engine life under tropical humid conditions, with sulphur dioxide and trioxide fumes, abrasive dust and coal particles of 5 to 10 microns present in the atmosphere. The minimum efficiency of filters shall be 90% down to 5 micron size.

9.4.7 Engine Exhaust System:

- a) Exhaust system should create minimum back pressure.
- b) The exhaust back pressure should be within the limits as specified by DG manufacturer. However, it should be within the limits suggested by engine manufacturers to suit performance of the engine. Calculation for back pressure shall be submitted by successful bidder.
- c) Use of thimble is must while passing the pipe through concrete wall. The clearance around the pipe and wall is must for free movement and expansion/contraction of piping.
- d) Exhaust piping inside the genset room should be lagged LRB wool of proper density alongwith aluminium sheet cladding to avoid heat dissipation to engine room. The thickness of lagging should not be less than 75mm. Exhaust piping shall be suitably supported and padded to avoid damage to thermal insulation.
- e) Exhaust flexible shall have its free length when it is installed.
- f) The exhaust outlet should be in the direction of prevailing winds & should not allow exhaust gases to enter air inlet/windows etc.
- g) There should be rain trap to avoid rain water entry. If rain cap is used the distance between exhaust pipe & rain cap should be higher than diameter of pipe. It is also recommended that horizontal run of exhaust piping should have slope downwards away from engine towards the condensate trap. Silencer should be installed with drain plug at bottom.
- h) Residential type silencer should be provided in the engine exhaust pipe. The design and location of the silencer shall meet the requirement of back pressure.
- i) The flue gases from silencer shall be taken out to atmosphere through metallic, thermally insulated and cladded chimneys. These chimneys shall be made from M S class „B“ piping system conforming to IS 3589. Required flexible bellows, bends, expansion joints, load support etc. shall be provided as required.
- j) The exhaust chimney shall be insulated with minimum 75 mm thick thermal insulated glass wool/mineral wool up to silencer. The portion between flexible connection to silencer shall be lagged with Asbestos rope. The insulation should be held in position using wire chicken mesh. 24 gauge aluminium cladding sheet should be wrapped over exhaust pipe starting from engine upto the chimney top.
- k) Calculation for chimney size selection shall be furnished for approval.

9.4.8 COOLING SYSTEM:

The diesel engine should be water cooled with Radiator system and suitable size for each DG Set.

9.4.9 engine Governor :

- It shall be 100% Electronic fuel controller with electronic fuel injection system conforming to class A1 to BS:649 and shall be a self contained unit capable of monitoring speed. It shall be suitable for remote operation.
- Governing Performance
- Frequency Regulation Isochronous under varying loads from no load to full load.
- Frequency Drift $\pm 0.5\%$ drift for a 60 F (33 °C) change in ambient over 8 hours with temperature stabilization at both points.

9.4.10 Turbo Charger :

It shall be of a robust construction, suitable of being driven by engine exhaust having a common shaft for the turbine and blower. It shall draw air from filter of adequate capacity to suit the requirements of the engine.

9.4.11 Quietness of Operation:

- a) The engine shall be designed to achieve maximum quietness of operation.
- b) Efficient residential silencer shall be provided for the exhaust as well as the air intake.
- c) Noise level of the set shall be within the limits specified in relevant specifications (to be specified by bidder).
- d) Engine vibration level shall not exceed the limits specified in the relevant specification. (It is desired that vibration level do not exceed 250 micron peak to peak). (To be specified by bidder)

9.4.12 Engine Starting:

a) Engine starting shall be by electric starting motor complete with manual/automatic starting arrangement. The starter motor shall conform to IS-4722 and IS-325 and shall be of adequate power for its duty and be of inertia or pre- engaged type. The pinion shall positively disengage when the engine starts up or when the motor is de-energised. The engine cranking shall be only from the panel both for AMF & DG sets (Manual) and any engine starting devices etc, that are given as original fitment on the engine by engine manufacturers shall be either removed or padlocking arrangement given for this so that all normal start/stop operations could be done only from panel whether the set is AMF or manual.

The engine wiring shall be appropriately modified, ferruled to totally match with schematic drawings of the panel.

b) Time for Run-up to Speed:

From the initial operation of the starting device, the engine shall start, run up to normal speed and be capable of accepting 80% of full load within a maximum time of 25 seconds, and full load within 5 seconds thereafter.

9.4.13 Starter Battery:

a) The battery shall conform to the requirement of IS-7372. Starting battery sets of 24 V, heavy duty high performance approved make/quality shall be provided to enable crank & start the engine even in cold/winter morning conditions. Type/ voltage/AH capacity of same on 20 hour rated discharge period shall be indicated in the offer. The battery shall be capable of performing at least (6) six normal starts without recharging.

b) The Battery shall be provided with good quality teakwood stand painted with acid proof black paint with min 3 mm thick rubber mat below the battery.

c) Batteries shall be of lead container type only and not with PVC moulded sealed container so that each individual cells are available for individual monitoring during its life span. Each cell shall be provided with electrolyte filling cap with level floats for easy monitoring of electrolytic level.

d) For each battery system following accessories shall be provided :-

1. PVC Funnel
- 1 No.
2. Small PVC mugs with handle - 2 Nos.

(Red & white colour)
3. Hydrometer syringe type with float calibrated (not with zero markings only) with one spare float.

4. Centre zero voltmeter good quality with 3V-0-3V scale.
 5. PVC jerry-can white colour with tested quality distilled water, with can clearly arked with engraved PVC inscription plate "Distilled Water".
 6. One tin of petroleum jelly (500 gms).
 7. Painter brush 1" wide - 2 nos.
- e) The battery shall be provided with 2 nos. cables, min 1.5 m long heavy duty rubber/PVC insulated cabling with brazed tinned lug at one end and with brazed tinned brass terminal lug at battery end - for connecting batteries to cranking system - with 0.25 m long inter battery connecting cable.
 - f) The lugs shall be clearly stamped + or - and positive cable also red sleeved for easy identification.
 - g) The batteries shall be supplied fully filled and first charged ready to use.

9.4.14 Battery Charging System:

- a) Float cum quick charging system shall be provided at the DG Aux. panel with appropriate charger system, LC network, rate selector switch and generously rated charging transformer and silicon rectifier bridge, so that the cranking battery system can be kept fully charged at all times from E.B. supply network with quick charging rate limited to 0.8 times rated discharge current with provision in control transformer and Si rectifier present to enable boost charging the battery at 2 times rated discharge current in case of emergencies. To this and in the mode selector switch boost charge position shall be present which however shall be kept disconnected at mode selector switch normally.
- b) DC ammeters to clearly indicate float charging current and quick/boost charging current shall be provided.
- c) The float charging ammeter circuit logic shall be so as to bring in ckt only on demand through a P.B. provided the R.S.S. (Rate selector switch) in its float charging mode to prevent damage to the ammeter.
- d) Dropper resistor network on the load side of battery charger system shall be provided so that higher charger voltages in quick or boost conditions does not get impressed on the I/L and contactor coils, which voltage shall remain well within +1% of rated voltage.
- e) Battery charging subsystem shall be designed for continuous operation at cubicle ambient of 50 deg C corresponding to 45 deg C ambient outside and should be designed to operate at 1.5 times rated maximum current corresponding to boost charge current which can reach in practice as high as 2.5 times or 3 times rated discharge current.
- f) Any charger dynamo and dynamo charging current network present on the set shall either have to be removed or made inoperative so that both for AMF and manual application the cranking battery system is kept charged from the charger at the panels at all times during or shut down periods of the set.
- g) To the above and in case of manual DG Sets, the input to charger subsystem i.e., 240 V AC is foreseen to be provided from customer network from the portion that is normally supplied by manual DG Set during DG operation or being fed by E.B. System.

9.4.15 Engine Fitments:

The engine shall be provided with but not limited to following essential basic fitments.

- | | |
|-----------------------|--------------------------------------|
| - Crank case breather | -Dry type element. |
| - Air cleaner | -Dry type mounted |
| - Corrosion resistor | - coolant concentrate pre mix cooled |

- Lubricating oil cooler
 - Filters
 - Coolant Pump
 - Fuel Pumps
 - Governor
 - Turbo charger-Exhaust gas driven in case of turbo charged engines.
 - Flywheel with flywheel housing
 - Flexible coupling
 - Vibration dampers
 - Exhaust/Intake manifolds
 - Oil sump (crank case) with dip stick
 - Engine supports
 - Residential type silencer in exhaust system
 - Electrical starter 24 V
 - Safety controls & instruments
- - Lub oil & fuel oil, paper element type.
 - Priming & transfer
 - Electronic type as specified
 - SAE type
 - Spider type
 - One set

9.4.16 Engine Instrumentation:

The following instruments mounted on instrument panel shall be essentially present as minimum.

- Engine speed tachometer with service hour counter
- Lub oil pressure gauge
- Cooling water temperature gauge

The instrument panel shall be mounted on engine using rubber dampers for vibration isolation.

The metering shall be electronic digital type.

9.5 ALTERNATOR:

9.5.1 The alternator shall be burshless type with rotating field and static excitation circuit (separately excited PMG, MX 321 of Stamford or Leroy Somer make) controlled by field control unit suitably compounded for voltage and load current.

9.5.2 The alternator shall be in SP-DP enclosure, foot mounted with ball and roller bearings on end shields.

9.5.3 The alternator shall conform to IS:4722/BS:2613 and shall be suitable for tropical conditions. The rating of the alternator shall be designed on the basis of 45 °C Ambient inside the DG room.

9.5.4 The alternator shall comply with the following specifications:

9.5.4.1 Rating (site) 750 kVA (Prime duty type) as specified ready to use with AMF
(Auto main failure) (shall be capable of 10% over loading at the rated speed for one hour for every 12 hours continuous running).

Voltage	415 V
Speed	1500 RPM.
Frequency	50 Hz.
P. F.	0.8 lag
Enclosure	IP: 23.

Insulation H (shall be of glass bonded epoxy thermosetting type but temperature rise limited to class 'F').

Excitation Self excited, self regulated with brushless system and static Voltage control unit suitably compounded for voltage and current to maintain terminal voltage constant at 415V ± 5% at all load for p.f. not less than 0.8. lag

Terminal Box shall be suitable for 4no.X3.5cx300 sqmm ALUMINIUM AR XLPE Cables.

9.5.5 Neutral Point:

The winding of the alternator shall be star-connected and the leads shall be brought out to a separate terminal box. Space provision for neutral CT for REF protection shall be provided as required.

The C.T. Parameters will be as below:

1.5.5.1 Ratio : 800/1A (for 500 kVA DG Set)

Class : PS

9.5.6 Terminal box and Connection:

The alternator output terminals shall be enclosed in a terminal box mounted in an accessible position on the alternator frame. As far as possible, connections between the exciter and alternator shall be contained within the machine frame and connections carrying A.C. and D.C. shall be segregated from each other. The terminal box shall be of sufficient size to conveniently terminate 800 amp TPN Al Bus Bar .. which shall be intimated during detailed engineering. Suitable tinned copper pads shall be provided for bus bar termination along with all necessary hardware . Glands and lugs shall be provided for control cables also. For single phase cables, gland plate shall be of non-magnetic material. Gland plates shall be removable type.

9.5.7 The generator shall be complete with voltage transformers necessary for AVR reverse power protection. The VT ratio shall be 415/110 V.

— —
 $\sqrt{3}$ $\sqrt{3}$

9.5.8 The generating set shall be so designed that it is capable of reaching its full voltage and frequency and shall be ready to take full load within 30 seconds of a remote starting impulse being received. It shall be capable of starting the motor load over & above base load as given below.

Rating (KVA)	Base load (KW)	Starting motor over the base load (KW)
750	----	-----

Successful bidder shall submit calculation to prove above requirements.

9.5.9 Suitable space heaters shall be provided for alternators. These space heaters shall be switched on automatically when DG set is not running.

9.6 DIESEL GENERATOR CONTROL PANEL

C. ELECTRICAL PANEL

The electrical panel body will be fabricated out of MS sheet 14 / 16 SWG CRC sheet. Panel will be suitable for free standing floor mounting, indoor installation and dust & vermin proof. Control cables are ferruled for proper maintenance & wiring of panel. Detachable gland plates are provided. Suitable space for the cables out going and incoming termination.

The control panel will consist of the following:

1. 1no. of ACB **rated 1250A**, four pole, 65KA, 415V, draw out type, electrically operated make ABB/ L& T(U Power). / Siemens(3WL) as per approval of consultant / EIC . The protection scheme shall consist of, combination of SR15G release and the generator protection relay "MG30" of L&T make, relay with RS 485 port, also with shunt trip coil, Panel shall have following individual fault indications:

- a) 51V – voltage restrained time over current
- b) 50 – Instantaneous over current
- c) 50N – Instantaneous earth fault
- d) 49 - Thermal over load
- e) 59 – over voltage
- f) 81 – under / over frequency
- g) 27 – Under voltage
- h) Reset fault Push button, On / OFF push button with local and remote selection
- i) Aux contacts of breaker for future expansion 6 No + 6 NC

2. Bus bar Aluminum E91E grad with current density 1sqmm/0.8A, with 1250A capacity at 65KA, 415v fault level. Provision for incoming and outgoing cable terminations 300sq mm, 4 numbers ALAR XLPE cable with adequate space at each side.

3. Meters and indications

a) 95sqmm Ampere meter suitable scaled with selector switch with suitable CTs of class 1, and burden 15VA.

b) 95 sq mm Voltmeter suitable scaled with selector switch

c) 95 sq mm Frequency meter vibrating reed type.

- d) Indication lamps for generator ON and Breaker ON and RYB phases.
 - e) Indication of 3 phase power
 - f) Energy meter - make L & T quasar meter with RS 485 port.
 - g) P.F. meter
 - h) Low and High fuel level indications.
- 4.0 Other standard accessories to be accommodate in panel for engine and alternator as per design.
- 5.0 DOL starter for the drain and sump pumps with protections and power supply.
- 6.0 Required control cable duly tag with ferrule number shall be supplied with panel.
- 7.0 PLC 3100
- 8.0** Cable box extension to be provided for 800A TPN Aluminium Bus Duct.

9.7 TYPE TEST CERTIFICATES:

The bidder shall produce following type tests certificate of CPRI.

- a) Short circuit test at 41.7 KA fault level.
- b) Temperature rise test.
- c) Degree of protection test-IP55/IP54
- d) H.V. test.

9.8 FIRE INSURANCE APPROVAL

The bidder shall have TAC approval from Tariff Advisory committee ,CPPRI approval & copy of approvals shall be enclosed with bid.

9.9 INSPECTION

The Consultant's representative shall be free to inspect the equipment at several stages to be decided mutually. The equipment shall be dispatched only after the inspection & successful testing at manufacturers works.

9.10 DRAWINGS

Before starting the manufacture of the equipment, the successful bidder shall have to take approval from the Consultant. Any manufacturing done prior to approval or any change in specification shall be rectified by supplier. Minimum two sets of drawings sent for every approval & three sets shall be furnished after job completion.

9.11 OPERATION MANUALS

Three sets of operation manuals with the technical leaflets of the components used in the CPC & PBS are to be provided after completion of job.

9.12 PERFORMANCE GUARANTEE

All the equipments shall be guaranteed for 12 months from the date of commissioning.

9.13 APPLICABLE STANDARDS

The equipments covered under above specifications shall be designed, fabricated & tested in accordance with the applicable sections of the latest revisions of relevant Indian standards (IS) & all International Electro technical Commission's recommendations (IEC) As well as specifications given in this document.

The PCC & PDBS shall generally confirm to the requirement of the following standards amended up to date :

- a) IS-4237 General requirements of switchgear & control gear for voltage not exceeding 1000V

- b) IS-375 Arrangement of bus bars, main connection, auxiliaries & wiring.
- c) IS-2516 Requirement of the circuit breakers not exceeding 1000 V, selection & testing.
- d) IS-4047 Specification for heavy duty air break switches & fuses for voltages not exceeding 1000V.
- e) IS-2208 Specification for HRC cartridge fuse links up to 650V.
- f) IS-2507 Indian standards for current transformers (Part- I/II/III/IV)
IS-4201 Application guide for current transformers.
IS-2959 Specification for AC contractors of voltage not exceeding 1000V.
- g) IS-1822 Specifications for motor starters of voltages not exceeding 1000V.
- j) IS-5569 Electrical power connectors.
- k) IS-1336 Colour code recommendations for push buttons.
- l) IS-1248 Electrical indicating buttons.
- m) IS-4483 Preferred panel cutout dimensions.
- n) IS-2147 Degree of protection provided by enclosures for LV switchgears.
- o) IS-3072 Code of practice for installations & maintenance of switchgears for system voltages not exceeding 1000V.
- p) IES-439 Low voltage switchgear & control gear assemblies.
- q) IS-2032 Graphic symbols.
- r) IS-8623 Factory built assemblies.

9.14 ERECTION, TESTING, COMMISSIONING AND PERFORMANCE & GUARANTEE TESTS/PROCEDURE AT SITE:

9.14.1 Installation of DG Set :

The entire work of erection, testing and commissioning of equipment supplied under this package shall be carried out by contractor and performance and guarantee tests to be conducted at site are also included under the scope of this specification. For this purpose the contractor shall depute suitable qualified technical supervisor to site on advance intimation to the Owner along with all special testing equipment required for testing and performance and guarantee tests. The bidder(s) shall be responsible for the installation, testing, commissioning checks and performance & guarantee tests mentioned in relevant clauses of this volume and the checks recommended by the contractor. The contractor shall provide all tools, equipments and instruments required for installation, testing and commissioning.

The contractor shall ensure that the equipments supplied by him are installed in a neat workman like manner such that they are leveled, properly aligned and well oriented. The tolerances shall be established in Contractors drawings and/or as stipulated by the Owner.

All special tools and tackles and spares required for erection, testing and commissioning of equipment shall be supplied by the contractor.

Erection, testing and commissioning manuals and procedures shall be supplied, prior to despatch of the equipment.

The contractor shall ensure that the drawings, instruction and recommendations are correctly followed while handling, setting, testing and commissioning the equipment.

9.14.2 Commissioning Check Tests/Performance and Guarantee Test:

In addition to the checks and test recommended by the manufacturer, the contractor shall conduct the following acceptance tests to be carried out on one unit of each rating at Site. Rate for the load test shall be on per unit basis to enable owner to opt for load test on one unit of each rating or on all units.

a) Load Test/Performance Guarantee Test (At Site) :

The DG set shall be given test run for a period of 12 hours without exceeding the engine or alternator capacity followed by 10% overload for one hour as per specification and drawing. The supplier should make arrangement for load testing on load at site when site loads are ready to use.

This full load test is to be followed immediately by a 10% overload run for one hour. The performance of the engine, alternator and exciter shall be satisfactory at the end of this overload run.

At the end of the full-load run, and again at the end of the over-load run, tests for temperature rise and insulation resistance of the alternator as specified shall be taken.

During the load test half hourly records of the following shall be taken :-

- a) Ambient temperature
- b) Exhaust temp. when exhaust thermometer is fitted.
- c) Cooling water temp. at inlet and outlet point adjacent to the water output from the engine jacket.
- d) Lubricating oil pressure
- e) Speed

- f) Voltage, wattage and current output.
- g) Oil tank level
- h) Colour of exhaust gas
- i) At the end of load test guaranteed fuel consumption figures shall be established and deviation with actual and guaranteed figures to be ensured within permissible limit.
- j) Winding temperature.

b) Insulation resistance test for alternator:

Insulation resistance in mega-ohms between the coils and the frame of the alternator when tested with a 500 Volts megger shall not be less than 50 mega ohms.

c) Temperature rise test for alternator:

The temperature rise test of the alternator shall be carried out at the end of overload run of the D.G. Set. The procedure for temperature rise test shall be as follows:

"Just after overload test, the set shall be taken off for measurement of hot resistance of the alternator winding (stator and rotor) by using a suitable ductor. The cold resistance should also be measured before start of the DG Set. The temperature rise shall be computed by extra polation method".

d) Regulation Test:

The automatic and manual regulation of the alternator load at half and full rated load shall be tested for a nominal volts of 240 volts, between phase to neutral and at 0.8 p.f. to verify the requirements of voltage and frequency variation as per IS:4722.

e) Speed and Governing:

The speed of the engine shall be verified to ensure that it conforms to the requirement of BS:5514.

f) Vibrations:

The vibrations shall be measured during full load test as well as during the overload test and the limit shall be 10 microns.

g) Check of Fuel Consumption:

A check of the fuel consumption shall be made throughout the test run of full load and overload. This test shall be Verified thru Level Of Fuel in Fuel Tank.

h) Insulation Resistance of Wiring:

On completion of the engine tests, the insulation of each unit of local wiring in the control cubicles and other components of the engine set, shall be tested with a 500 V insulation tester. The insulation resistance shall not be less than one mega-ohm. between wires in a cable and engine set frame of cable sheath.

i) Functional Tests:

- a) Type of starting provided for the engine.
- b) Pilot and fault indication lamps.

j) Noise Level:

The equivalent 'A' weighted sound level measured at a distance of 1 meter horizontally from the base of any equipment furnished and installed under these specifications expressed in decibels to a reference of 0.0002 microbar, shall not exceed as per relevant standards.

Note : Tenderer shall specifically indicate the following guaranteed figures :-

- a) Fuel consumption - 50% - 75% - 100% load.
- b) Lube oil consumption.
- c) Engine vibration.
- d) Noise level.
- e) Winding temperature - 100% load.

**ACOUSTIC ENCLOSURE
(Shall be meeting the CPCB norms for testing & commissioning)**

1.0 CONSTRUCTION

- a) The container should be designed for easy access to serviceable parts.
- b) Modular construction for easy assembling and disassembling.
- c) Fabricated out of CACA sheet of 14 gauge. Base frame shall be made out of ISMC of suitable sections or made out of sheet steel minimum of thickness 5 mm pretreated for degreasing , phosphating , passivation with 7 tank process . All metal parts shall be powder coated for long lasting life & finish.
- d) The hardware shall be of high tensile grade i.e bolts of 10.9/8.8 grade. Hardware should be passivated.
- e) Fuel tank at the base of silent DG Set should have minimum 12 hours capacity. It should be provided with breather drain plug. The thickness of fuel tank should be minimum 3 mm.
- f) The fuel level shall be measured through a dip stick.
- g) There should provision for filling the fuel from outside as in the case of automobiles.
- h) Fuel tank shall be connected to engine with wire braided fuel pipes.
- i) Battery should be accommodated in a separate tray in the container.
- j) There should be provision for drain plugs for draining mobile oil/Diesel.
- k) The doors should be gasketed with high quality EPDM gaskets to avoid leakage sound.
- l) The door handles should be lockable type.

1.1 PAINTING

- a) The sheet metal components should be hot dip seven tank pretreated.
- b) To have long life of container it should be P.P based powder coated (inside as well as outside)
- c) Base frame should be epoxy coated when fabricated.

1.2 ACCOUSTIC ENCLOSURE

- a) Sound Proofing of enclosure should be done with quality rock wool/mineral wool confirming to IS-8183 of 96 Kg/M³ density.

- b) The rock wool/Glass wool should further be covered with fibre glass cloth/fibre tissue paper fire resistive and perforated powder coated sheet of 0.6mm thickness.
- c) Residential silencer shall be provided within the DG to control the exhaust noise.
- d) Interconnection between silencer and engine should be through stainless steel flexible hose/pipe.
- e) Attenuators should be provided to control sound at air entry to the container and exit from the container.

1.3 VENTILATION AND AIR CIRCULATION

The system shall be engineered to provide air inlet/exhaust acoustic louvers for efficient air circulation and shall have following special features :

- a) Adequate ventilation is to be provided to meet air requirement for combustion and heat removal.
- b) The temperature inside the enclosure shall not exceed 5-7dg C than the ambient temperature near air suction point.

1.4 ELECTRICAL

- a) The earthing point shall be isolated through DMC insulator mounted on enclosure.
- b) Control panel should be mounted in the container itself. All parameters should be visible from outside and all push buttons accessible easily.

1.5 GENERAL

- a) Engine carries warranty/guarantee of engine manufacturer for the DG set in the enclosure of Silent Diesel Generating Set.
- b) Emergency stop Push Button shall be provided outside the container.
- c) Minimum insertion loss shall be 25dB(A)
- d) Acoustic enclosure shall be approved from Central Pollution Control Board and Fire Nodal Office.

DATA SHEET FOR D.G. SETS

(To be filled by the Contractor)

S.No.	Description		750 KVA
1.0	Applicable Standards	:	BS 5514
2.0	ENGINE :		
2.1	Type	:	Furnished by the bidder
2.2	Make	:	As per List enclosed
2.3	Model	:	To be furnished by bidder
2.4	a) BHP	:	
	b) Output at site condition after derating at 45°C after deducting auxiliary power.	:	750 KVA
2.5	RPM	:	1500
2.6	No. of cylinder	:	To be furnished by bidder
2.7	Specific Fuel Consumption (Guaranteed)		

S.No.	Description		750 KVA
	a) Full Load	:	
	b) at 75% Load	:	
	c) at 50% Load	:	
2.8	Lube oil consumption in gm/hr.	:	
2.9	Cooling		
	a) Type of cooling	:	Water
	b) Maximum period for which engine can operate without CW supply.	:	To be furnished by bidder
2.10	Type of Starting	:	Electric
3.0	ALTERNATOR :		
3.1	Make	:	As per List Enclosed
3.2	Type of Enclosure	:	IP – 23
3.3	Mounting	:	Foot Mounted
3.4	Net kW Rating at 0.8 PF	:	600 KW
3.5	kVA Rating		
	a) Name Plate	:	750 KVA
	b) After deration as per site condition of 45°C ambient after deducting auxiliary power.	:	750 KVA
3.6	Insulation	:	Class "H" Temp rise limited to class F
3.7	Excitation	:	Separately Excited Brushless
3.8	Terminal Box Provided	:	1250A TPN AL
3.9	Earthing Studs	:	To be Provided.
3.10	Temperature rise above ambient (45 °C)		;
	a) Stator	:	
	b) Rotor	:	To be furnished.

S.No.	Description		750 KVA
	c) Cores	:	
3.11	Efficiency		
	a) at full load	:	
	b) at 75% load	:	
	c) at 50% load	:	
	d) at 25% load	:	
3.12	AVR type	:	Digital (Part of Integrated Panel)
3.13	Degree of protection	:	IP 23
3.14	Full load losses	:	To be furnished
3.15	Transient & sub-transient reactance	:	
3.16	Short circuit ratio	:	
4.0	Dimensions (L x W x H) of DG Set	:	
5.0	Weight (in Kgs)	:	
6.0	Anti-vibration pad provided (YES/NO)	:	Required
7.0	FLOAT CHARGER :		
7.1	Type	:	Rectifier
7.2	Make	:	As per List enclosed.
7.3	Ampere Rating	:	----- Amps.
7.4	Float Charger Panel Details		
	a) Sheet Steel (Cold Rolled)	:	To be furnished.
	b) Thickness of sheet steel	:	

S.No.	Description		750 KVA
	c) Type of mounting	:	Floor mounted
	d) Degree of protection for panel	:	IP – 52
	e) Cable Entry (Top/Bottom)	:	Top/ Bottom
	f) Glands/Conduit	:	Gland.
	g) Paint Shade	:	To be furnished.
8.0	CONTROL PANEL (OPTIONAL) (Engine Control Panel) :		
8.1	Type	:	Indoor Type.
8.2	Make	:	As per list enclosed
8.3	Facilities provided (bidder to furnish details & brief description) covered:		
	a) Monitoring	:	Digital.
	b) Startup	:	Auto/Manual.
	c) Changeover	:	Auto Change over.
	d) Parallel operation/synchronizing	:	Yes.
	e) Operation	:	Auto / Manual.
	f) Protection & interlocks & Safeguards	:	Yes.
8.4	Cable entry	:	To be furnished.
8.5	Weight	:	
8.6	Dimensions	:	

II) LIST OF APPROVED MAKES FOR DG SET WORKS :

S.NO.	MATERIAL	APPROVED MAKES
1.	LT Cables (Power & Control)	Finolex/RR KABEL / PRIMEKAB/RPG
2.	Crimping type lugs	Dowells/Jainson/3D
3.	Cable Glands	Comet/Jainson/Gripwell/Dowells
4.	DG Engine	Caterpillar/ Cummins
5.	Alternators	Stamford/KEC
6.	Anti Vibration mountings	Dunlop/GERB
7.	Battery	Exide/Standard/Amco/Furukawa
8.	Battery charger	Chhabi Electricals/Logicstat/Nelco/Excide/Amar Raja
9.	M.S./G.I. Pipes	TATA /Jindal
10.	Valves	Audco/C&R/Advance
11.	Pumps	Kirlorsker, Beacon, KSB
12.	Motor	Siemens, CGL, Kirlosker
13.	PLC	Allen Bradly / Siemens

Notes :

1. Make of any other items required but not specifically mentioned shall be got approved by Client/Consultant.
2. Make of various items offered by the tenderer shall clearly be marked in the above list. However the final choice of the selection of particular make solely lies with Client/Consultant which shall mutually be agreed upon before finalization of order.

33KV HT INDOOR PANEL

Item no. 1 33KV,1250A, 31.5ka/3sec VCB

STANDARDS AND MECHANICAL DATA

Metal Enclosed switchgear:	IEC 62271-200
General Purpose switches:	IEC 60265-1
Disconnectors and Earthing switches:	IEC 62271-102

Switch Fuse Combination:	IEC 62271-105
Common clauses:	IEC 60694
Cable bushings outside cone:	CENELEC EN 50181 interface C
Temperature class:	-25 °C - +40 °C indoor
Degree of protection:	
IP 67	
- Fusecanisters:	IP 67
- Front cover:	IP 2X
- Cable cover:	IP 3X
Busbars:	306 mm ² Cu
Earth bar (external):	120 mm ² Cu - Bolt dimension: M10
Thickness of Stainless Steel Tank:	2.0 mm
Colours:	
- Front cover:	RAL 7035
- Side and cable cover:	RAL 7035

A01 V Vaccum Circuit Breaker (Incomer)

SafePlus36 V is a vacuum circuit breaker module with vacuum circuit breaker, stored energy spring mechanism for O - 0,3 s - CO – 15 s - CO operating sequence, two-position operating mechanism for the isolator and earthing switch, busbars , interlocking and earthbar.

1	SafePlus 36 type V: Vacuum circuit breaker 36kV,1250A
1	Manometer
1	Busbar connection outside cone interface C left side
1	Capacitive voltage indication VPIS for outside cone left side
1	Cable support bars left side - adjustable
1	Protection cover left side
1	Control voltage, relay trip coil 24 V DC
1	Arc proof cable cover complete incl. Interlocking
1	Cable bushings interface C (400 bolted), 630 A, standard
1	Ashida Make self Powered relay -ADR141S

- 1 Capacitive voltage indication fixed type VPIS
- 1 Stored energy mech. for manual operation
- 1 Prepared for protection relay incl trip coil, aux.contact, wiring and diagrams
- 1 Low voltage compartment
- 1 100/1,2.5VA,5P10 Protection CTs

BUILDING MANAGEMENT SYSTEM

This specification calls for the Design, Engineering, supply, installation and commissioning of a complete, integrated Building management System in accordance with appropriate local and international standards; and the technical and performance criteria set out in this document.

This specification covers:

(a) BMS

It is not the intent to specify complete specification & complete component list herein, however the System shall in all respect confirm to high standard of design , engineering. Workmanship & performance shall be as per the design intent & highly reliable.

Product Competence

The system integrator will be required to demonstrate their competence to Design, Engineering, supply, install, commission and maintain the product line proposed in the specifications submission as follows:

Provide a letter of reference from the product manufacturer confirming the status with the manufacturer advising:

Exclusive or non-exclusive agreement to provide the system in the geographical territory for this specific project.

The system integrator will be fully supported by the manufacturer in meeting the requirements of this specification.

The system integrator shall provide evidence of competency in carrying out the following areas of work:

System design

Installation management

System configuration

System commissioning

System maintenance

When working on the system, each employee of the successful system integrator shall be required to carry identification

BUILDING AUTOMATION SYSTEM

SYSTEM DESCRIPTION & INPUT OUTPUT SUMMARY

The system will consist of a flat, open architecture that utilizes the Lon Talk protocol as the common communication protocol between all controlled and controlling devices, and LNS architecture for the definition of the device database. No other device database structure will be permitted. When necessary or desired, Lon Talk packets shall be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase

network bandwidth. Any such encapsulation of the Lon Talk protocol into IP datagrams shall conform to existing Lon Mark guidelines for such encapsulation. Systems that utilize non standard routing methods or hierarchal systems consisting of master or global controllers that poll and/or control less intelligent unitary controllers on a secondary bus will not be considered.

Microprocessor based Direct Digital Distributed Controllers (DDC) shall interface with sensors, actuators and environmental control systems (i.e. HVAC units, chillers, pumps, electrical & plumbing system etc.) and carry out followings functions:

Individual input/output point scanning, processing and control.

Centralized operation of the plant (remote control).

Dynamic graphic details of plant and building.

Energy Management through optimization of all connected electrical and mechanical plants.

Alarm Detection and early recognition of faults.

Time, event and holiday scheduling as well as temporary scheduling.

Prevention of unauthorized or unwanted access.

Communication interface and control.

The control system shall be designed such that mechanical equipment will be able to operate under stand-alone control. In general, the operation of any controllers on the network shall not rely on any other controller for its functional operation. System controllers that require a master computer will not be considered. Function specific modules may be used to supplement the functionality resident in each controller. As such, in the event of a network communication failure or the loss of any other controller on the LON, the control system shall continue to independently operate under local control of the resident program stored in nonvolatile memory as detailed herein. In such a case, each individual controller shall continue to perform basic functions until a network connection can be restored.

Reference Standards

All products of the BMS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided on request, with the submittal package. Systems or products not currently offering the following approvals are not acceptable.

1. Federal Communications Commission (FCC), Rules and Regulations, Volume II -July 1986 Part 15 Class A Radio Frequency Devices
2. FCC, Part 15, Subpart J, Class A Computing Devices
3. UL 504 - Industrial Control Equipment
4. UL 506 - Specialty Transformers
5. UL 910 - Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air-Handling Spaces
6. UL 916 - Energy Management Systems All
7. UL 1449 – Transient Voltage Suppression
8. Standard Test for Flame Propagation Height of Electrical and Optical - Fiber Cables Installed Vertically in Shafts
9. EIA/ANSI 232-E - Interface Between Data Technical Equipment and Data Circuit Terminal Equipment Employing Serial Binary Data Interchange
10. EIA 455 - Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices
11. IEEE C62.41- Surge Voltages in Low-Voltage AC Power Circuits

12. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems
13. NEMA 250 - Enclosures for Electrical Equipment

- 14. NEMA ICS 1 - Industrial Controls and Systems
- 15. NEMA ST 1 - Specialty Transformers
- 16. NCSBC Compliance, Energy: Performance of control system shall meet or surpass the requirements of ASHRAE/IESNA 90.1-1999.

Products

Utilize standard components for all assemblies. Custom hardware, operating system, and utility software are not acceptable.

All products (PCU's, TDCU's and ID's) shall contain LonWorks networking elements to allow ease of integration of devices from multiple vendors.

All materials, equipment and software shall be standard components, regularly manufactured for this and other systems and custom designed for this project. All systems and components shall be thoroughly tested.

CENTRAL STATIONS HARDWARE

The Control stations shall comprise of Personal computers (PC) providing high-level operator interface with the system. The terminals shall be capable of providing the operator with the facility for remote system interrogation, control, and retrieval / storage of logged data, annunciation of alarms and reports, analysis of recorded data and the formatting of management reports.

The control station shall consist of the following hardware with all of them suitable for the power supply voltage of 230 V AC ± 10%, 50 HZ + 3%.

Minimum Specifications for Workstations

FEATURES	DESCRIPTION
Processor	Intel Pentium IV 2.4 Ghz
Memory	2GB, DDR 333 Mhz expandable to 8GB
Cache (External)	512 KB Pipeline burst cache
ROM	256 Flash ROM, Can be upgraded from a diskette
Expansion Bus	3 PCI Slots, 4 ISA slots (3 slot shared)
Graphic Accelerator	ATI RagePro/AGP graphics accelerator, 4 MB SDRAM
Hard Disk	80 GB E-IDE/100 ATA
Power Supply	350 W switchable/50 Hz
Keyboard	104 keys window 98 keyboard, PS/2 Compatible
Operating System	Supports Windows XP, OS/2 Warp, Windows NT, DOS 6.22
Software	Office XP

Power Management	EPA compliant
Desktop Manager	Based on SNMP protocol
Antivirus Software	PC-Cilin or equivalent pre-loaded
Diagnostic Software	PAQ 95 or equivalent pre-loaded
Network	100 Mbps Network Interface Card with wake on LAN support
CD Writer	Built in 52X CD Writer with speakers

Key board : The central station shall be complete with detached 101-keys keyboard which includes full upper/lower case ASCII keyset, a numeric pad, dedicated cursor control pad, and a minimum of 10 programmable functional keys.

Colour Monitor : The colour monitors shall be with a minimum 19 inch diagonal nonglare screen and minimum Super VGA resolution of 1024 pixels horizontal, 768 lines vertical and minimum 16 base colors. The monitor shall be with tilt and swivel facilities.

Mouse : For keyboardless operation, in addition to the enhanced keyboard, a mouse shall also be provided as an alternative user interface for day to day system operation. 2 Nos. mouse pads shall be provided for each mouse.

Printers: The contractor shall provide printers as specified in the schematic diagram for printing alarms, operator transactions and reports.

There shall be two printers with each Control Station. One printer shall be dedicated for alarm printing and the second printer for printing reports, trend log, summary, totalizer logging, recording alarms and providing system reports etc. Each of these shall be identical and inter-changeable, and shall have the following characteristics:

All the printers shall be Dot matrix printers.

132 column/300 character per second print speed with minimum 24 pin head.

Adjustable line spacing of six or eight lines per inch with compressed mode option and bidirectional printing and logic seeking.

The available PCI slots on the PC shall be used only for communication cards and shall not be utilized for mounting protocol converter cards. If protocol 0converter cards are used, they shall be external to PC and separately powered and backed-up by the UPS supply.

CENTRAL STATION SOFTWARE

Command & Operating Software

As a minimum, the menu driven command and operating software shall permit the operator to perform the following tasks with a minimum knowledge of the HVAC Control System provided and basic computing skills.

Configure the network.

Create control sequences.

Graphical interface to systems.

Provide additional third party software to permit the operator to manage hard drive files such as access, delete, and copy, modify, etc. The package shall be object oriented and permit the user to manage directories upon boot-up. The file management software shall organize directories and sub-directories using files, file folder objects.

On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.

Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operator's access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

System Diagnostics. The system shall automatically monitor the operation of all HVAC control workstations, printers, modems, network connections, and nodes. The failure of these devices shall be annunciated to the operator.

Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archived on the hard disk for historical reporting. Provide the ability for the operator to obtain real time logs of designated lists of objects. Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer. Data shall be able to transferable to other software packages so as to create custom reports.

Web Browser Access: The DDC system shall provide total integration of the facility infrastructure systems with user access to all system data, either locally over a secure Intranet within the building or by remote access by a standard Web Browser over the Internet.

Graphical Object-Oriented Programming Software

The system shall include a graphical object-oriented programming function which shall be used to create all control sequences utilized in LONWORKS® programmable nodes. The graphical object-oriented programming function shall provide programming elements to be connected together to create a logic diagram. The graphical object-oriented programming function shall include elements for mathematical, logical, timing, setpoint, display and input/output functions to create logic diagrams that represent sequences of operation for LPNs.

Program elements shall be able to be combined into a custom template that can then be used as a standard function.

Program checkout and debug tools shall include display of real-time and/or simulated system variables and inter-object data on the programming screens. The user shall be able to assign fixed or variable values to inputs during the dynamic debugging of the control sequence.

The graphical programming tools shall provide the ability to print I/O lists, lists of standard network variables and lists of all parameters to be viewed by the HMI.

The programming software shall reside on each POT and OW server for programming and/or configuring each model of LPN on the project. The applications shall be downloaded and executed at the appropriate nodes. The software shall allow for updated applications via the network from the OW.

DDC programs are to be provided to meet the control strategies as called for in the sequence of operation sections of these specifications. Each LPN shall have available a full library of DDC algorithms, intrinsic control operators, arithmetic, trigonometric, logic, Proportional Control, Proportional plus Integral (PI), Proportional plus Integral plus Derivative (PID), and relational operators for implementation of control sequences. 2-POSITION, FLOATING, STANDARD I/O AND COUNTER INPUTS, TIME BASED DATA, CURVE FIT FUNCTION, PSYCHOMETRIC FUNCTIONS, INTEGRATION.

All DDC setpoints, gains, and time constants associated with DDC programs shall be available to the operator for display and modification via the POT, DDU or OW interface.

Library of Applications: A library of control, application, and graphic objects shall be provided to enable the creation of applications and user interface screens. Provide the capability to cut & paste objects and libraries into applications for a node/system. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together, using a built-in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface display shall not be acceptable.

Provide integral trend-logging presentation in the programming screen.

Print capability, with page break reference tags to allow down to 8 ½"x 11" size paper

Off-line simulations (step function, continuous run function, simulation of external inputs)

Dynamic presentation of logic in on-line state (all intermediate values)

Text to logic screens

Memory monitoring

Power cycle restart function

Run-time capability

Calculator objects, (basic stuff), including if-then-else, log, ln, exp, and trig functions.

Recognize standard network variable type data (nvi) and create network variables to put on the network (nvo)

Programming Objects

Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects, regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification.

Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.

The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system (step function and run mode, integral trend logging).

The system shall support object duplication within the Owner's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

Object Libraries

A standard library of object function blocks shall be included for development and setup of application logic, user interface displays, system services, and communication networks.

The function blocks in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library

Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.

Application Specific Node Configuration software Tools: Provide application specific node configuration software tools that will permit the individual LASN to be configured and commissioned with appropriate parameters. This software will reside on the POT. Functionality shall include:

Recognize all Standard Configuration Parameters (SCPTs)

Provide capability for setting all Standard Configuration Parameters (SCPTs)

Translation capability for user defined configuration parameters

Monitoring capability for rvo's from the nodes

Ability to set the values for rvi's to the nodes

Network Management

LonMaker for Windows network management software tool shall be used to assign domain, subnet, and node addresses to nodes; configure all routers and repeaters; define network data connections between LONWORKS® device network variables, known as "binding;" and record binding data into node addressing tables, and create a database of all addressing and binding information for all nodes on the network.

Network management shall include the following services: browse all network variables on nodes; Attach, Detach, Manage, Add, Remove, and Replace nodes; plus transmission error off-line, on-line reporting.

The network management database shall be resident in the operator workstation server, ensuring that anyone with proper user name/password authorization has access to the network management database at all times.

The software shall have Client/server capability to allow multiple users ability to manipulate the database simultaneously.

Human-Machine Interface - Operator Workstation Software

The HMI shall be client/server architecture to allow multiple client access to an Ethernet connected server. The workstation shall operate also as a stand-alone workstation/server.

The software shall enable an operator to interact with various devices including LONWORKS® nodes, recorders, input/output (I/O) systems, intelligent transmitters, and other field devices.

It shall provide the following functions:

Calendar.

Scheduling.

Trending.

Alarm monitoring and routing.

Time synchronization.

Time zone handling

Integration of LONWORKS® controller data

Object linking and embedding for process control (OPC) for connectivity to third party OPC compliant software/devices

Color graphic display

On-line plots

Use Microsoft NT security

System documentation generation

Dynamic data exchange (DDE)

Dispatch of a single time schedule to all programmable nodes

System Configuration. At a minimum, the HMI shall permit the operator to perform the following tasks, with proper password access: Create, delete, upload, or modify control strategies.

Add/delete objects to the system.

Tune control loops through the adjustment of control loop parameters.

Enable or disable systems

Generate text file reports to a networked printer.

Select points to be alarmable and define the alarm state.

Configure alarms to be sent to Microsoft windows mail client

Select points to be trended over a period of time and initiate the recording of values automatically.

Provide different levels of security to every object in the HMI database

Modify and create users with passwords and access levels and also be able to use currently logged on users and passwords

Event Alarm Notification and Actions

The HMI software shall provide alarm recognition, storage, routing, management, and analysis.

The HMI software shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.

Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:

To alarm.

Return to normal.

To fault.

Provide for the creation of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.

Provide timed (schedule) routing of alarms by class, object, group, or node.

Provide alarm generation from "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

Control equipment and network failures shall be treated as alarms and annunciated.

Alarms shall be annunciated in any of the following manners as defined by the user:

Screen message text.

Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:

Day of week.

Time of day.

Recipient.

Pagers via paging services that initiate a page on receipt of email message.

Auto answer (at OWS) and auto dial (from node)

Graphic with flashing alarm object(s).

Printed message, routed directly to a dedicated alarm printer.

Audio messages.

The following shall be recorded by the OWS HMI software for each alarm (at a minimum):

Time and date.

Location (building, floor, zone, office number, etc.).

Equipment (air handler #, accessway, etc.).

Acknowledge time, date, and user who issued acknowledgement.

Number of occurrences

Alarm actions may be initiated by user defined programmable objects created for that purpose.

Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

A log of all alarms shall be maintained by the OWS HMI and shall be available for review by the user.

Attach a graphic screen, text notes, and/or plant status report, to each alarm, as defined by user.

Repeat/nuisance alarms must have feature to be disabled, and a feature for monitoring disabled alarms.

The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. An alarm notification window will supercede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms.

The dedicated alarm window shall provide user selectable colors for each different priority of alarm.

Data Collection and Storage Requirements

The OWS HMI shall have the ability to collect data for any property of any object and store this data for future use.

The data collection shall be performed by objects, resident in the node, and if desired OWS, shall have, at a minimum, the following configurable properties:

For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.

For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.

For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.

Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

All log data shall be stored in a database in the OWS HIM and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.

Systems that cannot provide log data in HTML formats at a minimum shall not be acceptable.

The OW shall have the ability to archive its log data either locally (to itself), or remotely to a OWS server. Provide the ability to configure the following archiving properties, at a minimum:

Archive on time of day.

Archive on user-defined number of data stores in the log (buffer size).

Archive when log has reached its user-defined capacity of data stores.

Provide ability to clear logs once archived.

Audit Log

Provide and maintain an Audit Log that tracks all activities performed on the OWS HMI. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally to OWS HMI or to a server. For each log entry, provide the following data:

Time and date.

User ID.

Change or activity: i.e., change setpoint, add or delete objects, commands, etc.

Database Backup and Storage

The OW shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

Shall have the ability to automatically complete full or partial backups; and have the ability to full or partial restore. Partial is defined as only items that have changed in the database.

Copies of the current database and, at the most recently saved database shall be stored in the OW. The age of the most recently saved database is dependent on the user-defined database save interval.

Graphical Real-Time Displays. The HMI, shall at a minimum, support the following graphical features and functions:

Graphic screens shall be developed using any drawing package capable of generating and importing a GIF, BMP, DWG, DXF, or JPG file format. In addition to, or in lieu of a graphic background, the HMI shall support the use of scanned pictures.

Graphic screens shall contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML, or XML document links, schedule objects, hyperlinks to other URLs, and links to other graphic screens.

Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.

Commands to start and stop binary objects shall be done by clicking the selected object and selecting the appropriate command from the pop-up menu. Data entry may be typed or mouse entered.

Adjustments to analog objects, such as set points, shall be done by clicking the selected object and entering value or using a graphical slider to adjust the value.

On-Line Help. Provide a context sensitive help system to assist the operator in operation and editing of the system. Help screens shall be available for all applications and shall provide the relevant data for that particular screen.

Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data.

System security shall be selectable for each operator.

The system administrator shall have the ability to set passwords and security levels for all other operators.

Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object.

Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected.

All system security data shall be stored in an encrypted format.

Each object in the HMI database must be able to have a security policy applied to it.

System Diagnostics. The system shall automatically monitor the operation of network connections and controllers. The failure of any device shall be annunciated to the operator.

DDE Server - The HMI software shall be able to communicate and exchange data with any Third Party DDE compliant application.

MICROSOFT REPORT GENERATION – The HMI software shall be able to seamlessly interact with Microsoft Office Products, including Excel, with no additional programming.

DIRECT DIGITAL CONTROLLER

DIRECT DIGITAL CONTROLLER (DDC) HARDWARE REQUIREMENT:

DDC controllers shall be capable of fully "stand-alone" operation i.e. in the event of loss of communication with other DDCs or Control Station, they shall be able to function on their own. The controllers shall be LonWorks based products.

The controllers shall consist of minimum single 32-bit microprocessors for reliable throughput, based with EEPROM based operating system (O.S.).

The memory available to the controller board as working space for storage of the Operating system software and data files shall be decided on the basis of number of points being controlled by them.

The controllers shall be UL listed and conforming to CE (Euro norms).

Controllers requiring nickle-cadmium/lithium battery to support the full operation of the RAM, shall have battery back-up upto 12 hours in the event of a localised mains failure. The battery shall not be required to supply power to actuators, valves, dampers etc.

In addition to the above battery reserve a further battery shall be provided to retain the RAM for a minimum of 2 days, after the expiration of the standard battery.

A low battery alarm shall be provided with each Controller and with an indication at the Control Station.

In case the memory is stored on EEPROM, the battery backup will not be required.

The Controllers shall have proportional control, Proportional plus Integral (PI) Control, Proportional plus Integral plus Derivative (PID) Control, Two Position Control and Time Proportioning Control and algorithms

etc, all in its memory and all available for use by the user, i.e. all the control modes shall be software selectable at any time and in any combination. The analog output of Proportional Control, PI Control, and PID Control shall continuously be updated and output by the program shall be provided. Between cycles the analog output shall retain its last value. Enhanced integral action in lieu of Derivative function shall not be acceptable.

The controllers shall have a resident real time for providing time of day, day of week, date, month and year. These shall be capable of being synchronized with other clocks in the network.

Back-up power shall support the clock. Upon power restoration all clocks shall be automatically synchronized.

The microprocessor based DDCs shall be provided with power supply, A/D and D/A converters, memory, and capacity to accommodate a maximum of 18 input/output (I/O) hardware points (with or without an

expansion board). DDCs with a lower capacity of points shall preferably be provided at the locations with relatively less input/output points.

If the controllers provided by the contractor have the configurable plug in function cards, then the following minimum specifications shall have to be met :

In addition to the basic outstation, a minimum of two slots shall be provided for the insertion of plug-in function cards.

The cards shall provide for analog or digital, input or output, hardwired connections to the installed plant.

The quantity and combination of these cards shall be determined by the requirements of the plant in that location with the concurrence of the Owner/ Consultant.

The DDCs shall have 15% spare capacity (digital/analog input/output) to give flexibility for future expansion.

All DDC controllers shall be capable of handling voltage, milli-ampere, resistance or open and closed contacts inputs in any mix, if required.

Analog inputs/outputs of the following minimum types shall be supported :

4-20 mA.

0-1 volts.

0-10 volts.

0-5 volts, and

2-10 volts.

Resistance Signals (either PTC or NTC)

(PT 100, PT 1000, PT 3000, Balco 500, NI 1000)

Digital input/output types to be supported shall be, but not limited to the following:

Normally-open contacts.

Normally-closed contacts.

Modulating outputs shall be true proportional outputs and not floating control type.

Controller's packaging shall be such that, complete installation and check out of field wiring can be done prior to the installation of electronic boards.

All board terminations shall be made via plug-in connectors to facilitate trouble-shooting, repair and replacement. Soldering of connections shall not be permitted.

Controllers shall preferably be equipped with diagnostic LED indicators with atleast indication for Power up Test OK, and Bus Error. All LED's shall be visible without opening the panel door.

It shall be possible for the controllers to accept regulated uninterrupted power supply to maintain full operation of the controller functions (control, logging, monitoring and communications) in the event of a localised mains failure.

Controllers requiring fan cooling are not acceptable.

There shall be the facility for accessing controller data information locally, via a portable plug-in keypad display which can be common to all controllers and normally removed to prevent unauthorised tampering. Alternatively each controller shall have a keypad and display integral with its casing for local interrogation and adjustment. In either case, access to the system thus provided shall be restricted by passwords in the same way as at the main operator terminal.

In case the Portable operator Terminals (POT) are required to programme the controllers, sockets shall be provided for same. Attachment of POT shall not interrupt or disable normal panel operation or bus connection in any way.

The controllers shall be housed in vandal proof boxes to protect them from tampering by any unauthorized personnel. All DDC controllers used in plant room spaces and external application shall be housed IP66/IP54 rating enclosures.

It shall be possible to add new controllers to the system without taking any part of the system off-line.

DIRECT DIGITAL CONTROLLERS CAPABILITIES:

The Controllers shall have a self analysis feature and shall transmit any malfunction messages to the Control Station. For any failed chip the diagnostic tests, printout shall include identification of each and every chip on the board with the chip number/location and whether the chip "Passed" or "Failed" the diagnostic test. This is a desired requirement as it would facilitate trouble-shooting and ensure the shortest possible down time of any failed controller. Controllers without such safety feature shall be provided with custom software diagnostic resident in the EEPROM. The tenderer shall confirm in writing that all controllers are provided with this diagnostic requirement.

Operating system (O.S.) software for controllers shall be EPROM resident.

Controllers shall have resident in its memory and available to the programs, a relevant library of algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences.

In the event of failure of communication between the controllers and/or Control Station terminal, alarms, reports and logs shall be stored at the controllers and transmitted to the terminal on restoration of communication.

In the event of memory loss of a Controller, or the expiration of back-up power, on start-up of the unit the necessary data-base shall be downloaded automatically and without operator instruction. Controllers requiring a manual intervention for the re-boot of software are not desired.

Where information is required to be transmitted between controllers for the sharing of data such as outside air temperature, it shall be possible for global points to be allocated such that information may be transmitted either on change of incremental value or at specific time intervals.

Controllers must be able to perform the following energy management functions as a minimum.

Time & Event programs

Holiday Scheduling

Maximum and Distributed power demand

Optimum start and stop program

Night purge

Load reset

Zero energy band

Duty cycle

Enthalpy analysis and control

Run Time Totalization

Sequencing and Optimization

Exception scheduling

Detailed description of software features and operating sequence of all available energy management software shall be submitted with the tender for evaluation by the Consultant.

The DDC Controllers shall have Adaptive Control capability whereby the control software measures response time and adjusts control parameters accordingly to provide optimum control. The software shall allow self-tuning of the variable control loops (all or any of P, P+I, P+I+D) of the AHUs and chiller system so as to provide the most efficient and optimised controls at different load conditions. The energy management programs shall update their parameters based on past experience and current operating conditions.

Alarm Lockout shall be provided to prevent nuisance alarms. On the initial start up of air handler and other mechanical equipment a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating an alarm comparison logic.

Tenderers shall indicate their proposed system alarm handling capability & features.

Run time shall be accumulated based on the status of a digital input point. It shall be possible to total either ON time or OFF time. Run time counts shall be resident in non-volatile memory.

It shall be possible to accommodate Holiday and other planned exceptions to the normal time programs. Exception schedules shall be operator programmable up to one year in advance.

Distributed power demand program shall be based on a sliding window instantaneous demand trend algorithm. The DDC interfaced to the demand meter shall calculate the demand, forecast the demand trend, compare it to the established demand limits, and initiate load shedding or re-establishment of loads as required. Shedding shall be on a sequential basis with least important loads shed first and restored last.

SYSTEM INTERFACE UNITS (SIU) / LAN ROUTERS / REPEATERS

General

Equip each router with a network transceiver on each network port (inbound and outbound) as dictated by the network type (Type 1 - FTT, Type 2 - TP).

The network router shall be designed to route messages from a segment, sub-net, or domain in full duplex communication mode.

Routers shall utilize LonTalk® protocol transport, network, session layers to transparently route messages bound for a node address in another sub-net or domain.

Routers and repeaters shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions utilizing LONWORKS® software tool.

The routers and repeaters shall be capable of DIN rail or panel mounting and be equipped with status LED lights for Network traffic and power.

Provide a minimum of two Neuron 3120 or 3150 processors for use as the network router communication controller.

Ethernet IP Router

Equip each router with an Ethernet IP communication on one side and a LonTalk® transceiver Type 1 FTT or Type 2 - TP on the other side.

The network router shall be designed to route messages from a segment, sub-net, or domain in full duplex communication mode.

On Ethernet IP side, the router shall utilize Ethernet IP protocol transport to route messages.

On the LonTalk® side, the routers shall utilize LonTalk® protocol transport, network, session layers to transparently route messages bound for a node address in another sub-net or domain.

Routers shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions utilizing LonWorks® software tool.

The routers shall be capable of DIN rail or panel mounting and be equipped with status LED lights for Network traffic and power.

PORTABLE OPERATORS TERMINAL (POT)

General Requirements.

The DDUs shall permit the project operating staff to:

Display point values

Display parameters

Change time schedule elements

List and acknowledge alarms

Monitor points in the system

Command points (manual overrides) of points

Override input points (put inputs in test)

Read and check LonWorks variables on the network

Password protected

Node configuration for Fan Coil and Rooftop Unit TCUs

DDU with the following components:

Liquid Crystal Display

Minimum 4x20 character

Pushbuttons for scrolling display and enter

Permanent mount or portable connection.

DATA COMMUNICATION

The communication between controllers shall be via a dedicated communication network as per Lon Works recommended standards. Controller's microprocessor failures shall not cause loss of communication of the remainder of any network. All networks shall support global application programs, without the presence of a host PC.

Each controller shall have equal rights for data transfer and shall report in its predetermined time slot. There shall be no separate device designated as the communication's master. Those systems using dependent controllers shall be pointed out by the contractor and a dual redundant transmission media with automatic switching and reporting in the event of line faults will have to be provided.

The communication network shall be such that:

Every DDC must be capable of communicating with all DDC's.

Network connected devices with no messages to transmit shall indicate "No failure" message each cycle. Lack of this message after successive retries shall constitute a communication or device failure.

Specifications for Integrator Device (for third party device / equipment integration) and Lon-over-IP are provided in annexures.

FIELD DEVICES

ELECTRIC AND ELECTRONIC CONTROLS RELATED EQUIPMENT

General Requirements

All controls shall be capable of operating in ambient conditions varying between 0-55 deg. C and 90% R.H. non-condensing.

All Control devices shall have a 20 mm conduit knockout. Alternatively, they shall be supplied with adaptors for 20 mm conduit.

Ancillary Items

When items of equipment are installed in the situations listed below, the BAS contractor shall include the following ancillary items :

Weather Protection

All devices required to be weatherproofed are detailed in the Schedule of Quantities. IP ratings for the equipment is mentioned in the respective section.

Pipe work Immersion

Corrosion resisting pockets of a length suitable for the complete active length of the device, screwed ½" (13 mm) or ¾" (20 mm) NPT suitable for the temperature, pressure and medium.

Duct Mounting (Metal or Builders Work)

Mounting flanges, clamping bushes, couplings, locknuts, gaskets, brackets, sealing glands and any special fittings necessitated by the device.

Additional features

Concealed Adjustment : All two position switching devices shall have concealed adjustment unless detailed otherwise in the Schedule of Quantities.

Operating Voltage : All two position switching devices shall operate on 230 v a.c and all accessible live parts shall be shrouded. An earth terminal shall be provided.

TEMPERATURE SENSOR

Temperature sensors for space, pipes and ducts, shall be of the Resistance Temperature detector (RTD) type or thermistor. These shall be two wire type and shall conform to the following specifications :

Immersion sensors shall be high accuracy type with a high resistance versus temperature change. The accuracy shall be at least ± 0.33 degrees F and sensitivity of at least 2 ohm/F.

Immersion sensors shall be provided with separate stainless steel thermo well. These shall be manufactured from bar stock with hydrostatic pressure rating of at least suitable for PN20.

The connection to the pipe shall be screwed $\frac{3}{4}$ inch NPT (M). An aluminum sleeve shall be provided to ensure proper heat transfer from the well to the sensor. Terminations to be provided on the head. Flying leads shall not be acceptable.

The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections.

Duct temperature sensors shall be with rigid stem and of averaging type. These shall be suitable for duct installation.

Outdoor air temperature sensor shall be provided with a sun shield.

The sensors shall not be mounted near any heat source such as windows, electrical appliances etc.

The temperature sensors may be of any of the following types :

PT 100, PT 1000, PT 3000

NI 100, NI 1000

Balco 500.

Thermistor

NTC1800

HUMIDITY SENSOR

Space and duct humidity sensors shall be of capacitance type with an effective sensing range of 10% to 90% RH. Accuracy shall be + 3% or better. Duct mounted humidity sensors shall be provided with a sampling chamber. Wall mounted sensors shall be provided with a housing. The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections. The sensors shall not be mounted near any heat source such as windows, electrical appliances etc.

FLOW METER

Water flow meters shall be either sonic type or electromagnetic type. For electromagnetic flow meter, Teflon lining with 316 SS electrodes must be provided. The housing shall have IP 55 protection. Vendors shall have to get their design/ selection approved by the Consultant, prior to the supply.

The exact ranges to be set shall be determined by the contractor at the time of commissioning. It should be possible to zero the flowmeter without any external instruments, with the overall accuracy of at least $\pm 1\%$ full scale.

PRESSURE TRANSMITTER FOR WATER

Pressure transmitters shall be piezo-electric type or diaphragm type. (Bourdon Tube type shall not be acceptable). Output shall be 4-20mA or 0-10V DC and the range as specified in the data sheet depending on the line pressure. Power supply shall be either 24 V AC, 24 V DC or 230 V AC. Connection shall be as per manufacturer's standards. The pressure detector shall be capable of withstanding a hydraulic test pressure of twice the working pressure. The set point shall fall within 40%-70% of the sensing range and detector shall have sensitivity such that change of 1.5% from the stabilized condition shall cause modulation of the corrective element. The sensor must be pressure compensated for a medium temperature of -10°C to 60°C with ambient ranging between 0°C to 55°C .

DIFFERENTIAL PRESSURE SWITCH FOR PIPE WORK

These shall be used to measure pressure differential across suction and discharge of pumps. The range shall be as specified in the data sheet. Switch shall be ON with increase in differential. Housing for these shall be weather proof with IP 55 protection. The pressure switch shall be capable of withstanding a hydraulic test pressure of 1.5 times the working pressure. The set point shall fall in 40-70% of the scale range and shall have differentials adjustable over 10%-30% of the scale range. The switches shall be provided with site adjustable scale and with 2 NO/NC contacts.

DIFFERENTIAL PRESSURE SWITCH FOR AIR SYSTEMS

These shall be diaphragm operated. Switches shall be supplied with air connections permitting their use as static or differential pressure switches.

The switch shall be of differential pressure type complete with connecting tube and metal bends for connections to the duct. The housing shall be IP 54 rated. The pressure switches shall be available in minimum of 3 ranges suitable for applications like Air flow proving, dirty filter, etc. The set point shall be concealed type. The contact shall be SPDT type with 230 VAC, 1 A rating.

The switch shall be supplied suitable for wall mounting on ducts in any plane. It should be mounted in such a way that the condensation flow out of the sensing tips. Proper adaptor shall be provided for the cables.

The set point shall fall within 40%-70% of the scale range and have differentials adjustable over 10%-30% of the scale range.

The switches shall be provided with site adjustable scale and with 2 NO/NC contacts.

AIR FLOW SWITCHES

Air flow switches shall be selected for the correct air velocity, duct size and mounting attitude. If any special atmospheric conditions are detailed in the Schedule of Quantity the parts of the switches shall be suitably

coated or made to withstand such conditions. These shall be suitable for mounting in any plane. Output shall be 2 NO/NC potential free. Site adjustable scale shall also be provided.

AIR PRESSURE SENSOR

The pressure sensor shall be differential type. The construction shall be spring loaded diaphragm type. The movement of the membrane in relation to the pressure should be converted by an inductive electromagnet coupling which would give an output suitable for the controller. The pressure sensor shall be in a housing having IP 54 ratings in accordance with IEC 529. Suitable mounting arrangement shall be available on the sensor. The sensor shall come complete with the PVC tubes & probes.

WATER FLOW SWITCH

These shall be paddle type and suitable for the type of liquid flowing in the line. Output shall be 2NO/2NC potential free.

TRANSDUCERS FOR ELECTRICAL SERVICES

Electrical transducers shall be integrated electronic type and rack mounted on the field. These shall work on 230 V supply with the output being standard type i.e. 4-20 mA, 0- 10 Volts etc.

Power factor, Voltage, Current, Frequency and Kilowatt transducers shall have standard output signal for measurement for the specified variable.

Kilowatt-Hour metering (if any) shall be poly-phase, three- element with current transformer (CT) operated type. The metering shall feature high accuracy with no more than +/- 1% error over the expected load range. The coils shall be totally encapsulated against high impulse levels.

LEVEL SWITCH

The level switches shall have to meet the following requirement :

Type : Float Type/Capacitance
Mounting : To suit application.
Connection : Flanged ANSI 150 lbs RF Carbon steel
Float material : 316 SS
Stem Material : 316 SS
Output : 2 NO, 2 NC potential free
Switch Enclosure : IP 55

CONTROL VALVES (AIR HANDLING UNITS)

Control valves for the Air Handling Units shall be globe type, two way suitable for Variable flow hydraulic system.

The Manufacturer's standards shall be applicable for these valves.

Valves

- a. Type : Two way mixing
- b. Stem / Trim : SS-316 or better
- c. Plug and seat : SS-316 or better
- d. Plug characteristics : Equal Percentage

- e. Service : Chilled water
- f. Stroke Length : Minimum 20 mm
- g. Compliance : IEC 534
- h. Packing : Teflon

Actuator

- a. Actuator : Electrical/Electronic/Magnetic.
- b. Actuator type : Proportionating(Modulating)
- c. Spring return function : Yes
- d. Travel limit switch : 2 Nos. for open and close.
- e. Hand wheel : Required
- f. Input signal : 0 – 10 V dc, 4 –20 mA
- g. Power Supply : 240 V ac
- h. Thrust : To be selected by the vendor
- i. End Connections : Screwed upto 2" Beyond that ANSI 150 Lb RF
- j. Noise Level : Not exceeding 70 DB
- k. Weather Proof : NEMAI

Note :

Actuator should be directly coupled to the trim. Eccentric linkages not acceptable.
Leakage not to exceed 0.1% of flow.

CONTROL FOR FCU

Control valves for the Air Handling Units shall be globe type, two way suitable for Variable flow hydronic system as indicated in BOQ.

Two way motorized valves

Two way motorized valves shall be provided in chilled water lines at each fan coil units. The valve shall be actuated by space thermostat. Constant space conditions shall be maintained by allowing chilled water

through the coil. The valve shall be provided with spring return function so that it revert to fully closed position when fan is shut off. Valve shall be two/three position with flare connections. Valve shall have the facility to replace motor \ actuator without removing the valve body Actuator shall be suitable for 240 V, 50 Hz ac or 24V ac. Maximum close off pressure shall be selected to suite the CV requirement.

Thermostat

Thermostat shall be snap acting fixed differential type thermostat for air-conditioning application for actuating the two way valve at each fan coil unit with HI-MED-LO fan switch and system setting OFF-FAN-COOL. Switching off must break fan circuit. Thermostat shall be provided with necessary relays to operate valve of cooling coil.

TWO WAY MOTORIZED BUTTERFLY VALVE

Valve

- a. Type of valve : Butterfly Valve.
- b. Body Material : Carbon steel ASTM A 216
- c. Body seat ring (if applicable) : Gr WCB

- d. Vane : SS-316
- e. Packing : Teflon
- f. Mounting Stool : Required.
- g. Shaft : SS-316
- h. Seat : Nitrile rubber
- J Fasteners : SS-316

Actuators

- Type : Electric
- Duty : On/Off (Maximum 50 operations per day)
- Motor power supply : 230 V AC or 415 V 3-phase
- Travel limit switches : 2 Nos
- Torque limit switches. : 2 Nos
- Hand wheel : Required
- Speed : Approx 150 mm/min

NOTE

Actuator must open/ close with one changeover contact. Control panel, if required, must be supplied integral with the Actuator.

No gear box is envisaged, however if gear box is provided, the travel limit switches must be connected directly to the valve stem.

Cover tube for the valve stem must be provided

ELECTRONIC METERING

Electronic metering shall be provided on the main LT panel at incoming and outgoing feeders. These meters shall be free supply by the BAS contractor to the Electrical contractor whereby these shall be installed in the LT panel by the Electrical contractor. The electrical contractor shall also provide necessary CT, PT and 220 V power input for the meters. All further control wiring and networking of the meters shall be in scope of BAS contractor.

The specifications for the electronic meters to be supplied by BAS contractor is as follows:

- Type : Static Power Meter
Class 1.0 accuracy.
- Instantaneous Measurements : V (1-n), V (1-1) & 1 per ph & avg. V & I unbalance
- PF per ph & total, frequency
- Power & BI-directional energy (active, apparent, reactive)
- Peak & Predictive Demand (I, W, VA, VAR totals)
- V & I harmonics (Individual & Total)
- Time of use (internal calendar, multiple daily tariff, energy & demand accumulators).

- Features :
 - a. Event Triggered
 - b. Sequence of event

- c. Panel mountable
- d. Internal battery backup
- e. Transducerless connection via standard CT / PT
- f. Y2K compliance

Display : Local LCD display panel user formattable display with scrollable screens.

Software interface shall be ensured by BAS contractor for the electronic meters. Systems requiring transducers for duplicating the data shall not be accepted.

All the instantaneous measurements shall be displayed on the control stations and the data shall be logged. It shall be possible to access minimum / maximum logging of any parameter with alarm annunciation for unusual measurements. The system shall also accept user defined "Set-Point" limit of any parameter.

ENCLOSURES FOR CONTROLLERS AND ELECTRICAL PANELS

All the controllers shall be housed in Lockable Vandal proof boxes which shall either be floor mounted or wall mounted. These shall be free standing, totally enclosed, dust and vermin proof and suitable for tropical climatic conditions.

The panel shall be metal enclosed 14 SWG CRCA sheet steel cubicle with gaskets between all adjacent units and beneath all covers to render the joints dust proof. All doors and covers shall be hinged and latched and shall be folded and braced as necessary to provide a rigid support. Joints of any kind in sheet metal shall be seam welded with welding slag grounded off and welding pits wiped smooth with plumber metal.

All panels and covers shall be properly fitted and secured with the frame and holes in the panels correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with nuts. Self threading screws shall not be used in the construction of control panels. Knockout holes of approved size and number shall be provided in the panels in conformity with the location of incoming and outgoing conduits/cables. Lamps shall be provided to support the weight of the cables. The dimension of the boxes shall depend on the requirement with the colour decided in consultation with the Architect/Consultant.

Note : All panel enclosures used in plant room spaces and external to building shall be suitable for outdoor application (IP 54 protection) and UL listed.

CONDUITS AND WIRING

Prior to laying and fixing of conduits, the contractor shall carefully examine the drawings indicating the layout, satisfy himself about the sufficiency of number and sizes of conduits, sizes and location of conduits and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of Architect/Engineers Any modifications suggested by the Contractor shall be got approved by the Architect /Engineers before the actual laying of conduits is commenced.

CONDUITS / TRUNKER

Conduits and accessories shall conform to relevant Indian Standards. PVC conduits of required dia shall be used as called for in the schedule of quantities. Joints between conduits and accessories shall be securely made, with help of adhesive.

The conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

CONNECTIONS

All jointing methods shall be subject to the approval of the Architect/Engineer. Separate conduits shall run for all power wiring.

The threads and sockets shall be free from grease and oil. Connections between conduit and controller metal boxes shall be by means of brass hexagon smooth bore bush, fixed inside the box and connected through a coupler to the conduit. The joints in conduits shall be smooth to avoid damage to insulation of conductors while pulling them through the conduits.

BENDS IN CONDUIT

Where necessary, bends or diversions may be achieved by means of bends and/or circular inspection boxes with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with a finished wall surface. No bends shall have radius less than 2-1/2 times the outside diameter of the conduit.

SIGNAL CABLING & COMMUNICATION CABLING

The signal cable shall be of the following specifications :

- a. Wire : Annealed Tinned Copper
- b. Size : 1.5 sq. mm, 7 strands
- c. No. of conductors : Two (One pair)
- d. Shielding : Overall beld foil Aluminium polyester shield.
- e. Jacket : Chrome PVC
- f. Nominal DCR : 17.6 ohm/km for conductor
57.0 ohm/km for shield
- g. Nominal OD : 8.5 mm
- h. Nominal capacitance : 130 pF/m between conductors
at 1 KHz 180 pF/m between one
conductor and other
conductors connected to shield.
- i. Colour : Black and Red

COMMUNICATION CABLE

The communication cable shall be of the following specifications :

- a. Wire : Annealed Tinned Copper
- b. Size : Minimum 24 AWG stranded
- c. No. of conductors : One pair (2 conductor)
- d. Shielding : Overall beld foil Aluminium polyester shield.
- e. Jacket : Chrome PVC
- f. Nominal DCR : 78.7 ohm/km for conductor, 55.8 ohm/km for shield
- g. Nominal OD : 5.64 mm
- h. Nominal capacitance : 131 pF/m between conductors at 1 KHz 243 pF/m
between one conductor and other conductors connected to shield.
- i. Colour : Black and Red, Black and White)

Training

The tenderer shall arrange for training of purchaser's personnel at manufacturer's premises and site as well. Following training should be provided

1. Details Training of hardware, Software & integration for BMS system.

Approved Make List					
S.no.	Item	Make			
1	PVC insulated copper conductor , PVC insulated & Sheathed flexible copper conductor FRLS ISI marked	Finolex	RR Kabel	LAPP	Anchor, Havell's , polycab
2	PVC insulated Telephone / Cat 6 / TV cable ISI marked FRLS	Finolex	RR Kabel	LAPP	Anchor, Havell's , polycab
3	PVC conduit pipe ISI marked & accessories	BEC	Polycab	Precision	AKG , Modi, Shrinath, Kent,
4	Modular type flush type switch, socket , ceiling rose, lamp holder, call bell,	Legrand (MYRIUS)	MK (BLENDZ)	Anchor Roma	Schenider , C&S, L&T,Wipro North West, HPL,
5	MCB(Miniature Circuit Breaker 10KA), Isolator, RCCB, RCBO, MCB-DB	Philips	ABB	Schenider (acti9)	L&T, C&S,
6	XLPE insulated cable	Finolex	RAVIN Cables	RR Cable	Polycab, Havell's
7	GLS, CFL, SV,MH, Lamp	Philips	Bajaj	Crompton	osram, GEC,
8	LED lamp	Philips	Bajaj	Crompton	Wipro, osram
9	Luminaries SV, MH, CFL, FTL-T5	Philips	Bajaj	Crompton	Wipro
10	Luminaries LED,	Philips	Bajaj	Crompton	Wipro
11	GI pipe ISI Mark	TATA	Swastik	Jindal	Surya
12	ACSR , AAAC conductor	Grandlay	Diacab	Daimond Power	
13	Electronic ballast	Philips	Bajaj	Crompton	Wipro, osram
14	Electric Ceiling fans	Cromton	Bajaj	Usha	Orient, Havell's
15	Wall mounting fan, Cabin fan, Exhaust fan,	Almonard	Crompton	Bajaj	Usha, Orient,
16	Steel tubular pole	As per IS 2713-1980			
17	Octagonal pole	Bajaj	Philips	Valmont	
18	Ornmental pole	Bajaj	Dwarka	Homedec	
19	Cable Glands	Comet	Calter(National)	Cosmos	Jainson

20	Cable Lugs	Comet	Calter(National)	Cosmos	Jainson	1
21	ACB (Air Circuit Breaker) EDO type	ABB	SIEMENS(3WL)	Schneider (Masterpact)	L&T (U-POWER)	6 1
22	SFU	ABB	SIEMENS	L&T	Schneider	
23	Fan / Lumanaries Capacitors	Asian	Bajaj	Unistar	Epcos	
24	Power Capacitor Mixed Dielectric Type	Epcos (Super Heavy Duty)	Dukati (Neptune)	Unistar		
25	Ammeter , Voltmeter , Ammeter/Voltmeter Selector Switch	AE	Elmeasure	Conzerv(schenider)	L&T , Neptune	
26	33KV Pin Insulator Porcelain	Jayshree	Atlas	WSI		
27	33KV Disc Insulator Porcelain	Jayshree	Atlas	WSI		
28	33KV Pin Insulator Polymer	ABIL	Jayshree	Sarvana Global		
29	33KV Disc Insulator Polymer	ABIL	Jayshree	Sarvana Global		
30	Air Break Switch (AB SWITCH)	Atlas	Pactil	Kiron		
31	Drop Out Fuse (DO FUSE) UNIT	Atlas	Pactil	Kiron		
32	33KV HT Cable Jointing Kit (Indoor & outdoor)	Raychem	M-Seal	3M		
33	Lightening Conductor	ABB	Indelec	Schenider	Siemens	
34	Transformer	MEHI Transformers (Madhya Pradesh Transformers)	Voltamp	Crompton	AMES-IMPEX	
35	DG SET	Kirloskar	Caterpillar	Cummins (Sudhir)	MTU	
36	Sealed Maintenance Free (SMF) BATTRIES	Rocket	Amar Raja	Exide		
37	Battery Charger	Chavi	Hertz Electronics	BCH		
38	33KV HT VCB PANEL	ABB	Siemens	Schenider		
39	UPS(On line)	Emerson	APC	HI-REL		
40	Inverter (Sine wave)	Microtech	SU-KAM	Luminous		
41	LED TV	Samsung	LG	Sony		
42	Computer System	Lenovo	Dell	HP		
43	Water Level Controller (4 Probe Type)	Minilec	Gelco			
44	Energy Management System	Elmeasure	Conzerv (Schenider)	Neptune		
45	Time Totaliser	EAPL	Selectron			

46	Change Over Switches (On Load) , Auto Change Over Switches	HPL Socomec	ABB	C&S		1 6 2
47	APFC(Automatic Power Factor Correction) RELAY (40mA sensitivity)	Dukati	Conzerv (Schenider)	Epcos		
48	Annunciation Window	Minilec	EAPL	Conzerv (Schenider)		
49	MCCB (Moduled Case Circuit Breakers)	ABB	Schenider(NSX Series)	Legrand	L&T (D-sine)	
50	Starters/Contactors	ABB	Schenider	L&T	Siemens	
51	Relays	English Electric	AVK-SEGC	Easun Reyolle		
52	Connectors	Elemex	Wago	Connectwell		
53	Push Buttons / Indicating Lamps (LED TYPE)	ABB	L&T	Siemens	Tecnik , Salzer	
54	Panel Manufacturer	CPRI APPROVED ,TAC APPROVED				
55	Protection Relay	English Electric	AVK-SEGC	Easun Reyolle		
56	Resin Cast Current Transformer for LT & HT	AE	Reco	Kappa	Newtec	
57	Hardware (Bolts, Nuts, Spring Washers etc.)	Unbrako	GKW			
58	Industrial Power Socket	Legrand	ABB	BCH	Schenider	
59	UPVC/CPVC/HDPE PVC Pipe	Kissan	Kasta	Suprme		
60	Steel Structure	Jindal	Sail			
61	Celling Ring / Wall Speakers	Bosch(Precedio)	Honeywell (PAVA)			
62	Public Address Audio System	Bosch(Precedio)	Honeywell (PAVA)			
63	Fire Alarm Panel , Detectors , Devices (Addressable Type)	Esser Notifier	Siemens Fire Finder	Johnson Control		
64	Closed Circuit Tele Vision (CCTV) Camera IP	CP Plus	Dahua	Gobler	Honeywell	
65	Network Video Recorder	CP Plus	Dahua	Gobler	Honeywell	
66	EPABX (Digital Type)	Usha Coral	Siemens	NCC	Panasonic	
67	Lamps for LED Lighting Fixture	Cree	Edison			
68	Switches for Computer Data	HP	Cisco	3COM		
69	Patch Panels	Commscope	AMP	Molex		

70	Variable Frequency Drive VFD	ABB	Siemens	AllenBradely	
71	BMS (Building Management) System	Schenider	ACL	Tridium (Honeywell)	
72	BMS 32 Bit DDC Controller	Schenider	ACL	Tridium (Honeywell)	
73	Temperature Sensor	Schenider	ACL	Tridium (Honeywell)	
74	Outside Temperature & Rh Sensor	Schenider	ACL	Tridium (Honeywell)	
75	Pressure Transmitter	Schenider	ACL	Tridium (Honeywell)	
76	Differential Pressure Switch Water	Schenider	ACL	Tridium (Honeywell)	
77	Differential Pressure Sensor Water	Schenider	ACL	Tridium (Honeywell)	
78	Differential Pressure Switch Air/ Blower	Schenider	ACL	Tridium (Honeywell)	
79	Duct Type Temperature/ Rh Sensor	Schenider	ACL	Tridium (Honeywell)	
80	Air / water Switch	Schenider	ACL	Tridium (Honeywell)	
81	Level Switch	Schenider	ACL	Tridium (Honeywell)	
82	Flame Proof Level Switch	Schenider	ACL	Tridium (Honeywell)	
83	DG Voltage Transducer	Schenider	ACL	Tridium (Honeywell)	
84	Flow Meter	Forbes Marashal	Emmerson	ABB	
85	Flow Switch	Forbes Marashal	Emmerson	ABB	
86	2 Way Valve	Schenider	Tridium (Honeywell)	Danfoss	Siemens
87	BTU Meter	Landis & GRS	Shenitec	Kampstrup	Sinro
88	CO2 Sensor	Honeywell	Greystone	Siemens	

NOTE :

All The materials to be ISI marked.

The materials shall be only of the approved makes as specified in this .

The Contractor shall submit samples of all the makes as specified in this list and the Consultant / AKVN shall have the power to select any of them.

Consultant/ AKVN decision in this regard shall be binding on the Contractor.

In case any material is not available for any one or all of these approved makes the Consultant/ AKVN shall select and approve alternative make(s).

ANNEXURE – E4

PLUMBING WORKS

For all SOR items refer MPPWD SOR 2014 with effective from 1st August 2014 / NBC/ CPWD with all amendment up to date.

II) TECHNICAL SPECIFICATIONS OF PLUMBING SYSTEM FOR NON SOR ITEMS

A) SANITARY FIXTURES:

1.0 TOILETS FOR DISABLED:

Where specified in washroom facilities designed to accommodate physically handicapped, accessories should be provided as directed by the EIC

Stainless steel grab bars of required size suitable for concealed or exposed mounting and non-slip gripping surface shall be provided in all washrooms to be used by physically handicapped as directed by the EIC

B) SEWERAGE & DRAINAGE SYSTEM:

1.0 CLEAN OUT PLUGS :

1.1 Contractor shall provide cast brass clean out plugs as required. Clean out plugs shall be threaded and provided with key holes for opening. Clean out plugs shall be fixed to the pipe by a GI socket and lead caulked joint.

2.0 UPVC PIPES & FITTINGS:

The pipes shall be round & shall be supplied in straight lengths with socketed ends. The internal & external surfaces of pipes shall be smooth, clean, free from grooving & other defects. The ends shall be cleanly cut & square with the axis of the pipe.

Rainwater pipe shall be UPVC class IV conforming to IS : 4985 – 1983.

a. Fittings:

Fittings shall be of the same make as that of pipes, injection molded & shall conform to Indian Standard.

b. Laying & Jointing:

The pipes shall be laid & clamped to wooden plugs fixed above the surface of the wall, Alternatively plastic clamps of suitable designs shall be preferred. Provision shall be made for the effect of thermal movement by not gripping or disturbing the pipe at supports between the anchors for suspended pipes. The supports shall allow the repeated movements to take place without abrasion.

c. Supports:

UPVC pipes require supports at close intervals. Recommended support spacing for unplasticised PVC pipes is 1400 mm for pipes 50 mm dia and above. Pipes shall be aligned properly before fixing them on the wooden plugs with clamps. Even if the wooden plugs are fixed using a plumb line, pipe shall also be checked for its alignment before clamping, piping shall be properly supported on, or suspended from clamps, hangers as specified and as required. The contractor shall adequately design all the brackets, saddles, anchors, clamps & hangers & be responsible for their structural sufficiency. Pipe supports shall primer coated with rust preventive paint & finish coated black.

d. Repairs:

Temporary or emergency repairs may be made to the damaged pipes, permanent repairs should be made by replacement of the damaged section. If any split or chip out occur in the wall of the pipe, the repair shall be carried out by cutting the pipe and the inserting new piece of pipe of same length and bath joints (ends) should be sealed with couplers. However in horizontal lines no joint shall be given.

e. Pipe Sleeves:

Pipe sleeves, 50 mm larger diameter than pipes shall be provided wherever pipes pass through walls & slabs and annular space filled with fiberglass & finished with retainer rings. All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes & burrs removed before laying. Open ends of the pipe shall be closed as the pipe is installed to avoid entrance of foreign matter.

f. Testing:

All pipes & fittings including joints shall be tested for 3M height of water retention and lift in working conditions.

C) WATER SUPPLY SYSTEM :

1.0 NON-RETURN VALVES:

All non-return valves shall be provided as shown in the drawings conforming to relevant Indian Standards and in accordance with the following specifications.

Size	Construction	Ends
UPto 65 mm.	Gun metal	Flanged
80 mm and above	Gun metal/cast iron	Flanged

Non-return valves shall be of approved make.

2.0 WATER METERS

Water meters of approved make and design shall be supplied for installation at locations as shown. The water meters shall meet with the approval of local supply authorities. Suitable valves and chambers or wall meter box to house the meters shall also be provided along with the meters.

The meters shall conform to Indian Standard IS:779 and IS:2373. Calibration certificate shall be obtained and submitted for each water meter.

Provision shall also be made to lock the water meter. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use in conjunction with padlocks, the hole provided for padlocks shall be a diameter not less than 4mm.

2.1 Installation Of Water Meter And Stop Cock

The water supply lines shall be cut to the required lengths at the position where the meter and stop cock are required to be fixed. Suitable fittings shall be attached to the pipes. The meter and stop cock shall be fixed in a position by means of connecting pipes, jam nut and socket etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed. And the meter installed exactly horizontal or vertical in the flow line in the direction shown by the arrow cast on the body of the meter. Care shall be taken that the factory seal of the meter is not disturbed. Wherever the meter shall be fixed to a newly fitted pipe line, the pipe line shall have to be completely washed before fitting the meter.

2.2 TESTING

The Contractor shall notify the Architect three days in advance of any test so that the Architect can witness the tests if he so wishes.

All water supply system shall be tested to hydrostatic pressure test of at least one and a half (1.5) times the maximum pressure but not less than 10Kg/Sq.cm for a period of not less than 8 hours. All leaks and defects in joints revealed during the testing shall be rectified and got approved at site by retest. Piping required subsequent to the above pressure test shall be retested in the same manner.

System may be tested in sections and such sections shall be entirely retested on completion.

The Contractor shall make sure that proper noiseless circulation of fluid is achieved through the entire piping network of the system concerned. In case of improper circulation, the contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and refinishing of floors and walls as required.

In addition to the sectional testing carried out during the construction, contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings, to the building, furniture and fixtures shall be made good by the contractor during the defects liability period without any cost.

After commissioning of the water supply system, contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Owner's site representative.

3.0. VALVES

All valves (gate, globe, check, safety) shall be of gun metal suitable for the particular service as specified. All valves shall be of the particular duty and design as specified. Valves shall either be of screwed type or flanged type, as specified, with suitable flanges and non-corrosive bolts and gaskets. Tail pieces as required shall be supplied along with valves. Gate, globe and check valves shall conform to Indian Standard IS:776 and non-return valves and swing check type reflux to IS:5312.

Sluice valves, where specified shall be flanged sluice valves of cast iron body. The spindle, valve seat and wedge nuts shall be gunmetal. They shall generally have non-rising spindle and shall be of the particular duty and design as specified. The valves shall be supplied with suitable flanges, non-corrosive bolts and asbestos fibre gaskets. Sluice valves shall conform to Indian standard IS:780 and IS:2906.

Ball valves with floats to be fixed in storage tanks shall consist of cast brass lever arm having copper balls (26 SWG) screwed to the arm integrally. The copper ball shall have bronze welded seams. The closing/opening mechanism incorporating the piston and cylinder shall be non-corrosive metal and include washers. The size and construction of ball valves and float shall be suitable for desired working pressure operating the supply system. Where called for brass valves shall be supplied with brass hexagonal back nuts to secure them to the tanks and a socket to connect to supply pipe.

Globe valves on Hot-water line shall be union bonnet with stem/disc and body seat ring of SS. Suitable for temperature upto 80° C.

S.No	Type of Valve	Size	Construction	Ends
a.	Isolating Valve	15 mm to 50 mm 65 mm and above	Gun Metal Gun Metal	Screwed Flanged
b.	Sluice Valve & Butterfly Valve	65 mm and above	Cast Iron	Flanged
c.	G.M. non return valve	15 mm to 50 mm 65 mm above	Gun Metal Gun Metal	Screwed Flanged
d.	Flap Type – Non return valve	65 mm and above	Cast Iron	Flanged

All valves shall be suitable for the working pressure involved.

4.0 Pressure Reducing Valve Set

Each pressure reducing valve set shall be complete with pressure reducing or pressure regulating valve, isolating valves, pressure gauges on inlet and outlet, pressure relief valve on outlet and filter on inlet.

Each pressure reducing valve shall contain loading neoprene diaphragm and a full floating, self aligning, ignition resistant seat and shall be of the single stage, pressure reduction type with provision for manually adjusting the delivery pressure. The valve shall fail safe to the low pressure.

Valves shall be capable of operating at the maintaining automatically the respective delivery pressure and flow rates as indicated and shall not be liable to creep. Valves shall also be capable of maintaining the pre-set downstream pressure under static condition.

The filter on each inlet to a pressure reducing valve shall be of replaceable porous sintered metal type.

5.0 Pressure Relief Valves

Each pressure relief valve shall be of the fully enclosed type and fitted with hand easing gear.

Each pressure relief valve in a pressure reducing station shall have a flow capacity equal to that of the pressure reducing valve.

Pressure relief valves in locations other than reducing stations shall have flow capacities equal to that of the associated equipment.

II. TECHNICAL SPECIFICATIONS PUMPS & WTP WORKS FOR NON SOR ITEMS

A) SPECIFICATION FOR WATER SUPPLY & DRAINAGE PUMPS:

1.0 SCOPE OF WORK:

Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to supply install and commission the water supply and drainage pumps as described hereinafter and given in the Bill of Quantities and/or shown on the drawings.

2.0 GENERAL REQUIREMENTS:

2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Project Manager.

2.2 All equipment shall be of the best available make manufactured by reputed firms.

2.3 All equipment shall be installed on suitable foundations, true to level and in a neat workmanlike manner.

2.4 Equipment shall be so installed as to provide sufficient clearance between the end walls and between equipment to equipment.

2.5 Piping within the pump house shall be so done as to prevent any obstruction in the movement within the pump house.

2.6 Each pumping set shall be provided with a Ball Valve / butterfly valve on the suction and delivery side and a dual plate type return valve on the delivery side.

2.7 All delivery headers/hanging pipes within the pump house shall be floor supported.

SPECIFICATION FOR PUMPS:

3.0 PUMPING SETS FOR SOFTENER FEED PUMPS, WATER TRANSFER PUMPS :

Water supply pumps shall be suitable for Raw / clean filtered water. Pumps shall be single/multi stage, monobloc vertical/horizontal, and centrifugal pumps. Each pump should be able operate to a curve required by the operating conditions.

3.1 Specifications for Vertical in Line Multistage Centrifugal Pump

The pump shall be of vertical-in-line multistage centrifugal type suitable for speed up to 2900 rpm. The suction and discharge shall be in line with one another. The max. operating liquid temperature for the pump shall be able to withstand up to 120 deg C.

Pumps shall also be able to modify with original add on modules to suit other applications if necessary. Such applications can be increase in operating temperature up to 180 deg C, pumping aggressive liquid, horizontal mounting, belt driven, low NPSH, high inlet pressure and high pressure pumping, ETC.

Documentation shall include data booklet, pump curves, pump and motor technical data, Installation and operation manual, service and part lists, service video if any. All documentation must be available on line.

The motors shall be vertically stool mounted on top of the pump casing and the pump casing shall be designed to take the dynamic load of the motor.

The motor shall be provided with thrust bearing to cater for the downward thrust of the pump.

All pumps c/w more than 7.5kw motor size shall have design which have extended pump head, this will enable the changing of the shaft seal without lifting of the motor. A hard-wearing cartridge seal and spacer coupling shall incorporate in the pump for easy replacement. No special tool is required during maintenance. As such, minimum labor is involved in maintaining the pump.

The impeller shall be laser welded and be fitted to a rounded shaft with split cone and split cone nut. Renewable wear rings shall be provided and cater for wear and tear.

The rotating coupling shall be protected by means of a stainless steel coupling guard.

The pump component shall comply to the following material requirements:

- A) Pump Shaft - Stainless Steel AISI 316
- B) Pump Impeller - Stainless Steel AISI 316
- C) Pump Outer Sleeve - Stainless Steel AISI 316
- D) Pump Intermediate Chamber - Stainless Steel AISI 316
- E) Pump Base - Stainless Steel AISI 316

F) Staybolt - Stainless Steel AISI 316

G) Coupling Guard - Stainless Steel AISI 316

H) Shaft Seal - Stainless Steel AISI 316

I) Pump Head - Stainless Steel AISI 316

The pump performance curve shall comply to the tolerance standard according to ISO 9906 Annexure A.

Electric Motors

The electric motor shall be of EFF 1, and C E marking, with totally enclosed fan cooled squirrel cage induction type suitable for operation on a 380V - 415V/3/50Hz voltage supply. The motor shall be design based on 40 deg C ambient temperature and up to a max. of 2900 rpm. The motor shall be of class F insulation and IP55 enclosure with a max. surface temp. of not more than 150 deg C.

The motor shall comply with the requirement of BS4999 or other compatible IEC standard.

Direct on line starting method are requirement for motor up to 2.2 kW and star delta starting are required from 3 kW onwards.

All motors shall be sized for pumping operation based on non overloading conditions.

The motor shall be suitable for 20 start/stop per hours.

All motor must comply to the followings efficiency ranges for energy conservation:

A) 0.37 kW – 1.1 kW - 82% and above

B) 1.5 kW – 7.5 kW - 84% and above

C) 11 kW and above - 90% and above

The terminal box shall be positioned to accept cables which rise vertically from below or alternatively in such a way as to accept cable from a cable tray without stress being introduced to the cable.

3.2 Specifications for Horizontal Split Case Centrifugal Pumps

General Specifications

3.2.1 The contractor shall furnish and install pumps as outlined on the equipment schedule and described in these specifications.

Pumps shall be of a single stage double suction horizontal split case centrifugal pump(s) or equal, designed to deliver the scheduled flow rate (in LPS), the specified total dynamic head (in m), at the scheduled efficiency and scheduled speed (RPM).

To insure maximum efficient throughout the operating range, the proposed pumps duty point shall be as closed as possible to the pump BEP.

The efficiency curves of the proposed pumps shall have broad bands characteristic.

To insure cavitations-free operation, each pump's NPSH requirement must be low enough to permit stable, continuous operation at 120% or greater of best efficiency point.

Each Pump shall be factory hydrostatically tested per HI standards.

It shall then be thoroughly cleaned and painted with at least one layer of primer and follow with finishing coats prior to shipment.

3.2.2 Pump Casing

Pumps shall have the upper and lower halves casing divided on the horizontal centerline.

The casing halves shall be accurately machined; bolted and doweled together.

A non-asbestos type gasket material shall be furnished between the casing halves.

The casing material shall be close-grained cast iron with a minimum tensile strength of 35,000 PSI. The grade of cast Iron shall be ASTM A48 Class 30 or equal. Pump casing shall be suitable for 175 or 250 PSI working pressure.

Pump suction and discharge flanges shall be #125 or #250 ANSI and be machined flat face.

Casing shall be supplied with plugged vent, drain and gauge tapping ports.

Casings shall be compensated dual volute design suitable for the scheduled working pressure and shall be hydrostatically tested at 150% of the maximum working pressure under which the pump could operate at the designed rated speed.

Pumps shall be fitted with lead-free bronze renewable case wear rings indexed with a dowel pin for fixed positioning. Material grade of wear rings shall be ASTM B148, C95400 or equal.

Removal of the upper casing half and bearing housings shall permit removal of the complete rotating assembly without disturbing piping connections.

3.2.3 Seal & Bearing Housing

Pumps shall be provided with removable bearing housings, which will permit inspection and/or replacement of the mechanical seals, shaft sleeves, and bearings without removing the rotating assembly or upper casing half.

Pumps shall provide with suction baffles to insure smooth suction inflow and even suction distribution insuring quiet and vibration free operation.

Bearing housing shall be bolted to the upper and lower casing halves for a full 360-degree support registered fit to insure positive alignment.

3.2.4 Pumps Impeller

The lead-free bronze/Stainless steel impeller shall be an enclosed Francis vane type, double suction design, hydraulically and dynamically balanced.

The grade of the impeller material shall be ASTM I836, C89833/ANSI SS 304 or equal.

The impeller is to be securely mounted on the pump shaft, and attached with a steel key.

The impeller shall be locked in position by threaded shaft sleeves. The impeller shall be trimmed to meet the specific hydraulic requirements.

3.2.5 Impeller trim must be equal to or less than 90% of maximum diameter, which will fit into the pump casing.

3.2.6 Pumps Shaft

The pump shaft shall be of 300 series Stainless steel equal to AISI SS420, precision ground to provide a true running rotating element.

To insure good rigidity and strengths of the pump shaft, the shaft diameter at the impeller section shall be 3.175 mm (1/8") larger than the rest of the section.

3.2.7 Pumps Bearings

The pump shaft shall be adequately supported by the pump bearings to limit the shaft deflection to 0.002 inches.

Bearings shall be ball type, grease lubricated and locked to the shaft with positive locks of ample size to withstand any axial thrust loads. Bearing shall provide a minimum life of 10 years when calculated at 50% of Best-Efficiency-Point for the scheduled pumps.

3.2.8 Pumps Shaft Seals

The pump manufacturer shall recommend the proper mechanical seal based on the pressure, temperature and liquid outlined on the equipment schedule.

Mechanical seals, at a minimum, shall have ceramic stationary seat against Carbon on rotating sealing face; and Buna elastomers or other suitable materials for continuous operation at 225 deg F. (100 deg C)

The shaft seals shall be capable of being serviced/replacement without disconnecting of the pump from piping and opening of the pump upper casing.

3.2.9 Pumps Shaft Sleeves

Pumps shall be provided with Lead-free bronze or SS 303 shaft sleeves and shall be firmly attached to the pump shaft through threading and locking means.

Shaft sleeve design shall prevent corrosion and wear to the shaft. Material grade of shaft sleeve shall be ASTM A836, C89833.

3.2.10 Pumps Base, Coupling and Guard

The pumps shall be mounted on fabricated steel base and directly connected through a heavy-duty flexible coupling to a horizontal motor as outlined in these specifications.

The pump manufacturer shall provide an OSHA coupling guard, which shall be mounted between the pump and motor and attached firmly to the base.

The minimum base plate stiffness shall conform to ANSI/HI 1.3.4-1997 for Horizontal Base-plate Design Standard.

3.2.11 Electric Motors

The motor shall be sized to operate continuously without exceeding the horsepower rating (as outlined in the schedule) regardless of the flow and head throughout the operating range of the "System Curve."

Motors shall be Squirrel Cage Induction type in accordance to IEC design, TEFC, IP 55 enclosure with Class F insulation, EFF I or II and suitable for continued operation.

Motors shall be suitable for 380V-415V/3P/50Hz-power supply.

3.2.11 Motors that used with VFD shall be of spike resistance winding and equipped with temperature sensor for protect the motor winding due to over-temp.

General Specification for Pumps Installation

Pump and motor shall be pre-aligned at the manufacturer factory. The contractor shall realign the pump and motor at site before start up.

Alignment limits shall be according to the standards of the Hydraulic Institute or manufacturer recommendation and shall be carried out with laser alignment tools or dial gauges.

Site realignment shall be carried out after grouting of base, connection of piping; system and pump casing completely bleed and filled with pumping fluid.

If pump sets are installed on inertia base, it shall be properly leveled by adjusting the vibration isolation dampers below the inertia block.

The contractor shall insure that the pumps foundation/inertia blocks are accurately sized; the pump set seating face shall be properly leveled. Pump set shall be properly installed and bolted in position by anchor bolts.

Piping connected to the pumps flanges must be properly aligned, free of stresses and forces.

The contractor shall insure that pumps submitted will meet the design flow, head and efficiencies as outlined in the equipment schedule.

3.3 Specification of End Suction, Vertical Split Case Centrifugal Pumps

Pumps should be Non self priming, single stage, horizontal end suction pumps centrifugal volute pumps with back pull out design with axial suction port, radial discharge port and horizontal shaft components.

Pump design should allow the pump to remain in place (without disturbing suction & discharge pipelines) during the maintenance.

Pumps should be dynamically balanced and impellers should be hydraulically balanced. Shaft seal should be of unbalanced mechanical seal type. Seal faces should be Carbon/Silicon Carbide.

The pump casing should be in Cast Iron. The shaft should be of Stainless Steel AISI 304/ 420. The impeller should be made of Bronze. The speed of rotations of pumpsets should not be more than 2900 rpm.

The pump housing, the motor stool and the motor stator housing should be electrocoated (CED coated i.e Cathodic Electro Deposit) and the treatment should include:

- a) Alkaline cleaning.
- b) Pre-treatment with zinc phosphate coating.
- c) Cathodic electrocoating (epoxy).
- d) Curing of paint film as 200-225 deg C.

3.3.1 Normal painted/spray painted pumps will not be accepted

Pump should be short/long coupled with the suitable motor at the factory only. Complete pump-motor set should be tested for the desired duty point. Assembly of the pump-motor at site will not be accepted.

3.3.2 MOTOR

The pump should be directly coupled to motor, which should be totally enclosed, fan cooled, squirrel cage motor with main dimensions according to IEC. Enclosure class should be IP 55 with "F" insulation Class. Motors should be of minimum efficiency – II class. The motor rating should be such as to ensure no

overloading of the motor throughout its capacity range. Motor shall be suitable for 3 phase, 380-415 V, 50 Hz.

Note: Any Pump or the whole set shall be stable on rubber vibration eliminating pads appropriate for each pump as recommended by the manufacturer and accepted by the Project Managers.

3.4 PUMPS FOR DRAINAGE AND SEWAGE:

3.4.1 SPECIFICATIONS FOR SUBMERSIBLE SEWAGE GRINDER PUMPS

PUMP

The Pump casing shall be of cast iron. Pump casing shall be easily removable from the motor for full inspection of impeller. The pump should constitute a grinder system, which cuts destructible solids to even smaller pieces.

The impeller shall be of semi-open centrifugal flow design. Impeller material shall be cast iron or ductile iron, and the impellers shall be statically and dynamically balanced with **no wear rings**.

The suction clearance between impeller and pump casing in pumps with semi-axial centrifugal impellers shall be in the axial direction only.

The clearance must be fully adjustable with adjusting screws.

Other major pump components shall be of cast iron. All exposed fasteners and lock washers shall be of stainless steel.

Material of construction :

Pump Casing : Cast Iron

Impeller : Cast Iron

Pump Shaft : Stainless Steel

Mechanical Seal Primary : SiC / SiC

Secondary : SiC / Carbon

3.4.2 PUMP MOTOR

The motor shall be watertight according to IEC class IP 68, and incorporate class F , insulation materials to withstand a continuous operating temperature of 155 deg C. The pump and motor shall be able to operate continuously submerged in and capable of handling liquids with a maximum temperature of 40 deg C.

Motor housing shall be of cast iron. The rotor shall be solid cast and dynamically balanced. The pump shaft shall be of stainless steel or high-tensile steel with protective sealed stainless steel shaft sleeve. Shaft bearings shall be permanently grease-lubricated and sealed for life.

Double mechanical cartridge shaft seals shall be provided. The seals shall be oil-lubricated.

The seal springs located inside the oil housing should be fully protected from the pumped liquid. The mechanical seals should be able to withstand rotation on either side.

All static seals at watertight joints shall be nitrile O-ring type. Power and control cables shall be clamped against tensile loads and have a serviceable inlet to the motor, with a hermetically sealed polyurethane filled, stainless steel cable plug connection . The pump and electric cables shall be capable of continuous

submergence, without loss of waterproof integrity to a depth of 20 m. The motor must be designed to take a minimum of 10 starts per hour.

The motor shall have internal protection devices, consisting of thermal switches embedded in the stator windings. Provision to check the insulation resistance to be provided.

3.4.3 SUBMERGED INSTALLATION

Each pump shall be provided with a guide shoe attached to the pump discharge flange. **A replaceable Neoprene Seal shall be provided as an integral part of the guide shoe to form a seal to avoid metal to metal contact with the base plate.**

The guide shoe shall direct the pump down two vertical guide rails and onto the discharge connection in a simpler linear movement. No portion of the pump shall be supported directly on the bottom of the wet well, guide rails or lifting chain.

The base plate shall be designed with an integral 90 deg elbow, or adapt to a commercially available elbow.

Control Panel for Sewage/Drainage pumps:

Design, fabrication, assembling, wiring, supply, installation, testing and commissioning of control panel fabricated out of 14 gauge CRCA sheet steel in with reinforcement of suitable size angle iron, channel „□ sections irons and/or flats wherever necessary. Cable gland plates shall be provided on top as well as at the bottom of the panels. Panels shall be treated with all anticorrosive process before painting as per specifications with 2 coats of red oxide primer and final approved shade of powder coated paint. 2 Nos. earthing terminals shall be provided for 3 phase, 4 wire, 50 Hz supply system. Lifting hooks shall also be provided in case of large panels. Approval shall be taken for each panel before fabrication. Cadmium Plated hardware shall be used in fabrication of panels.

Panel should have the following features/components as minimum:

- a. Auto – Manual selection of the pumps. In case of Auto mode pumps shall run on the basis of float level switches. Each pump will have its own float level switch.
- b. Single-phase preventer.
- c. Changeover of pumps to ensure equal wear and tear of all the pumps.
- d. 0-500 volts square digital or analog voltmeter with selector switch protected by 2 amps TP MCB- 1 Set
- e. 0-300 amps square digital or analog ammeter with selector switch and 300/5 amps 10 VA CL: 1 CTs. – 1 Set
- f. Phase indicating lamps protected by 2 amp SP MCB - 3 Sets
- g. Starters with overload relays, MCB`s etc as per the rating and quantity of the selected pumps.
- h. Push buttons for manual start of the pumps. Quantity should be as per the BOQ/number of pumps.
- i. Indicating lamps for phase, start/stop/trip and high-level indication.
- j. Potential free contacts for start, stop and trip of the pumps through BMS (in Manual mode).
- k. Necessary internal wiring, interlocking, earthing for all equipment shall also included

3.4.4 SPECIFICATIONS FOR SUBMERSIBLE DRAINAGE PUMPS

PUMP

The Pump shall be rugged heavy-duty. Casing of the pump shall be of cast iron.

The impeller shall be of semi-open centrifugal flow design. Impeller material shall be cast iron and the impellers shall be statically and dynamically balanced with **no wear rings**.

The drainage pump shall be with steel strainer to avoid clogging.

Other major pump components shall be of cast iron. All exposed fasteners shall be of stainless steel (i.e SS 304).

The Drainage pump shall be provided with Triple Sealing system for most reliable sealing. The sealing system consists of double mechanical seal or tandem Seal and additional lip seal located directly behind the impeller to protect against contamination.

Material of construction:

Pump Casing : Cast Iron

Impeller : Cast Iron

Rotar Shaft : Stainless Steel

Mechanical Seal Primary : SiC / SiC

Secondary : SiC / Carbon

Additional Lip seal :

PUMP MOTOR

The motor shall be according to NEMA Design B, class ,IP 68, and incorporate class H , insulation materials to withstand a continuous operating temperature of 180 deg C. The pump and motor shall be able to operate continuously submerged in and capable of handling liquids with a maximum temperature of 40 deg C.

Motor housing shall be of cast iron. The rotor shall be solid cast and dynamically balanced. The pump shaft shall be of **Stainless steel or high-tensile steel. Shaft bearings shall be permanently grease-lubricated and sealed for life.**

Double mechanical shaft seals shall be provided. The seals shall be oil-lubricated.

The seal springs located inside the oil housing should be fully protected from the pumped liquid. The mechanical seals should be able to withstand rotation on either side.

All static seals at watertight joints shall be nitrile O-ring type. Power and control cables shall be clamped against tensile loads and have a unique two part, integrally molded cable entry to provide water tight sealing. The pump and electric cables shall be capable of continuous submergence, without loss of waterproof integrity to a depth of 20 m. The motor must be designed to take a minimum of 15 starts per hour.

The motor shall have internal protection devices, consisting of thermal switches embedded in the stator windings. Provision to check the insulation resistance to be provided.

Control Panel for Drainage pumps:

Design, fabrication, assembling, wiring, supply, installation, testing and commissioning of control panel fabricated out of 14 gauge CRCA sheet steel in with reinforcement of suitable size angle iron, channel „□ sections irons and/or flats wherever necessary. Cable gland plates shall be provided on top as well as at the bottom of the panels. Panels shall be treated with all anticorrosive process before painting as per specifications with 2 coats of red oxide primer and final approved shade of powder coated paint. 2 Nos.

earthing terminals shall be provided for 3 phase, 4 wire, 50 Hz supply system. Lifting hooks shall also be provided in case of large panels. Approval shall be taken for each panel before fabrication. Cadmium Plated hardware shall be used in fabrication of panels.

Panel should have the following features/components as minimum:

- a. Auto – Manual selection of the pumps. In case of Auto mode pumps shall run on the basis of float level switches. Each pump will have its own float level switch.
- b. Single-phase preventer.
- c. Changeover of pumps to ensure equal wear and tear of all the pumps.
- d. 0-500 volts square digital or analog voltmeter with selector switch protected by 2 amps TP MCB- 1 Set
- e. 0-300 amps square digital or analog ammeter with selector switch and 300/5 amps 10 VA CL: 1 CTs. – 1 Set
- f. Phase indicating lamps protected by 2 amp SP MCB - 3 Sets
- g. Starters with overload relays, MCB`s etc as per the rating and quantity of the selected pumps.
- h. Push buttons for manual start of the pumps. Quantity should be as per the BOQ/number of pumps.
- i. Indicating lamps for phase, start/stop/trip and high-level indication.
- j. Potential free contacts for start, stop and trip of the pumps through BMS (in Manual mode).
- k. Necessary internal wiring, interlocking, earthing for all equipment shall also included

Panel should be complete in all respect.

3.4.5 SPECIFICATIONS FOR SUBMERSIBLE SEWAGE PUMPS

PUMP

The pump shall be Submersible drainage pump type with Vertical single-stage stainless steel submersible type with vertical discharge port and integrated

Submersible single or three phase totally enclosed motor in insulation class F.

The pump shall be fitted with a suction strainer for screening of larger particles.

The pump shall be for ready to use and supplied with a control box including motor starter (in case of 3 Phase) and motor protection. The pump shall be supplied with level switch for automatic start and stop and 10 m level switch cable and of the plug type with glass sealing compound in the socket to prevent penetration of humidity into the stator windings..

The impeller shall be Semi-open/Vortex impeller for 12/35/50 mm free passage suitable for pumping groundwater, surface water, rain water and similar.

The pump shall have a double shaft seal and an intermediate oil chamber pre-filled with non-toxic special oil.

The pump shall have a riser pipe, a cooling jacket for continuous cooling of the motor by the pumped liquid and long-life deep-groove greased-for-life ball bearings.

PUMP MOTOR

The motor shall be watertight according to IEC class IP 68, and incorporate class F , insulation materials to withstand a continuous operating temperature of 155 deg C. The pump and motor shall be able to operate continuously submerged in and capable of handling liquids with a maximum temperature of 55 deg C.

The pump shaft shall be of stainless steel or high-tensile steel with protective sealed stainless steel shaft sleeve. Shaft bearings shall be permanently grease-lubricated and sealed for life.

The specifications of the Control Panel for Sewage pumps shall be same as that for drainage pumps as mentioned above

4.0 LEVEL CONTROLLERS :

4.1 Level controllers for all water supply pumps shall be electronic low voltage type using required number of stainless steel type probes, shrouded in PVC sheath or encapsulated in a stainless steel pipe.

4.2 Level controllers for all drainage pumps shall be Polypropylene level switch, hermetically moulded, double chamber and should be mercury free operated micro switch with adjustable switch differential.

5.0 PIPE & FITTINGS (FOR HEADERS AND CONNECTIONS) :

5.1 Pump suction and delivery headers shall be galvanized iron pipes heavy class with matching fittings. The pipe joints shall be threaded as per manufacturer's instructions.

5.2 Vibration Eliminators :

Provide on all suction and delivery lines as shown on the drawings double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connectors shall be as per site requirements in accordance with manufacturer details.

6.0 Valves :

6.1 Butterfly Valves:

All valves 65 mm dia and above shall be C.I. slim seal butterfly valves or sluice valve. Butterfly valves shall be of best quality conforming to I.S. 13095 of class specified.

6.2 Non-Return Valves (Check Valves):

Non-return valves shall be cast iron dual plate type with cast iron body and gunmetal internal parts conforming to IS: 5312.

6.3 Ball Valves:

All valves of 50 mm dia and below shall be heavy duty ball valve of S.S. / bronze body, screwed ends suitable for a test pressure of 25kg/sqcm.

7.0 PAINTING AND CLEANUP:

a) On completion of the installation contractor shall scrub clean all pumps, piping, filters and equipment and apply one coat of primer as required.

b) Apply two or more coats of synthetic enamel paint of approved make and shade on steel pipes.

c) Provide painted identification legend and direction arrows on all equipment and piping as directed by Project Manager.

d) On final completion of the work, contractor shall cleanup the site Pump room of all surplus materials rubbish and leave the place in a broom-cleaned condition.

8.0 MEASUREMENT:

Measurement shall be as per the general guidelines of quantity.

B) WATER TREATMENT EQUIPMENT:

1.0 GENERAL REQUIREMENTS:

1.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Project Manager.

1.2 All equipment shall be of the best available make manufactured by reputed firms.

1.3 All equipment shall be installed on suitable foundations, true to level and in a neat workman like manner.

1.4 Equipment shall be so installed as to provide sufficient clearance between the end walls and between equipment to equipment.

1.5 Piping within the pump house shall be so done as to prevent any obstruction in the movement within the pump house.

2.0 WATER FILTERS FOR DOMESTIC WATER SUPPLY :

2.1 Water filter shall be designed in accordance with the code of unfired pressure vessel conforming to I.S. 2825.

2.2 Water filter shall be pressure dual media/activated carbon filter may be altered to suite contractor's own design of the most efficient performance.

2.3 Filters shall be vertical type of required diameter. The shell and dished ends shall be fabricated from M.S. sheet. Tank suitable to with stand a working pressure given in Bill of Quantities. The shell shall have a minimum thickness of 6 mm and dished ends 8 mm or as per manufactures recommendations.

2.4 Each filter shall have at least one pressure tight manhole cover for inspection and repairs.

2.5 Each filter shall be provided with screwed or flanged connections for inlet, outlet individual drain connections and all face piping, diaphragm valves and all other connections necessary and required.

2.6 Face piping shall be G.I. class „C“ as per IS : 1239 – Part I.

3.0 CHEMICAL DOSING PUMP :

3.1 Chemical dosing system comprising of metering pump, 100 lts. Capacity FRP / HDPE solution tank with level gauge and lid on top.

3.2 Motor driven metering pump with mechanically activated diaphragm with oil lubricated gear mechanism. The output of the plug should be adjustable operation from 10-100%. Pump construction shall be corrosion resistant polypropylene or similar material dosing pump shall be used for :

3.3 Each pump shall be provided with an injector assembly with suction and delivery piping complete in all respects.

4.0 WATER SOFTENER:

4.1 Softeners shall be designed in accordance with the code of unfired pressure vessel conforming to I.S. 2825.

4.2 Softeners shall be designed to give required hardness. Softener shall provided with suitable grade of Cation exchange resins in quantity to be indicated by the contractor at the time of tendering.

4.3 Softener vessel shall be fabricated from MS sheet with dished ends and self supporting arrangement. Vessel shall be suitable for a working pressure given in bill of quantities. The shell shall have a minimum thickness of 6 mm and dished ends 8 mm or as per manufacturer recommendation.

4.4 The vessel shall have an internal collecting and distribution system of manufacturer's design.

4.5 Softener shall have a set of face piping for inlet, outlet brine injection with all valves. Suitable drain shall be provided. Pipes shall be GI class „C“.

4.6 One set of hydraulic injector with control valve, brine delivery pipes with adjustable indicating lamps.

4.7 One cylindrical FRP saturator and mixing tank, provided with brine delivery piping with adjustable level indicating clamp and control valves complete. The tank shall be of capacity as given in the schedule of quantities.

4.8 One orifice board for indicating wash and rinse rate to be filtered in drain sump.

4.9 One charge of supporting gravel, sand and "Cation" resin in requisite quantity.

4.9.1 One water testing kit with instructions for testing water samples.

5.0 PIPE AND FITTINGS (FOR HEADERS AND CONNECTIONS) :

5.1 Pump suction and delivery headers shall be of approved corrosion resistant material with matching fittings. The pipe joints shall be threaded or as manufacturer's instructions.

5.2 Valves :

- Valves 65 mm dia and above shall C.I. Slim Seal butterfly valves (PN 1.6).
- Valves up to 50 mm dia shall be ball valve.
- Non return valve shall be CI dual plate type non return (PN1.6).

C) COMMISSIONING AND GUARANTEES :

1.0 SCOPE OF WORK:

Work under this section shall consist of precommissioning, commissioning, testing and providing guarantees for all equipment, appliances and accessories supplied and installed by the contractor under this contract.

2.0 GENERAL REQUIREMENTS:

2.1 The rates quoted in this tender shall be inclusive of the works given in this section.

2.2 Contractor shall provide all tools equipment, metering and testing devices required for the purpose.

2.3 On award of work, contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

3.0 PRECOMMISSIONING:

3.1 On completion of the installation of all pumps, piping, valves, pipe connections, and water level controlling devices the contractor shall proceed as follows :-

A. Pipe work:

- i) Check all clamps, supports and hangers provided for the pipes.
- ii) Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specifications. If any leakage is found, rectify the same and retest the pipes.

4.0 COMMISSIONING & TESTING:

A. Handing over:

- i) All commissioning and testing shall be done by the contractor to the complete satisfaction of the Project Manager, and the job handed over to the Project Manager, or his authorised representative.
- ii) Contractor shall also handover, to the Project Manager, all maintenance & operation manuals and all other items as per the terms of the contract.

D) ELECTRICAL INSTALLATIONS:

1.0 GENERAL:

This section covers the general requirements for electrical work to be installed under this specification.

The Contractor shall supply and install all electric wiring, switchgear etc., necessary for the complete, safe and satisfactory operation of the plant covered by the Specification. All electrical wiring and cables shall be properly tagged to the satisfaction of the Consultant / E-i-C

All equipment provided shall be „tropicalized“, i.e. designed for use in conditions up to 50oC ambient air temperature and 100% relative humidity.

All equipment, materials, workmanship and fittings shall comply with the appropriate Indian Standard or Code of Practice as listed in the relevant paragraphs of this Section, or any approved equivalent international standards.

2.0 ELECTRICAL SUPPLY:

The electricity supply shall be 415/240 Volts, 50 Hz, 3 phase, 4 wire. All equipment shall be designed to operated with a + 10% voltage tolerance without a loss of rated output. All equipment shall be connected to ensure that the phases are balanced, to the requirements of the local supply authority.

3.0 SWITCHBOARDS AND SWITCHBOARD EQUIPMENT:

a) Motor Control Panel :

Control panels shall be self-contained suitable for the location indicated and an operating environment of 50 degree C, built up of enclosed compartments conforming to form 3B as per BS 5486 Part-I : 1990 and IEC 439-1 to preclude fault transference between sections of the switchboard.

Control panels shall be arranged for the maximum safety of personnel. All power wiring and busbars shall be fully enclosed with isolating and insulating barriers and interlocks provided to ensure maximum safeguards. All switches shall be lockable in both of the „OFF“ or „ON“ positions.

Control panel shall be of the floor standing, type tested modular design, totally enclosed “dead front” type, consisting of dished front panels and doors built up on an approved substantial mild steel angle or channel

frame with no cross-struts, and shall be fitted with removable rear and end panels held in position with six fixing points.

All panels and doors shall be constructed of best quality, dead-flat CRCA MS sheet not less than 2 mm thick. Neat cutouts shall be provided in dished panels to allow the exposure of circuit breaker escutcheons and toggles, and switch operating handles and indicators only. The edges of all outlets and drilled holes shall be burr free.

Doors shall be stiffened and provided with metal based neoprene gaskets and concealed non-ferrous door hinges. Door handles shall be chrome plated and incorporate a barrel type locking mechanism and shaft adjustment for increasing sealing pressure.

All switches/MCCB shall be provided with mechanical interlocks to prevent any positive access to any equipment inside the cubicle when the switch is in the „ON“ position.

Dished panels shall be stiffened and held in place with chrome plated castle head nuts attached to fixed studs of not less than 10mm nominal diameter. All fixing hardware shall be cadmium plated.

The removable rear panels shall be provided with a pair of handles for easy fixing/removal of the panels.

Provision shall be made for lifting cubicle switchboards. Eye bolts shall not be used when subjected to shear stresses.

Adequate provision and space shall be provided for bending and connecting cables, which shall be separated from switchboard busbars.

All internal small wiring shall be PVC insulated, neatly, bunched and run on supporting cleats or in trunking, colour coded and labeled or sleeved for identification. All switch-board small wiring is to terminate on labeled terminal boards or strips to which external connections are made.

Insulators, including busbar supports, shall be non-hygroscopic and non-deteriorating. The use of fibrous materials, linseed oil, varnish, “Presspalin”, etc is prohibited.

Low voltage switchboards shall be constructed to withstand a system fault level of 25 KA at 415 volts for 1 seconds. Low voltage switchboards shall be designed to comply IS : 13947-1993.

Type test certificates, issued by an reputable and independent testing authority such as CPRI certifying the circuit breaker, busbar and its enclosure shall be submitted for review.

Ventilating water-proof louvers are to be provided on the sides and back and are to be of approved design with internal dust baffles.

Where ventilating fans are installed, a low level, filtered air intake shall be provided. The filter shall be removable from outside the switchboard.

Current transformers shall be mounted without reduction of busbars or connections and arranged for ease of removal.

b) Wall Mounted Panel:

Wall mounted panels with an appropriate rating and number of circuits shall be provided to supply power to plant located throughout the building.

Panel enclosures are to be fabricated from CRCA sheet metal of minimum 2 mm thickness and finished in enamel of a colour to the approval of the Architect. Inside the enclosure door, a circuit chart indicating the number of ways, location of equipment, loading and protection rating shall be fixed.

All wiring terminations, busbars, and live parts within the panel board shall be adequately shrouded and an insulating front shield of minimum 1.6mm thickness shall be provided to completely screen the unit's interior. Only the operating dolly and insulated surround shall project through the shield.

The units are to be provided with sufficient wiring ways for outgoing circuits at both the top and bottom of the board. Space for future ways shall be provided.

c) Busbars :

All busbars shall be made of hard drawn high conductivity aluminium. Conductor conforming to grade 91E of IS 5082-1981, making and arrangement of the busbars, connections and auxiliary wiring shall be to relevant Indian Standard. Bus bars shall be insulated with heat shrunk PVC sleaving of 1.1 KV grade and Bus bar joints shall be provided with clip on shrouds.

Busbars shall be adequately rated and supported by porcelain or moulded insulators spaced at suitable intervals, the complete assembly being capable of withstanding the maximum mechanical stress to which it may be subjected under fault conditions. Full size neutral bars shall be provided.

Busbars shall be so arranged that all conductors can be brought onto the bars without undue bending.

Conductors between the busbars and MCCBs or isolators are to be high conductivity aluminium bar having a current rating of not less than that of the switches to which they are connected. The conductors are to be insulated with PVC sheathing and colour coded for phase identification.

Removable bolted links shall be provided for the accommodation of current transformers for metering and protection facilities without affecting the mechanical and electrical properties of the busbars as a whole.

d) Moulded Case Circuit Breakers (MCCBs) :

All moulded case circuit breakers shall conform to IS : 13947-1993, and be of one approved manufacture throughout the project.

The body and base of the units are to be moulded and the units are to be sealed after assembly.

The load handling contacts are to be silver/tungsten and the contacts and operating mechanism so designed as to give a wiping action both at make and break.

The breaker operating mechanism is to be of the trip-free type so designed to prevent the load handling contacts from closing on a fault.

The toggle handle shall open and close all poles of a multipole circuit breaker simultaneously. A fault on one pole shall open all poles.

The MCCBs shall have the fault level rated as per schedule of quantities.

Circuit protection against overload and fault conditions is to be provided by means of a thermal-magnetic device designed to give thermal operation on overload and magnetic operation under fault conditions.

The position of the breaker operating dolly is to be clearly indicated for „ON“ and „OFF“.

MCCBs shall be suitable for use at temperatures of 50oC Ambient.

e) Miniature Circuit Breaker :

Single pole or triple pole miniature circuit breakers (MCB) are to be used for sub-circuit protection.

All MCBs shall conform to IS : 8828-1996. The body and base of the units are to be moulded bakelite or similar material and the units are to be sealed after assembly.

The load handling contacts are to be silver/tungsten, and the contacts and operating mechanism shall be so designed as to give a wiping action both at make and break.

The breaker operating mechanism is to be the trip free type. A thermal-magnetic time tripping mechanism is to be included for circuit protection against overload and short circuit. Short circuit level of MCBs shall not be less than 10 KA.

Tripping characteristics of MCBs shall be able to discriminate with up stream breakers.

f) Isolators :

All isolators whether mounted in a cubicle type switchboard or separately mounted shall be heavy duty type conforming to the requirements of IS : 13947-1993. All contacts are to be fully shrouded and are to have a breaking capacity on manual operation as required by British Standards.

Operation of switches shall be independent of the operator's control, with a quick make/quick break action.

The links for switch are to be high rupturing capacity.

The category of duty of the main switchboard, submain switches and cable tee-offs shall be as indicated in the schedules.

Switches and isolators mounted in cubicle type switch-boards are to be enclosed in separate sheet metal compartments, and mechanical interlocks are to be provided between the cubicle doors and the switch operating mechanisms, so arranged that the cubicle door may not be opened with the switch in the „ON“ position. Similarly it shall not be possible to close the switch with the cubicle door open, except that provision shall be made within the cubicle for authorized persons to defeat the mechanical interlock for test purposes, and close the switch with the door in the open position.

The „ON“ and „OFF“ positions of all switches and isolators shall be clearly indicated by a mechanical flag indicator or similar device.

In TPN switch units, bolted neutral links are to be fitted. For single pole and neutral switches and isolating switches, the neutral conductor is to be taken through a bolted link.

g) Contactors :

Contactors or control relays are to be single or triple pole, conforming to IS : 13947-1993 (part IV Section 3). The rating shall be as noted on the drawing but in any case, shall not be less than 10A or the rating of the circuit, whichever is the greater. All ratings shall be “continuous” and all contacts shall be silver plated. Contactor coils shall operate from the supply provided.

h) Measuring Instruments and Protection Relays :

All ammeters and voltmeters for use in conjunction with switch-gear are to be of the moving iron pattern to comply with relevant Indian Standard.

Unless otherwise specified, all meters are to be 96mm dial square flush pattern with quadrant scales.

Ammeters with scale deflections greater than 100A installed in the Switch Board shall indicate all phase and neutral currents.

All ammeters shall have a continuous overload capability of 120% of the upper limit of the scale for two hours. Each ammeter shall be provided with an adjustable red index pointer to indicate the normal full load current.

Ammeters shall be provided for motors of 5.5KW or larger and they shall be capable of starting current and shall have a compressed overload scale for this purpose. Motor current reading shall be provided on one phase only.

Voltmeters shall be of accuracy Class 2 and have expanded scales.

Voltmeters shall be connected to the incoming side of the power supply through 6 ampere MCBs.

Mechanical zero adjustment shall be provided for voltmeters and ammeters by means of a screw slot at the face of the meters.

Energy and maximum demand meters shall be installed as specified. Energy meters shall provide a direct, single, digital reading, without the need to apply multiplication factors.

Earth fault and overcurrent protection relays shall be as specified in the drawings.

Current transformers for measurement and protection shall be of ring pattern, clamped on readily removable, bolted copper links with accessible terminals.

Selector switches of the rotary type shall be provided to enable all phase currents and all phase and phase to neutral voltages to be read.

Instrument MCB shall be mounted on the panel adjacent to their associated instruments.

All instrument and indicating lamp wiring behind hinged front panels shall be protected by clear acrylic sheets.

The arrangement, scale deflections and ratios of all instruments and relays shall be approved prior to assembly of the associated switchboard.

i) Labelling :

All items of equipment on the switchboard shall be labeled to indicate function with black Traffolyte labels and white engraved lettering securely fixed with chrome plated screws. Lettering shall be at least 10mm high. Labels to all switches, isolators and the like shall indicate the supply and cable details. All labels shall be approved prior to engraving.

The use of adhesive labels will not be permitted. All electrical equipment not mounted on the switchboard shall also be labeled as specified above.

j) Time Delays.

Time delays shall be provided to prevent the simultaneous starting of any two motors above 3.5 kW and to prevent short cycling of automatically controlled motors.

k) Control Switches.

All control switches shall be of the rotary type of approved manufacturer.

Each control switch shall be panel mounted and engraved to clearly indicate the equipment controlled or function of the switch.

l) Indicating Lamps. :

Indicating lamps shall be individual flush mounted units. Lamps shall have chromium plated and polished solid brass body and ring with metallic threaded section and shall be circular in shape of approximately 22 mm diameter.

Indicating lamps shall be of 240/110 V and rated to withstand not less than 20% continuous over voltage.

Lamps shall be well ventilated and the design shall permit removal of lamp glasses and bulbs from the front of the unit without the need of any special tool.

A push button lamp test facility shall be provided for all switchboards.

Indicating lamps shall be colour coded as follows:

Green - Motor stopped, circuit breaker OFF.

Amber - Supply available.

White - Valve open, circuit breaker auto trip.

Red - Motor running, circuit breaker ON.

Blue - Valve closed.

Control circuit shall be of 240V supply.

m) Push Button Switches:

Push button switches shall comply with and be tested and certified to relevant Indian standard. Electrical rating shall be 500V AC or 250 V DC as appropriate. Push buttons for alarm duty shall be minimum of 2 amp rated Push buttons for control duty shall be 10 amp rated.

Push buttons shall be individual flush mounted units with metallic chromium plated and polished solid brass body and ring, circular in shape and approximately 20mm diameter.

Unless specified otherwise, push buttons shall be colour coded as follows :

Green - Start motor

White - Open valve

Red - Stop motor

Blue - Closed valve.

Black - Reset protection/alarm, lamp test

Yellow - Accept alarm

n) Earth System :

All metal work associated with the switchboard installation not forming part of a phase or neutral circuit shall be bonded together and shall be solidly and effectively earthed through the system provided by the Main Electrical Contractor. Continuous earth bus suitable to withstand prospective short circuit current shall be provided. Hinged doors shall be connected to earth through adequately sized flexible braids. It shall be the responsibility of this Contractor to ensure that adequate means of earthing are provided.

o) Cabling :

A cabling zone clear of busbars, switch and circuit breaker chambers shall be provided in such a manner to give minimum difficulty in connecting sub-main cables entering the switchboard for connection to switch units or circuit breakers. The cabling zone shall be fully isolated from any live metal part so that future cabling and alterations can be carried out in complete safety without the necessity of shutting down the complete switchboard.

p) Terminal Blocks :

Terminal blocks for control wiring shall be rated not less than 20 amp and shall clamp the wire securely between two plates secured by a captive screw.

Terminal blocks shall have easily removable copper links to short circuit adjacent terminals or shall be fitted with suitable holders where required. Pinch screw type terminal blocks will not be acceptable.

Cables having the same number shall be terminated at adjacent terminals and connected by means of cable links at the terminal block. The incoming cable cores shall be terminated at the lower or outer side of the block, and the outgoing cable cores at the upper or inner side of the terminal block, and cable links on any free side.

Terminal blocks at different voltage, shall be segregated into groups, distinctively labeled and provided with permanent rigid barriers. Terminals in groups shall have separate non-combustible transparent plastic covers.

100% spare terminals shall be provided on each terminal block.

q) Wiring Diagrams :

Prepare construction layouts and functional wiring diagrams of all switchboards, which shall be reviewed prior to commencement of any work thereon.

The wiring diagrams shall show control circuits separate from main circuits and shall indicate the size of each conductor and the colour, number and/or terminal connection designation of each control conductor.

Switchboard drawings shall include a schedule of all equipment mounted therein, including make, model, and where applicable, fuse rating and set point of all variable adjusters.

Circuit diagrams shall be mounted near the switchboard in an approved location and shall be covered with either glass or clear Perspex sheet not less than 3mm thick.

r) General Requirements :

The Contractor shall ensure that the switchboards ordered can be accommodated (together with the control cubicles) in the space provided.

A rubber insulating mat shall be placed in front of the switchboard for its entire length.

4.0 PVC INSULATED ARMoured COPPER CABLE :

Cables of this type are to be 1100 volt grade complying to IS-1554-1998 with each conductor of the same cross sectional area.

PVC insulated and colour coded cores shall be sheathed with PVC which shall serve as a bedding for galvanized strip armouring. The armouring shall be covered with an outer PVC sheath.

Cables shall be terminated in a gland fitted with an armour clamp. The gland body shall be provided with an internal conical seating to receive the armour wires ensuring that the armour wires are tightly clamped between the armour cone and conical armour seating.

The minimum bending radius for power cables shall be twelve times the overall cable diameter.

When cables are run on a wall they shall be cleated at distances not exceeding 1 metre.

5.0 PVC INSULATED ALUMINIUM CABLES :

PVC insulated aluminum cables shall comply with IS:1554-1988 (Part I). Cables are to be 1100 volt grade depending on size.

6.0 WIRING:

The current carrying capacity is to be in accordance with IEE Wiring Regulations and is to be limited by the allowable voltage drop.

All wiring shall be carried out on the loop-in system. For conduit wiring systems, wiring shall be drawn into the conduits after the whole of the conduit installation has been completed. No joints or connectors will be allowed in any such cables, except that connectors may be used in accessible positions within lighting fittings or device outlet boxes.

All cables shall be colour coded consistently over their entire length. Red, yellow and blue shall be used for phase conductor and black and green for neutral and earth respectively.

The maximum number of cables that may be accommodated in a given size of conduit, cable tray, trunking is not to exceed the number given in the Indian Standard.

Where wiring penetrates fire walls, then these shall be sealed using fire retardant pillows packed tightly on both sides of the penetration. Internal fire barriers within trunking shall also be provided. All fire retardant materials used shall be to the approval of the Architect and local authorities.

Floor penetrations for cable risers shall be made weatherproof progressively during construction to minimize damage due to the weather.

Where wiring penetrates vapour barriers, adequate air tight seals shall be provided. Wiring shall enter the low temperature area via conduit and the conduit itself shall be sealed internally to provide an airtight barrier within the conduit.

All wiring associated with equipment necessary for fire and smoke control shall be provided.

7.0 CONDUIT:

All conduits shall be heavy gauge galvanized/black enameled ERW steel complying with relevant Indian Standard. No conduits shall be less than 25 mm nominal diameter. Conduit shall be concealed in concrete as construction proceeds, and so arranged as to drain naturally to outlet boxes. Prior to laying, this Contractor shall check with the Contractor responsible for the building work that conduits of the sizes

proposed will not affect the structural integrity of the concrete. Sealing caps shall be placed on all conduits before concrete pouring commences to ensure no water enters the conduit. Expansion couplings shall be fitted at all building expansion joints.

Surface conduits shall in no circumstances be fixed to floor slabs.

All conduit systems are to be installed fully in accordance with the requirements of the IEE Regulations.

All conduits shall be swabbed through to clean out all dirt, burrs and moisture.

All sets and bends in conduit runs are to be formed on site with bending machines. Distortion of conduits due to bending is not acceptable.

Runs between draw-in boxes are not to have more than two right angle bends or their equivalent and the length of such runs shall be limited to 12 m to permit easy drawing-in of cables.

Flexible conduit shall be used for final connections to equipment subject to vibration.

The conduit shall be watertight with the provision of separate earth wire enclosed for earth continuity. All flexible steel conduit shall be PVC sheathed.

The contractor shall make good any damage to the finish of all conduits including threads cut at site, by painting damaged areas with two coats of aluminium primer paint.

Supply for review prior to installation conduit layout drawings for the entire installation. The approved set shall be kept upto date on site and on completion, three sets of record drawings shall be provided for record purposes.

8.0 CONDUIT BOXES:

All conduit junction boxes are to be malleable iron (surface mounted) or mild steel (concealed) and of standard pattern.

Standard pattern boxes are to be used with conduits up to and including 25 mm diameter. Rectangular pattern boxes are to be used for conduits of 25 mm diameter and larger. For the drawing-in of cables, standard pattern through boxes are to be used. All conduit boxes are to be galvanized finish.

Adaptor boxes are to be of galvanized zinc passivized mild steel not less than 3 mm thick. Boxes are to be not less than 5 mm deep and of such dimensions as will enable the largest size cable for which the conduit run is suitable to be drawn in without excessive bending of the cables. Covers of approved material with fixing screws are to be provided. All boxes are to be drilled for holes according to the conduit entries required.

All conduit entries to adaptor boxes, outlet boxes and switchgears are to be made with couplings and hexagonal male bushes.

The protective coating of the boxes shall be heavy both inside and outside.

9.0 CABLE TRUNKING :

Metal trunking shall comply with BS 4678 and shall be manufactured in minimum lengths of 2 m from 2 mm thick zinc sprayed sheet steel finished with rust resisting primer and sprayed overall grey enamel. Covers are to be held in place by screws. Trunking shall be terminated with end flanges bolted directly to switch or distribution boards. Connecting pieces are to be used and bolted with cadmium plated mushroom head steel screws, nuts and shake-proof washers. Each joint is to have a copper link to ensure electrical continuity.

Conduit entries to trunking shall be made with couplings and brass make bushes. Knockouts will not be required and trunkings may be drilled on site.

Trunkings shall not contain more cable than allowed by the space factors described in the IEE Regulations.

Each joint shall have a copper bond bolted to each adjacent trunking to ensure electrical continuity. All frayed and sharp edges shall be removed from trunking before installation.

Conduit entry to trunking shall be by coupling and male bush. Knock-outs shall not be provided, and trunking shall be drilled on site.

Where trunking crosses expansion joints, a trunking system which will allow for expansion and maintain earth continuity shall be used. The system used shall be reviewed by the Architect prior to manufacture.

Where the trunking passes through floors or fire compartments, fire resisting barriers shall be provided.

All supports and hangers shall be of hot-dipped galvanized mild steel construction with min. coating thickness of 85 micron and 210 micron for indoor and outdoor installation respectively. All bolts and nuts shall be electroplated with zinc or cadmium with min. plating thickness of 25 micron.

10.0 CABLE TRAYS:

Cable trays are to be of a perforated pattern 1.6mm minimum mild steel with returned edges galvanized overall.

Trays shall be supported from the soffit of structural slabs and beams by mild steel rods not less than 6mm diameter and underslung mild steel angles, or alternatively, supported on steel angle brackets secured to walls. The former method shall be preferred where practicable. All supports and hangers shall be hot-dipped galvanized with bolts and nuts electroplated.

11.0 MOTORS :

All motors shall be of a type constructed to relevant Indian Standard.

Motors shall be selected to obtain the most suitable drive for the specified equipment, as recommended by the equipment manufacturers. Squirrel cage induction motors are preferred. Motors shall generally be three phase. Motors 1 KW or less may be single phase.

Ratings shall be based on continuous duty in the prescribed environment or an ambient temperature of 43 degree C whichever is the more demanding.

Motors in all cases shall be entirely suitable for the duty. A margin of not less than 10% shall be provided between the continuous rating of the motors (without overloading) and the maximum power absorbed by the item of equipment (as installed) under its most arduous operating condition, taking account of the characteristics of the driving machine. All motors up to 30 KW shall have full load efficiency of not less than 85% and power factor of not less than 85. Motors of rating greater than 30 KW shall have full load efficiency of not less than 90% and power factor of not less than 0.85.

Winding insulation and general construction of the motor casing, terminal block etc. shall be to Class F, allowing 80 degree C temperature rise above ambient, unless otherwise specified.

All motors shall have an isolating switch adjacent to and within sight of the motor. The switch shall be such that all conductors to the motor are isolated in one operation.

Motors up to and including 3.7 KW shall be fitted with ball bearings at both ends. Larger motors shall be fitted with roller or deep groove ball bearings. Motors operating with vertical shafts shall be equipped with bearings designed to counter unbalanced end thrust. Except where noted, motors shall have a synchronous speed not exceeding 1500 rpm.

All motors rated at 22 KW or more shall be fitted with thermistors or other sealed, temperature sensitive devices embedded in the windings and suitable for connection to motor protection control circuits.

Terminal blocks enclosed in cast iron or aluminum boxes shall be provided for all wiring connections to motors. The blocks shall be arranged to enable easy access for maintenance.

Motors shall be mounted on a common bed plate with the driven machine wherever possible. The whole assembly shall be supported on vibration isolating material or springs to eliminate the transmission of noise and vibration into the structure. All holding down bolts required shall be supplied and fixed by this Contractor.

Motors rated in excess of 5.5KW shall be supplied with anti-condensation heaters, controlled such that the heater is only „ON“ when the motor is „OFF“.

The drive selected for any machine shall be the type recommended by the manufacturer of the driven machine and subject to approval. All drives shall be fitted with safety guards.

For multi-winding motors there shall be no way that the motor isolating switch can be operated whereby any winding may be energized whilst another winding is isolated.

Terminal boxes shall be of such dimensions as will ensure access to the terminals and allow room for the supply leads.

Each box shall be fitted with normal bottom or top cable entry. With exception of motors with ratings less than 1 KW, all boxes shall be capable of being turned to a further 3 positions, 90 degrees apart without affecting the terminal base or terminals. Standardize frame sizes for all applications so that the minimum practical number of motors need be carried as spares. Ensure that motors of different frame sizes spared by a single motor be provided with adaptor plates, oversize couplings, oversize terminal boxes, standard keyways etc to facilitate replacement.

Motors of a particular type or application shall be of the same manufacturer.

Motors above 7.5 KW shall be provided with suitably sized tinned brass cable sockets. The type of cable terminations shall be as shown on the drawings. Three phase motors shall be fitted with separate earthing terminals.

On all motors over 25 kg in weight, lifting eyes or lugs shall be supplied.

Unless specified otherwise, enclosures for motors shall be as follows :-

Hazardous areas : Flame proof

External : TEFC – Tropical

In forced air flow : TE non-fan cooled or TEFC

Areas subject to hosing : Hose proof

All other areas : TEFC

All motors shall be provided with name plates. Motors shall have a maximum SPL of 85db(A) at 1 metre.

Overloads and thermistor protection shall not be provided for smoke exhaust fan motors or stair pressurization fan motors which operate only under a fire alarm condition and are essential for fire and smoke control.

Motors for fans having a dual function, e.g. smoke spil/return air fans, which are essential for fire and smoke control, shall be protected as specified above. However, such protection shall be overridden in a fire alarm condition.

Protection for supply air fan motors shall be provided as indicated above and shall remain in circuit at all times.

12.0 STARTERS:

Contractors used in starters shall be of Class AC3 type provided with silver alloy contacts. Auxiliary contacts shall be provided to facilitate the connection of interlocks, status indication and auxiliary controls. Unless explicitly described, a minimum of one normally open and one normally closed contact shall be provided.

Each starter shall be completed with protection incorporating the following features :

overload protection in each supply phase adjustable from 80 to 120% of full rated load.

Manual reset

Phase failure protection

Ambient temperature compensation

An auxiliary contact to signal an overload condition.

Contactors or complete starters not mounted in switchboards shall be contained in metal or approved plastic enclosures with conduit entries, shrouded "stop" and "start" push buttons and a manual "reset" button, which may be combined with the "stop" button.

Generally, reduced voltage starters of the following type shall be selected :-

Motors from 5.5 kW to 150 KW Star delta

Motors in excess of 29 KW

Each starter of the open transition "Star-Delta" (OT.SD) type shall include the following :-

One (1) main-line contactor suitably rated for the motor.

Star and Delta configuration contactors suitably rated for the motor, mechanically and electrically interlocked to prevent simultaneous operation.

One (1) triple pole overload relay meeting the requirements as specified previously in this clause under „Generally□.

One (1) approved time delay relay, with at least 0-30 second adjustable time delay period, to control the star to delta switching contactors.

Closed transition reduced voltage starters shall be approved type and manufacture and shall be capable of starting the motor from stopped to full load speed without interruption and in such a manner that the torque developed by the motor increases as uniformly as practicable during the whole starting sequence.

Closed Transition "Star-Delta" Starters (CT. SD)

Each starter of this type shall include the following equipment :-

- The equipment as specified in Clause "Open Transition Star-Delta Starters (OT.SD)".
- A suitably rated transition resistance bank such as to allow approximately full load supply current when in circuit prior to opening of the star point. The short time rating of the resistors shall also be considered in relation to the length of their "in circuit" requirements.
- A transition contactor suitably rated to facilitate connection of the resistance bank during the transition period.
- Any additional auxiliary contacts, timers, etc required for the transition sequencing operation.

13.0 EARTHING :

All metal work associated with the electrical installation but not forming part of a phase or neutral circuit shall be bonded together and solidly and effectively earthed.

Metal conduit, ducts and cable armour shall be earthed at the switch-board at which they originate by means of locknuts, screwed connection or cable gland.

The electrical resistance of metallic enclosures or framework to earth shall be low enough to permit the passage of current necessary to operate the device protecting the associated circuit.

The size of all earth continuity and bonding conductors shall be in accordance with the Local Regulations.

All earth conductors fixed or run outside the building shall be protected against corrosion and mechanical damage.

14.0 MOTOR CONTROL CIRCUITS :

For each motor provide the following :-

- a) On-off-auto test switch
- b) Blue power on light
- c) Green pilot light
- d) Red fault light
- e) Auxiliary contacts for remote stop-start.
- f) Auxiliary contacts for remote status indication.

(Items e and f to be connected to a labeled terminal strip in the switchboard).

15.0 RADIO INTERFERENCE :

All equipment and systems shall be properly designed to ensure that there is no interference caused to any transmitters, receivers or other electronic equipment in the near vicinity. Should interference be detected, the Contractor shall provide free of charge devices capable of eliminating such interference.

16.0 ISOLATING SWITCHES :

All items of equipment shall be provided with isolating switches adjacent to the item of equipment in an accessible position.

Isolators shall be capable of being padlocked in either the on, auto or off positions.

Isolators for motors and equipment which are essential for fire and smoke control shall be labelled as specified elsewhere and in addition a second label with white lettering on a red background reading :

WARNING – ESSENTIAL FOR LIFE SAFETY

Do not switch off except in absolute emergency shall be provided.

17.0 DDC/BAS INTERFACING :

For installations incorporating a DDC/BM system, a separate terminal strip shall be provided in each switchboard for connection of DDC/BM interface cabling for monitoring and for control. Terminals shall be segregated from other terminals in the same panel and shall be of a different colour.

Contacts for monitoring of status and alarm conditions shall be potential free and arranged to close when the item of plant runs or when an alarm condition occurs. Contacts shall incorporate a wiping action to provide a consistently very low contact resistance and eliminate “open circuit” (high resistance) conditions due to oxide build up on contact surfaces. Contacts shall provide positive indication, compatible with the extra low voltage monitoring supply from the DDC/BM.

This Contractor shall co-ordinate with the DDC/BM Contractor to determine the control output voltage from the DDC/BM. Interface relays shall be mounted within each panel and controlled direct from the DDC/BM at this voltage. Relay coil current and relay characteristic shall be completely compatible with the DDC/BM system.

Status and alarm contacts and relay interface connections shall be individually connected to terminals (that is, two connections per item). Any looping required for common connections shall be made at the terminal strip as required.

All DDC/BM point numbers shall be shown on the wiring diagrams consistent with the DDC/BASM numbering system.

ANNEXURE- A

APPLICABLE CODES, STANDARDS AND PUBLICATIONS

1.0 All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practices. All equipment and material being supplied by the Contractor shall meet the requirements of IS., Tariff advisory committee's regulation (fire insurance), electrical inspectorate and Indian Electricity rules and other Codes/Publications as given below.

A) 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 1 introduction and general information.
IS : 1367 (Part- 2)	Technical supply conditions for threaded steel fasteners : Part 2 product grades and tolerances.
IS : 1554 (Part- 1)	PVC insulated (heavy duty) electric cables : Part 1 for working voltages up to and including 1100V.
IS : 1554 (Part- 2)	PVC insulated (heavy duty) electric cables : Part 2 for working voltages from 3.3 kV up to and including 11 kV.
IS : 1726	Specification for cast iron manhole 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 pipe lines
IS : 2527	Code of practice for fixing rainwater gutters and down pipes for roof drainage.

Approved Make List for Plumbing Pumps & WTP

S.no.	Item	Make			
1	G.I. Pipes/M.S. Pipe	Tata Steel	Jindal (Hisar)	Prakash Surya	
2	G.I. fittings (malleable cast iron)	Unik	Jain Sons	Zoloto M	DRP
3	Ball Valve	RB (Italy)	TBS	VB	Zoloto
4	Butterfly valves	C&R	Inter Valve	Castle	VB
5	Non return valve G.M	RB (Italy)		VB	Zoloto
6	C.I. (Dual Plate Type)	C&R	Inter Valve	Castle	
7	Water Meter	Kay Cee	Kent	Desmesh	
8	Air Vent Valve	Oven trop (Germany)	CIM	Rapid Control	
9	Flanges	Table „H“	Class 150		
10	Epoxy Paint & Paint Primer	Berger	Asian		
11	Anti Corrosive Tape for Pipe protection (As Per IS : 1022 - 1982)	Pypcoat	Marphalt	Cotek	
12	Level Indicator	Technika	Minilec		
13	Level Controller	Technika	Femac	NandShyam	
14	Foot Valve	Kirloskar	Kalpana		
15	Multiport Valve	Pharer (U.S.A)	Flack (U.S.A)		
16	Water Supply Pumps	Grundfos	D.P (Holland)	ITT	Kirloskar
17	Sump Pumps (Sewage, Drainage & Storm Water)	Grundfos	D.P (Holland)	Willo	Kirloskar
18	Dosing Pump	Grundfos	Asia LMI	Meter Pump (Italy)	Prominent
19	Motor	Kirloskar	Siemens	Crompton	ABB
20	Flow Meter	B-Meter	Kranti		
21	PH Meter	VATS	Hanna (Italy)	Prominet	
22	Pressure Switch	Danfoss	Indfoss	Potter	
23	Vibration Eliminator / Antivibration Mounting	Resistoflex	Kanwel		
24	Pressure Sand Filter/Activated Carbon Filter Vessel	Fabricated			
25	Water Softner Vessel	Fabricated			
26	F.R.P Vessel	Pentair/Structural	Structural		
27	Pressure Gauges	Fiebig / H Guru	H Guru		
28	Resin	Thermax	Ion Exchange	Doshi Ion Exchange	
29	Strainers	Emerald	Zoloto	Maharaja Casting	
30	Power Cables & Control Cables	Polycab	RPG	Universal	Nicco
31	PVC insulated copper wires	Finolex	National	Skyline	
32	Single phase preventor	L&T	Siemens	ABB	
33	Relays	L&T	Alstom	Siemens	
34	Indicating Lamps	L&T	GE	BCH	Siemens
35	Lugs	Dowell	Lotus		
36	Push buttons	L&T	Siemens		

37	Fuses & fuse bases	L&T	GE		
38	Current Transformer/Voltage		Electric Automatic BCH	Indcoil	
39	Timers	L&T		Siemens	G.E. Power Contracts
40	Time delay relay/limit switch	Cutler Hammer	L&T		
41	Controls	Honeywell	Staefa	Penn	Danfoss
42	Starters/Switches/Contractors	L&T	Siemens	GE	
43	Changer over switches	HPL Socomec	H.H. Elcon	C&S	L&T
44	Annunciator	Minilec	Equivalent		
45	ACB/MCCB	L&T	Siemens	Merlin Gerin	
46	Miniature Circuit Breakers	L&T(Hager)	GE	MDS	Siemens
47	Terminals	Elmex			
48	Conduits	Precision	BEC	AKG	
49	Earth Leakage Relay	PIC Make			
50	Battery Charger	AE	Chhabi Electric	Waves Electronics	
51	Battery	Exide	Standard		
52	Selector switch	Kaycee	L&T		
53	Indicating instruments	AE	Rishabh	Meco	
54	Cable glands	Stripwell	Comex		
55	Bimetallic Crimping type lugs	Dowells			
56	Water flow meter	ABB	B meter	Scambler	Tyco
NOTE :					
All The materials to be ISI marked.					
The materials shall be only of the approved makes as specified in this .					
The Contractor shall submit samples of all the makes as specified in this list and the Consultant /AKVN shall have the power to select any of them.					
Consultant/ AKVN decision in this regard shall be binding on the Contractor.					
In case any material is not available for any one or all of these approved makes the Consultant/AKVN shall select and approve alternative make(s).					

Approved Make List for Plumbing - SOR ITEMS					
S.no.	Item	Make			
1	Sanitary ware	Jaguar	Kohler		
2	Seat covers (Heavy Duty)	Jaguar	Kohler		
3	C.P fittings & Bathroom accessories	Jaguar	Kohler		
4	Stainless Steel Sink	Jaguar	Kohler		
5	C.P. Grating	GMGR	Chilly		
6	G.I fitting	Unik	Zoloto	Jainsons	R Brand
7	Ball Valve	Audco	RB (Italy)	Danfoss	Zoloto
8	GM Peet Valve	Audco	Leader	Zoloto	
9	GM Wheel Valve	Audco	Leader	Zoloto	
10	Butterfly valves	Audco	C&R	RB (Italy)	Zoloto
11	CI Pipes/fittings (I.S: 3989-1984)	NECO	RIF	kaplinash	
12	CI Pipe / fittings (IS:1729)	NECO	RIF	kaplinash	
13	C.I Manhole Cover (IS: 1726–1991)	NECO	RIF	kaplinash	
14	C.I. Grating	NECO	RIF	kaplinash	
15	CI pipes „Class LA□	Neco	Kesoram	Electrosteel	kaplinash
16	Stoneware pipes/Gully traps	Perfect	R.K	Anand	
17	UPVC pipes/fittings	Supreme	Finolex		
18	CPVC Pipes and Fittings	Flowguard (Astral, Ajay)	Ashirwad		
19	PP-R pipes and fittings	Supreme	Prince		
20	Welding Rods	Advani Oerlikon			
21	Pressure Guage	H. Guru	Jack Tech	Forbes Marshall	Waaree
22	RCC Grating	Pratibha	Alcock		
23	Aluminium Ladder	Simplex			
24	Electronic Flow Meter	Rockwin	Aquamate		
25	Oil Level Indicator	Mineclec			
26	Irrigation Accessories	Supreme	Finolex		
27	SFRC Manhole Cover/Grating	K.K. Manhole	Jain spun pipe	Pragati	
28	R.C.C Pipe	Jain Spun Pipe	Pragati	Daya Spun Pipe	
29	Automatic Flushing Cistern	TOSHI	AOS Angash International	Utec	
30	Hand Drier	TOSHI	UTEC	KOPAL	
31	Pipe Supports, Hangers	Intello Tech	GMGR	Hilti	Fischer
32	Flanges	Table „H□	Class 150		
33	Insulation	Thermaxflex	Armaflex	Kiflex	
34	Anti Corrosive Bitumastic Paint	Asian	Burger		
35	Epoxy Paint	Asian	Burger		
36	C.I. S&S / Double flanged fittings	Kartar	National	Kesoram	
NOTE :					
All The materials to be ISI marked.					
The materials shall be only of the approved makes as specified in this .					
The Contractor shall submit samples of all the makes as specified in this list and the Consultant /AKVN					

shall have the power to select any of them.

Consultant/ AKVN decision in this regard shall be binding on the Contractor.

In case any material is not available for any one or all of these approved makes the Consultant/ AKVN shall select and approve alternative make(s).

Approved Make List for Plumbing - NON SOR ITEMS					
S.no.	Item	Make			
1	C.P. Grating	GMGR	Chilly		
2	Cast Brass Clean Out Plugs	GMGR	Neer		
3	Pressure Reducing Valves	RB(Italy)	Sant	Danfoss	
4	G.M. Non return valve	RB (Italy)	Danfoss		
5	C.I. Non return valve	Audco	C&R	Zoloto	Castle
6	UPVC pipes/fittings	Supreme	Finolex		
7	Water Level Controller	Technica	Waaree		
8	Water Level Indicator	Technica	Waaree		
9	Water Meter	Kay Cee	Kent	Desmesh	
10	Air Vent Valve	Oven trop (Germany)	CIM	RB(Italy)	
11	Strainers	RB	Sun	Trishul	
12	Float Valve	Zoloto	HBD	Esseti	CSA Atena
NOTE :					
All The materials to be ISI marked.					
The materials shall be only of the approved makes as specified in this .					
The Contractor shall submit samples of all the makes as specified in this list and the Consultant / AKVN shall have the power to select any of them.					
Consultant/ AKVN decision in this regard shall be binding on the Contractor.					
In case any material is not available for any one or all of these approved makes the Consultant/ AKVN shall select and approve alternative make(s).					

ANNEXURE – E5

FIRE FIGHTING

For all SOR items refer MPPWD SOR 2014 with effective from 1st August 2014 / NBC/ CPWD with all amendment up to date.

TECHINCAL SPECIFICATINS FIRE FIGHTING WORKS FOR NON SOR ITEMS

FIRE PROTECTION SYSTEM

1.0. AIR CUSHION TANK

Every wet riser shall be provided with an air cushion tank at its top most point. The air cushion shall be provided with an automatic air release cock, 20 mm dia drain pipe, drain valve and shut off valve.

2.0. VALVES

2.1 Sluice Valves

Sluice valves shall be double flanged valves with cast iron body. The spindle, wall seat and wedge nuts shall be of bronze. They shall generally have non-rising spindle and shall be of the particular duty and design called for.

The valves shall be supplied with suitable flanges, non- corrosive bolts and asbestos fibre gaskets. Sluice valves shall conform to Indian Standard IS : 780-1969 and IS : 2906 .

2.2 Gun Metal Valves

Gun metal Valves shall be used for smaller dia pipes, and for threaded connections. The Valves shall bear certification as per IS:778

The body and bonnet shall be of gun metal to IS:318. The stem gland and gland nut shall be of forged brass to IS:6912. The hand wheel shall be of cast iron to IS:210.

The Hand wheel shall be of high quality finish to avoid hand abrasions. Movement shall also be easy. The spindle shall be non rising type.

2.3 Non-Return Valve

Non-Return valves shall be cast iron double flanged with cast iron body and gunmetal internal parts conforming to IS:5312.

2.4 Pressure Relief Valve

Each System shall be provided with a Pressure Relief Valves. The Valve shall be spring actuated and set to operate as per field requirement. The Valve shall be constructed of bronze and provided with an open discharge orifice for releasing the water. The Valve shall be open lift type.

3.0 PRESSURE GAUGE

Pressure gauge shall be provided near all individual connections of the hydrant system with isolation valves and near each flow switch assembly of the sprinkler system. Pressure gauge shall be 50 mm dia gunmetal bourdon type with gunmental isolation ball valve, tapping and connecting pipe and nipple. The gauge shall be installed at appropriate height for easy readability.

4.0 Installation Control Valves

Each installation shall be provided with a set of installation control valves comprising:-

- a. An Alarm Valve.
- b. A Water Motor Alarm & Gong.
- c. Installation valves shall be installed on the sprinkler circuits as shown on the drawings.

d. Tenderer shall submit detailed shop drawings showing the exact location, details of installation of the valves/alarm in all respects.

e. Installation valve shall comprise of a cast iron body with gunmetal trim, and double seated clapper check valves, pressure gauges, test valve and orifice assembly and drain valve with pressure gauges, turbine water gong including all accessories necessary and required and as supplied by original equipment manufacturer and required for full and satisfactory performance of the system. A cast iron isolation valve with lock and chain at the inlet of the installation valve shall be provided.

5.0 Inspection And Test Valve Assembly

Inspection and testing of the automatic starting of the sprinkler system shall be done by providing an assembly consisting of gunmetal valves, gunmetal sight glass, bye-pass valve and orifice assembly as per approved drawing.

6.0 HAND HELD FIRE EXTINGUISHERS

6.1 Hand Appliances

6.1.2 Scope

Work under this section shall consist of furnishing all labour, materials, appliances and equipment necessary and required to install fire extinguishing hand appliances as per relevant specification of various authorities.

Without restricting to the generality of the foregoing, the work shall consist of the following:

Installation of fully charged and tested fire extinguishing hand appliances of A B C powder type as required and specified in the drawings and schedule of rates.

6.2 General Requirements

Hand appliances shall be installed in easily accessible locations with the brackets fixed to the wall by suitable anchor fasteners.

Each appliance shall be provided with an inspection card indicating the date of inspection, testing, change of charge and other relevant data.

All appliances shall be fixed in a true workmanlike manner truly vertical and at correct locations.

Distribution / installation of fire extinguisher to be in accordance to IS:2190.

6.3 Measurement

Fire extinguishers shall be counted in numbers and include installation of all necessary items required as given in the specifications.

6.4. ABC Type Dry Powder Extinguisher

The Extinguisher shall be filled with ABC grade 40, Mono Ammonium Phosphate 40% from any approved manufacturer.

The capacity of the extinguisher when filled with Dry Chemical Powder (First filling) as per IS 4308, Part II, shall be 5 Kg +/-2% or 10 Kg +/- 3%.

The distribution of fire extinguishers to be as per IS 2190 - 1992

It shall be operated upright, with a squeeze grip valve to control discharge. The plunger neck shall have a safety clip, fitted with a pin, to prevent accidental discharge. It shall be pressurised with Dry Nitrogen, as expellant. The Nitrogen to be charged at a pressure of 15 Kg/cm²

Body shall be of mild steel conforming to relevant IS Standards. The neck ring shall be also mild steel and welded to the body. The discharge valve body, shall be forged brass or leaded bronze, while the spindle, spring and siphon tube shall be of brass. The nozzle shall be of brass, while the hose shall be

braided nylon. The body shall be cylindrical in shape, with the dish and dome welded to it. Sufficient space for Nitrogen gas shall be provided inside the body, above the powder filling.

The Neck Ring shall be externally threaded - the threading portion being 1.6 cm. The filler opening in the neck ring shall not less than 50 mm. Discharge nozzle shall be screwed to the hose. The design of the nozzle shall meet the performance requirement, so as to discharge at least 85% of contents upto a throw of 4 mtrs, continuously, at least for 15 seconds. The hose, forming part of discharge nozzle, shall be 500 mm long, with 10 mm dia internally for 5 Kg capacity and 12 mm for 10 Kg capacity. It shall have a pressure gauge fitted to the valve assembly or the cylinder to indicate pressure available inside. The extinguisher shall be treated with anti-corrosive paint, and it shall be labelled with words ABC 2.5 cm long, within a triangle of 5 cm on each face. The extinguisher body and valve assembly shall withstand internal pressure of 30 Kg/cm² for a minimum period of 2 minutes. The pressure gauge shall be imported and suited for the purpose.

6.5 Water Type Extinguisher (Gas Pressure Type)

The Extinguishing medium shall be primarily water stored under normal pressure, the discharge being affected by release of Carbon Dioxide Gas from a 120 gms cylinder.

The capacity of Extinguisher, when filled upto the indicated level, shall be 9 ltr +/- 5%

The skin thickness of the Cylinder shall be minimum 4.0 mm, fabricated from Mild Steel sheet, welded as required, with dish and dome, being of same thickness, and of size not exceeding the diameter of body. The diameter of body to be not less than 150 mm and not exceeding 200 mm. The neck shall be externally threaded upto a minimum depth of 16 mm, and leaded tin bronze.

The cap shall be of leaded tin bronze, and screwed on the body upto a minimum of 1.6 cm depth, with parallel screw thread to match the neck ring. The siphon tube to be of brass or G.I. and the strainer of Brass. The cartridge holder, knob, discharge fittings and plunger to be of Brass/Leaded tin bronze, and plunger of stainless steel, spring of stainless steel. The cap to have handle fixed to it. The discharge hose shall be braided nylon, of 10 mm dia and 600 mm long, with a nozzle of brass fitted at end.

The extinguisher shall be treated for anti-corrosion internally and externally, and externally painted with Fire Red paint. The paint shall be stove enamelled/powder coated. The cartridge shall be as per IS, and have 60 gm net carbon dioxide gas for expelling. The extinguisher, body and cap shall be treated to an internal hydraulic pressure of 25 Kg/cm². It shall have external marking with letter A, of 2.5 cm height, in block letters within a triangle of 5 cm each side. The extinguisher shall be upright in operation, with the body placed on ground and discharge tube with nozzle held in one hand to give a throw of not less than 6 mtr, and continue so for atleast 60 secs. The extinguisher body shall be clearly marked with ISI stamp (IS 940).

6.6 Carbon Dioxide Extinguisher

The Carbon Dioxide Extinguisher shall be as per IS: 2878

The body shall be constructed of seamless tube conforming to IS:7285 and having a convex dome and flat base. Its dia shall be maximum 140 mm, and the overall height shall not exceed 720 mm.

The discharge mechanism shall be through a control valve conforming to IS:3224. The internal syphon tube shall be of copper aluminium conforming to relevant specifications.

Hose Pipe shall be high pressure braided Rubber hose with a minimum burst pressure of 140 Kg/cm² and shall be approximately 1.0 meter in length having internal dia of 10 mm. The discharge horn shall be of high quality unbreakable plastic with gradually expanding shape, to convert liquid carbon dioxide into gas form. The hand grip of Discharge horn shall be insulated with Rubber of appropriate thickness. The gas shall be conforming to IS:307 and shall be stored at about 85 Kg/cm². The expansion ratio between stored liquid carbon dioxide to expanded gas shall be 1:9 times and the total discharge time (effective) shall be minimum 10 secs and maximum 25 secs.

The extinguisher shall fulfill the following test pressures:

Cylinder: 236 Kg/cm²
Control Valve: 125 Kg/cm²

Burst Pressure of Hose: 140 Kg/cm² minimum

It shall be an Upright type. The cylinder, including the control valve and high pressure Discharge Hose must comply with relevant Statutory Regulations, and be approved by Chief Controller of Explosives, Nagpur and also bear IS marking.

The Extinguisher including components shall be IS marked.

7.0 FIRE PUMPS AND ALLIED EQUIPMENTS

7.1 Scope

Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install electrically operated and diesel driven pumps and as required by drawings and specified hereinafter or given in the schedule of rates.

- a. Electrically operated pumps with motors and diesel engine driven pumps with diesel engine, common base plates, coupling, coupling guard and accessories.
- b. Automatic starting system with all accessories, wiring and connections and pressure switches.
- c. Motor control centre.
- d. Annunciation system with all accessories wiring and connections.
- e. Pressure gauges with isolation valves and piping, bleed and block valves.
- f. Suction strainers and accessories.
- g. Vibration eliminator pads and foundation bolts.
- h. Leak-off drain shall be led to the nearest floor drain.

7.2 General Requirements

Pumps shall be installed true to levels on suitable concrete foundations. Base plate shall be firmly fixed by properly grouted foundation bolts.

Pumps and motors shall be truly aligned by suitably instruments. Record of such alignment shall be furnished to the Project Manager.

All pump connections shall be standard flanged type with number of bolts as per relevant standard requirement for the working pressure. Companion flanges shall be provided with the pumps.

Manufacturers' instructions regarding installation, connections and commissioning shall be strictly followed.

Tenderer shall provide necessary test certificates, type test certificates, performance curves and NPSH curves of the pumps from the manufacturer when called for. The tenderer shall provide facilities to the Project Manager and Consultant for inspection of equipment during manufacturing and also to witness various tests at the manufacturer's works without any cost to the Project Manager or Consultant.

Seismic isolation and clamping for each pump and flexible connection on the suction as well as the discharge side shall be provided.

The tenderer shall submit with this tender a list of recommended spare parts for three years of normal operation and quote the prices for the same as a separate submittal / annexure.

7.3 Electric Fire Pump

General

The electric fire pump shall be suitable for automatic operation complete with necessary electric motor and automatic starting gear, suitable for operation on 415 volts, 3 phase, 50 Hz. A.C. system. Both the motor and the pump shall be assembled on a common base plate, fabricated M.S. channel type or cast iron type.

Drive

The pump shall be direct driven by means of a flexible coupling. Coupling guard shall also be provided.

7.4 Fire Pump

The fire pump shall be horizontally mounted centrifugal type. It shall have a capacity to deliver flow as specified, and developing adequate head so as to ensure a minimum pressure of 3.5 Kg/Sq.cm at the highest and the farthest outlet.

The pump shall be capable of giving a discharge of not less than 150 per cent of the rated discharge, at a head of not less than 65 per cent of the rated head. The shut off head shall be within 120 per cent of the rated head.

The pump casing shall be of cast iron to grade FG 200 to IS: 210 and parts like impeller, shaft sleeve, wearing ring etc. shall be of non-corrosive metal like bronze/brass/gun metal. The shaft shall be of stainless steel. Provision of mechanical seal shall also be made.

Bearings of the pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water. The pump shall be provided with a plate indicating the suction lift, delivery head, discharge, speed and number of stages. The pump casing shall be designed to withstand 1.5 times the working pressure.

Provision of Jockey Pump for low and high zone shall be made. The pump shall be vertical SS type and of detail as in schedule of quantity. Tenderer shall verify that the capacity of the Jockey pump shall not be less than 3% (Minimum 180 LPM) and not more than 10% of the installed pump capacity.

Motor

The motor shall be squirrel cage A.C. induction type suitable for operation on 415 volts 3 phase 50 Hz. system. The motor shall be totally enclosed fan cooled type conforming to protection clause IP 55. The class of insulation shall be F. The synchronous speed shall be 1500 RPM as specified. The motor shall be rated for continuous duty and shall have a horse power rating necessary to drive the pump at 150 per cent of its rated discharge with at least 65 per cent rated head. The motor shall conform to I.S.325-1978.

Motor Starter

The motor starter shall be as per detail in MCC. The unit shall include suitable current transformer and ammeter of suitable range on one line to indicate the current. The starter shall not incorporate under voltage, no voltage trip overload or SPP.

The starter assembly shall be suitably integrated in the power and control panel for the wet riser system & sprinkler system.

7.5 Diesel Fire Pump

General

The diesel pump set shall be suitable for automatic operation complete with necessary automatic starting gear, for starting on wet battery system and shall be complete with all accessories. Both engine and pump shall be assembled on a common base plate.

Drive

The pump shall be only direct driven by means of a flexible coupling. Coupling guard shall also be provided. The speed shall be 1500 RPM as specified.

Fire Pump

The fire pump shall be horizontally mounted centrifugal type. It shall have a capacity to deliver as specified, and developing adequate head so as to ensure a minimum pressure of 3.5 Kg/Sq.cm at the highest and the farthest outlet. The pump shall be multi stage as specified. The pump shall be capable of giving a discharge of not less than 150% of the rated discharge at a head of not less than 65% of the rated head. The shut off head shall be within 120% of the rated head.

The pump casing shall be of cast iron to grade FG 200 to IS 210 and parts like impeller, shaft sleeves, wearing-ring etc. shall be of non-corrosive metal like bronze/brass/gun metal. The shaft shall be stainless steel. Provision of mechanical seal shall also be made.

The pump casing shall be designed to withstand 1.5 times the working pressure.

Bearing of pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

Diesel Engine

Engine Rating - The engine shall be cold starting type without the necessity of preliminary heating of the engine cylinders or combustion chamber (for example, by wicks, cartridge, heater, plugs etc.). The engine shall be multi cylinder/vertical 4 stroke cycle, aircooled, diesel engine, developing suitable HP at the operating speed specified to drive the fire pump. Continuous capacity available for the load shall be exclusive of the power requirement of auxiliaries of the diesel engine, and the after correction for altitude, ambient temperature and humidity for the specified environmental conditions. This shall be at least 20% greater than the maximum HP required to drive the pump at its duty point.

It shall also be capable of driving the pump at 150% of the rated discharge at 65% of rated head. The engine shall be capable of continuous non-stop operation for 8 hours and major overhaul shall not be required before 3000 hours of operation. The engine shall have 10% overload capacity for one hour in any period of 12 hours continuous run. The engine shall accept full load within 15 seconds from the receipt of signal to start. The diesel engine shall conform to BS 649/IS 1601/IS 10002, all amended up to date.

a. **Engine Accessories** - The engine shall be complete with the following accessories:-

Fly wheel dynamically balanced.

Direct coupling for pump and coupling guard.

Corrosion Resistor.

Air cleaner.

Fuel service tank support, and fuel oil filter with necessary pipe work.

Elect. starting battery (2X24 v).
Exhaust silencer with necessary pipe work.
Governor.

Instrument panel housing all the gauges, including Tachometer, hour meter and starting switch with key (for manual starting).
Necessary safety controls.

b. **Fuel System** - The fuel shall be gravity fed from the engine fuel tank to the engine driven fuel pump. The engine fuel tank shall be mounted either over or adjacent to the engine itself or suitably wall mounted on bracket. The fuel filter shall be suitably located to permit easy servicing. All fuel tubing to the engine shall be with copper, with flexible hose connections where required. Plastic tubing shall not be permitted.

The fuel tank shall be of welded steel construction (3 mm. thick) and of capacity sufficient to allow the engine to run on full load for at least 8 hours. The tank shall be complete with necessary wall mounted supports, level indicator (protected against mechanical injury) inlet, outlet, overflow connections and drain plug and piping to the engine fuel tank. The outlet shall be so located as to avoid entry of any sediments into the fuel line to the engine.

As semi rotary hand pump for filling the daily service tank together with hose pipe 5 mtr. long with a foot valve etc. shall also form part of the scope of supply.

c. **Lubricating Oil System**- Forced feed Lub. Oil system shall be employed for positive lubrication. Necessary Lub. oil filters shall be provided, located suitably for convenient servicing.

d. **Starting System**- The starting system shall comprise necessary batteries (2x24v), 24 volts starter motor of adequate capacity and axle type gear to match with the toothed ring on the fly wheel. Bi metallic relay protection to protect starting motor from excessively long cranking runs suitably integrated with engine protection system shall be included within the scope of the work.
The capacity of the battery shall be suitable for meeting the needs of the starting system.

The battery capacity shall be adequate for 10 consecutive starts without recharging with cold engine under full compression.

The scope shall cover all cabling, terminals, initial charging etc.

e. **Exhaust System** - The exhaust system shall be complete with silencer suitable for outdoor installation, and silencer piping including bends and accessories needed for a run of 15 metre from the engine manifold.(Adjustment rates for extra lengths shall also be given).The total back pressure shall not exceed the engine manufacture's recommendation. The exhaust piping shall be suitably supported.

f. **Engine shut down mechanism**- This shall be auto/ manually operated and shall return automatically to the starting position after use.

g. **Governing System**- The engine shall be provided with an adjustable governor to control the engine speed within 5% of its rated speed under all conditions of load up to full load. The governor shall be set to maintain rated pump speed at maximum pump load.

h. **Engine Instrumentation**- Engine instrumentation shall include the following:-

- i) Lub. oil pressure gauge.
- ii) Lub. oil temperature gauge.
- iii) Water pressure gauge.
- iv) Water temperature gauge.

- v) Tachometer.
- vi) Hour meter.

The instrumentation panel shall be suitably resident mounted on the engine.

Engine Protection Devices- Following engine protection and automatic shut down facilities shall be provided:-

- i) Low lub.oil pressure.
- ii) High cooling water temp.
- iii) High lub.oil temperature.
- iv) Over speed shut down.

i. **Pipe Work** - All pipe lines with fittings and accessories required shall be provided for fuel oil, lub.oil and exhaust systems, copper piping of adequate sizes, shall be used for Lub.oil and fuel oil. M.S. piping will be permitted for exhaust.

j. **Anti Vibration Mounting**- Suitable vibration mounting duly approved by Project Manager shall be employed for mounting the unit so as to minimise transmission of vibration to the structure. The isolation efficiency achievable shall be clearly indicated.

k. **Battery Charger**-Necessary float and boost charger shall be incorporated in the control section of the power and control panel, to keep the battery in trim condition. Voltmeter to indicate the state of charge of the batteries shall be provided.

7.6 Pump Sets Assembly

On the main fire sprinkler and hydrant headers near pump sets a 150 mm dia by-pass valve located in an accessible location shall be provided along with a rate of flow rotameter calibrated in 1 pm and able to read 200% of the rated pump capacity. The delivery shall be connected to the fire tank.

Each and every pump set assembly shall be provided with suction valve (only for positive suction head), discharge valve, non-return valve and 150 mm dia Bourdon type pressure gauge with isolation valve.

7.7 Flexible Connectors

On all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors shall be provided. Connectors should be suitable for maximum working pressure of each pipe line on which it is mounted and tested to a test pressure of 1:5 time the operating pressure. Length of the connector shall be as per manufacturers standard.

7.8 Interlocking

The following inter-locking between the two main fire pumps (i.e. wet riser pump & sprinkler pump), the jockey pump and the diesel engine driven pump.

Only one category of pumps will work at a time i.e. either jockey pump or main fire pumps (wet riser and sprinkler, both the wet riser and sprinkler can come up at a time) or diesel driven pump.

	JOCKEY PUMP	WET RISER PUMP	DIESEL DRIVEN PUMP
i.	ON	OFF	OFF
ii.	OFF	ON	OFF
iii.	OFF	OFF	OFF
iv.	OFF	ON	OFF
v.	OFF	OFF	ON
vi.	OFF	OFF	ON
vii	OFF	ON	ON

7.9 Annunciation Panel

One solid state electronic annunciation panel, fully wired with visual display and audible alarm unit shall be provided to indicate :

- a. Flow condition in any flow switch indicating the area of distress and fire alarm.
- b. Starting and stopping of each hydrant pump.
- c. Starting and stopping of each jockey pump.
- d. Starting and stopping of each sprinkler pump.
- e. Failure of Hydrant / Sprinkler pump to start.
- f. High level in fire water storage tank compartment.
- g. Low level in fire water storage tank compartment.
- h. Low level in HSD day tank of the fire pump.

The panel shall be factory fabricated, wired and tested. All details shall be submitted with the tender. The annunciation panel shall be located in the security office / reception on the ground floor or as instructed by the Project Manager.

7.10 Vibration Isolation

The pumpset shall be mounted on rolled steel channels and 150 mm thick inertia block spring and ribbed neoprene vibration isolation mounting shall support the inertia block onto a 100 mm thick concrete plinths. The spring mountings shall have a maximum deflection of 15 mm. Reference shall be made to the section on "Noise and Vibration" for further technical requirements.

8.0 ELECTRICAL INSTALLATION

8.1 SCOPE

The scope of this section comprises of fabrication, supply, erection, testing and commissioning of Motor Control Centre (MCC), wiring and earthing of all air-conditioning equipment, components and accessories.

8.2 GENERAL

Work shall be carried out in accordance with the accompanying specifications and shall comply with the latest relevant Indian Standards and Electricity Rules and Regulations.

All motor control centres shall be CPRI approved and shall be suitable for operation on 3 phase/single phase 415/230 volts, 50 cycles power supply system.

8.3 CONSTRUCTIONAL FEATURES

The Motor Control Centre (MCC) electrical panels shall be sheet steel cabinet for indoor installation, dead front, floor mounting/wall mounting type and shall be 3b construction. The control panel shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors with Neoprene gasket. Control panel shall be suitable for the climatic conditions as specified in Specifications. Steel sheets used in the construction of Control panel shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall conform to relevant BIS Codes.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Control panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum clearance of 275 mm shall be provided between the floor of control panel and the lowest unit.

The control panel shall be of adequate size with a provision of 25% spare space to accommodate possible future breakers. Breakers shall be arranged in multi-tier. Knockout holes of appropriate size

and number shall be provided in the Motor Control Centre in conformity with the location of cable/conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram mounted on inside of door shutter protected with Hylam sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

8.4 WIRING SYSTEM

All L T power cabling between MCC and motors shall be carried out with 1100 volts grade PVC insulated, overall PVC sheathed aluminium conductor armoured cables, Cables shall be sized by applying proper derating factor. All control wiring shall be carried out by using PVC insulated copper conductor wires in conduits. Minimum size of control wiring shall be 1.5 sq mm. Minimum size of conductor for power wiring shall be 4 sq. mm 1100 volts grade PVC insulated copper conductor wires in conduit.

8.5 CIRCUIT COMPARTMENT

Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall have steel sheets on top and bottom of compartment. Sheet steel hinged lockable door shall be duly interlocked with the breaker in the "ON" position. Safety interlocks shall be provided to prevent the breaker from being drawn-out when the breaker is in „ON" position. The door shall not form an integral part of the draw-out portion of the panel. Sheet steel barriers shall be provided between the tiers in a vertical section.

8.6 INSTRUMENT ACCOMMODATION

Adequate space shall be provided for accommodating instruments, indicating lamps, control contactors and control MCBs. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker and bus bar. ON lamps shall be provided on all outgoing feeders.

8.7 BUS BAR CONNECTIONS

Bus bar and interconnections shall be of high conductivity electrolytic aluminium complying with requirement of grade E91E of IS:5082-1981 and shall be of rectangular cross section suitable for carrying the rated full load current and short circuit current without overheating of phase and neutral bus bar and shall be extendable on either side. Bus bar and interconnections shall be insulated with heat shrinkable sleeve and shall be colour coded and shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bar shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area shall be added to the bus bar to compensate for the holes. All connections between bus bar and breaker shall be through solid aluminium strips of proper size to carry full rated current as per approved for construction shop drawing and insulated with insulating sleeves. Bus bar shall be rated for current density of 1.0 amps/mm² cross section area.

8.8 TEMPERATURE - RISE LIMIT

Unless otherwise specified, in the case of external surface of enclosures of bus bar trunking system which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per relevant IS Codes.

8.9 CABLE COMPARTMENTS

Cable compartment of adequate size shall be provided in the control panel for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables as per approved for construction shop drawing.

8.10 MOULDED CASE CIRCUIT BREAKER (MCCB)

All MCCBs shall be motor duty and Current Limiting type, and comprise of Quick Make - break switching mechanism, preferably Double Break Contact system, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses. All MCCBs shall be capable of defined Variable overload adjustment. All MCCBs rated 200 Amps and above shall have adjustable Magnetic short circuit pick up.

The trip command shall override all other commands. MCCB shall employ maintenance free double break contact system to minimise the let thru energies and capable of achieving discrimination upto full short circuit capacity of downstream MCCB. The manufacturer shall provide both discrimination tables and let thru energy curves.

The breaking capacity of MCCBs shall be asked for in the schedule of quantities. The breaking capacities specified will be ICU=ICS i.e type-2. Co-ordination as per relevant IS and IEC Codes.

The MCCBs shall be provided with rotary handle operating mechanism. The handle position shall give positive indication of „ON“, „OFF“ or „Tripped“ thus qualifying to Disconnection as per the IS/IEC indicating the true position of all the contacts. In case of 4 pole MCCB the neutral shall be defined and capable of offering protection.

8.11 MINIATURE CIRCUIT BREAKER (MCB)

Miniature Circuit Breaker shall comply with relevant IS Codes and shall be quick make and break type for 230/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B,C,D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP and TPN miniature circuit breakers shall have a common trip bar independent to the external operating handle.

8.12 PAINTING

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be as per relevant BIS code.

8.13 LABELS

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the control panel shall be pasted on inside of the panel door and covered with transparent plastic sheet.

8.14 METERS

- i. All voltmeters and indicating lamps shall be through MCBs.
- ii. Meters and indicating instruments shall be plug type.
- iii. All CTs connection for meters shall be through Test Terminal Block (TTB).
- iv. CT ratio and burdens shall be as specified on the Single line diagram.

8.15 CURRENT TRANSFORMERS

Current transformers shall be provided for Control panels carrying current in excess of 60 amps. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.

The CTs shall conform to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class I.

8.16 SELECTOR SWITCH

Where called for, selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

8.17 STARTERS

Each motor shall be provided with a starter of suitable rating. Starters shall be in accordance with relevant IS Codes. All Star Delta and ATS Starters shall be fully automatic.

8.18 CONTACTOR

Contactor shall be built into a high strength thermoplastic body and shall be provided with an arc shield for quick arc extinguishing. Silver alloy tips shall be provided to ensure a high degree of reliability and endurance under continuous operation. The magnet system shall consist of laminated yoke and armature to ensure clean operation without hum or chatter.

Starters contactors shall have 3 main and 2 Nos. NO / NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta and Reduced Voltage Starters. The insulation for contactor coils shall be of Class "E".

Coil shall be tape wound vacuum impregnated and shall be housed in a thermostatic bobbin, suitable for tropical conditions and shall withstand voltage fluctuations. Coil shall be suitable for 220/415±10% volts AC, 50 cycles AC supply.

8.19 THERMAL OVERLOAD RELAY

Thermal over load relay shall have built in phase failure sensitive tripping mechanism to prevent against single phasing as well as on overloading. The relay shall operate on the differential system of protection to safeguard against three phase overload, single phasing and unbalanced voltage conditions.

Auto-manual conversion facility shall be provided to convert from auto-reset mode to manual-reset mode and vice-versa at site. Ambient temperature compensation shall be provided for variation in ambient temperature from -5° C to +55°C.

All overload relays shall be of three element, positive acting ambient temperature compensated time lagged thermal over load relays with adjustable setting. Relays shall be directly connected for motors upto 35 HP capacity. C.T. operated relays shall be provided for motors above 35 HP capacity. Heater circuit contactors may not be provided with overload relays.

8.20 TIME DELAY RELAYS

Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and shall have one set of auxiliary contacts for indicating lamp connection.

8.21 INDICATING LAMP AND METERING

All meters and indicating lamps shall be in accordance with IS:1248 and IS-1258. The meters shall be flush mounted type. The indicating lamp shall be of low wattage. Each MCC and control panel shall be provided with voltmeter 0-500 volts with three way and off selector switch, CT operated ammeter of suitable range with three nos. CTS of suitable ratio with three way and off selector switch, phase indicating lamps, and other indicating lamps as called for. Each phase indicating lamp shall be backed up with 5 MCB. Other indicating lamps shall be backed up with fuses as called for in Schedule of Quantities.

8.22 TOGGLE SWITCH

Toggle switches, where called for in Schedule of Quantities, shall be in conformity with relevant IS Codes and shall be of 5 amps rating.

8.23 PUSH BUTTON STATIONS

Push button stations shall be provided for manual starting and stopping of motors / equipment Green and Red colour push buttons shall be provided for „Starting□ and „Stopping□ operations. „Start□ or „Stop□ indicating flaps shall be provided for push buttons. Push Buttons shall be suitable for panel mounting and accessible from front without opening door, Lock lever shall be provided for „Stop□ push buttons. The push button contacts shall be suitable for 6 amps current capacity.

8.24 CONDUITS

Conduits and Accessories shall conform to relevant Indian Standards. Wall thickness shall be 16 gauge upto 32 mm dia and 14 gauge above 32 mm dia conduit. Screwed G.I.conduits shall be used. Joints between conduits and accessories shall be securely made, to ensure earth continuity. All conduit accessories shall be threaded type only. All raw metal shall be painted with bitumastic paint.

Only approved make of conduits and accessories shall be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

Maximum permissible number of 650/1100 volt grade PVC insulated wires that may be drawn into rigid non metallic or GI Conduits are given below :

Size of wires Nominal Cross section Area (Sq. mm.)	Maximum number of wires within conduit size(mm)				
	20	25	32	40	50
1.5	5	10	14	--	--
2.5	5	8	12	--	--
4	3	7	10	--	--
6	2	5	8	--	--
10	--	3	5	6	--
16	--	2	3	--	6
25	--	--	2	4	6
35	--	--	--	3	5

8.25 CABLES

M.V. Cables shall be PVC insulated aluminium conductor and armoured cables conforming to IS Codes. Cables shall be armoured and suitable for laying in trenches, ducts, and on cable trays

as required. M.V. Cables shall be termite resistant. Cable glands shall be double compression glands. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armoured cables.

8.26 CABLE LAYING

Cable shall be laid in accordance with IS code of Practice. Cables shall be laid on 14 gage factory fabricated perforated galvanized sheet steel cable trays, and cable drops / risers shall be fixed to ladder type cable trays factory fabricated out of galvanized steel angle. Access to all cables shall be provided to allow cable withdrawal / replacement in the future. Where more than one cable is running on a cable tray, one dia spacing shall be provided between cables to minimise the loss in current carrying capacity.

Cables shall be suitably supported with Galvanized saddles when run on walls / trays. When buried, they shall be laid in 350 mm wide and 750 mm deep trench and shall be covered with 250 mm thick layer of soft sifted sand & protected with bricks/tiles. Special care shall be taken to ensure that the cables are not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable.

8.27 WIRE AND WIRE SIZES

1100 volts grade PVC insulated copper conductor wires in conduit shall be used.

For all single phase/ 3 phase wiring, 1100 volts grade PVC insulated copper conductor wires shall be used. The equipment inside plant room shall be connected to the control panel by means of insulated copper conductor wires of adequate size in exposed conduits. Final connections to the equipment shall be through wiring enclosed in galvanized flexible conduits rigidly clamped at both ends and at regular intervals. An isolator shall be provided near each motor/equipment wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated copper conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification of control wiring.

The minimum size of control wiring shall be 1.5 sq. mm PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

Power wiring, cabling shall be of the following sizes:

- | | | |
|-------|---|--|
| i. | Upto 5 HP motors/ 5 KW heaters | 3 x 4 sq. mm copper conductor wires. |
| ii. | From 6 HP to 10 HP motors
6 KW to 7.5 KW heaters | 3 x 6 sq. mm copper conductor wires |
| iii. | From 12.5 HP to 15 HP wires | 2 Nos. 3 x 6 sq. mm copper conductor wires |
| iv. | From 20 HP to 25 HP motors | 2 Nos. 3 x 10 sq. mm copper conductor wires |
| v. | From 30 HP to 35 HP motors
armoured cable. | 2 nos. 3x 16 sq. mm aluminium conductor |
| vi. | From 40 HP to 50 HP motors
armoured cable. | 2 Nos. 3x25 sq. mm aluminium conductor |
| vii. | From 60 HP to 75 HP motors | 1 No. 3 x 70 sq. mm aluminium conductor
armoured cable. |
| viii. | 100 HP motors conductor | 1 No. 3 x 150 sq. mm. aluminium |

armoured cable

- ix. 200 HP motor conductor 2 No. 3 x 150 sq. mm.aluminium armoured cable.

All the switches, contactors, push button stations, indicating lamps shall be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors or as per manufacturer's recommendation.

	TYPE OF STARTER	CONTACTOR CURRENT CAPACITY	RELAY RANGE	OVERLOAD
5 HP Motors		DOL	16 amps	6-10 amps
7.5 HP motors		DOL	16 amps	9-15 amps
10 HP Motors		DOL	25 amps	9-15 amps
12.5 HP Motors	Star Delta		16 amps	9-15 amps
15 HP Motors		Star Delta	25 amps	9-15 amps
20 HP Motors		Star Delta	32 amps	14-23 amps
25 HP Motors		Star Delta	32 amps	14-23 amps
200 HP Motors		DOL	325 amps	CT Operated relay

Two speed motors when specified, shall be provided with DOL starter irrespective of it rating.

8.28 EARTHING

Earthing shall be provided in accordance with relevant BIS Codes and shall be copper strips /wires .The main panel shall be connected to main earthing system of the power supply. All single phase metal clad switches and control panels be earthed with minimum 3 mm diameter copper conductor wire. All 3 phase motors and equipment shall be earthed with 2 numbers distinct and independent copper wires / tapes as follows:

- i. Motor upto and including 10 HP rating. 2 Nos. 3 mm dia copper wires.
- ii. Motor 12.5 HP to 40 HP capacity 2 Nos. 4 mm dia copper wires
- iii. Motor 50 to 75 HP capacity. 2 Nos. 6 mm dia copper
- iv. Motor above 75 HP. 2 Nos. 25 mm x 3 mm copper tapes.

All switches shall be earthed with two numbers distinct and independent copper wires tapes as follows:

- i. 3 phase switches and control panels upto 60 amps rating. 2 nos. 3 mm dia copper wires.

- | | | |
|------|---|-----------------------------------|
| ii. | 3 phase switches, and control panels 63 amps to 100 amps rating. | 2 Nos. 4 mm dia copper wires. |
| iii. | 3 phase switches and control panels 125 amps to 200 amps rating. | 2 Nos. 6 mm dia copper wires. |
| iv. | 3 phase switches, control panels, bus ducts, above 200 amps rating. | 2 Nos. 3 mm x 25 mm copper tapes. |

The earthing connections shall be tapped off from the main earthing of electrical installation. The overlapping in earthing strips at joints where required shall be minimum 75 mm. These straight joints shall be rivetted with brass rivets & brazed in approved manner. Sweated lugs of adequate capacity and size shall be used for all termination of wires. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substance, and properly tinned.

8.29 DRAWINGS

Shop drawings for control panels and for wiring of equipment showing the route of conduit & cable shall be submitted by the contractor for approval of Architect/Consultant before starting the fabrication of panel and starting the work. On completion, four sets of complete "As-installed" drawings incorporating all details like, conduits routes, number of wires in conduit, location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the Contractor.

8.30 TESTING

Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS codes and test report furnished by a qualified and authorised person. The entire electrical installation shall be gotten approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of Project Manager. Testing of the panels shall be as per relevant BIS Codes :

8.31 PAINTING

All sheet steel work shall undergo a process of degreasing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be baked in an oven. The finishing treatment shall be by application of powder coating of approved shade.

8.32 MEASUREMENT OF ELECTRICAL CONTROL PANELS

As per general guidelines for quantities.

8.33 RUBBER MAT

Rubber mat shall be provided in front to cover the full length of all panels. Where back space is provided for working from the rear of the panel, rubber mat shall also be provided to cover the full length of panel.

9.0 COMMISSIONING & GUARANTEE

9.1 SCOPE OF WORK

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Architect/PMC/AKVN or his representative or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before performing any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The contractor shall also provide permanent Tee connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge & rota meters. Contractor shall also supply all required pressure gauge, temperature gauge & rotameter for system commissioning and balancing. The balancing shall be to the satisfaction of Consultant / Project Manager.

Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper within two weeks after completion of the tests.

9.2 PRECOMMISSIONING

On completion of the installation of all pumps, piping, valves, pipe connections, insulation etc. the Contractor shall proceed as follows:

- a. Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fittings and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.
- b. All strainers shall be inspected and cleaned out or replaced.
- c. When the entire systems are reasonably clean, a pre-treatment chemical shall be introduced and circulated for
at least 8 hours. Warning signs shall be provided at all outlets during pre-treatment. The pre-treatment
chemical shall:
 - Remove oil, grease and foreign residue from the pipe work and fittings;
 - Pre-condition the metal surfaces to resist reaction with water or air.
 - Establish an initial protective film;
 - After pre-treatment, the system shall be drained and refilled with fresh water and left until the system is put into operation.
 - Details and procedures of the pre-treatment shall be submitted to the Architect for approval.
- d. Check all clamps, supports and hangers provided for the pipes.
- e. Check all the equipment, piping and valves coming under hot water system and operate each and every valve
on the system to see if the valves are functioning properly. Thereafter conduct & hydro test of the system as

for (b) above.

- f. Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

Fire Protection System

- a. Check all hydrant valves by opening and closing : any valve found to be open shall be closed.
- b. Check all the piping under hydro test.
- c. Check that all suction and delivery connections are properly made for all pump sets.
- d. Check rotation of each motor after decoupling and correct the same if required.
- e. Test run each pump set.
- f. All pump sets shall be run continuously for 8 hours (if required with temporary piping back to the tank).

Commissioning and Testing

- a. Pressurise the fire hydrant system by running the jockey pump and after it attains the shutoff pressure of the pump , then
- b. Open bypass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the preset pressure. If necessary adjust the pressure switch for the jockey pump. Close by-pass valve.
- c. Open hydrant valve and allow the water to below into the fire water tank in order to avoid wastage of water. The main fire pump shall cut-in at the preset pressure and shall not cutout automatically on reaching the normal line pressure. The main fire pump shall stop only by manual push button. However the jockey pump shall cut-out as soon as the main pump starts,
- d. Switch off the main fire pump and test check the diesel engine driven pump in the same manner as the electrically driven pump,
- e. When the fire pumps have been checked for satisfactory working on automatic controls, open fire hydrant valves simultaneously and allow the hose pipes to discharge water into the fire tank to avoid wastage.
- f. Check each landing valve, male and female couplings and branch pipes, for compatibility with each other. Any fitting which is found to be incompatible and do not fit into the other properly shall be replace by the Contractor. Each landing valve shall also be checked by opening and closing under pressure.
- g. Check all annunciations by simulating the alarm conditions at site.

Sprinkler System

- a. Start the sprinkler pump and develop the required pressure in the sprinkler pipes.
- b. Open the test valve to test the automatic starting of the pump. If necessary , make necessary adjustments in the setting of pressure switch. The sprinkler water gong alarm shall also operate when the test valve is open. This operation is to be done for each and every section of the sprinkler system and the alarm for each section (via flow switch) shall be checked for operation.

- c. After satisfactory operation of the pump the Contractor shall set up mock fire and test the system.
- d. Check all annunciations by simulating the alarm conditions at site.

9.3 STATUTORY AUTHORITIES' TESTS AND INSPECTIONS

As and when notified in writing or instructed by the Architect, the Contractor shall submit shop drawing and attend all tests and inspections carried out by Local Fire Authorities, Water Authority and other Statutory Authorities, and shall forthwith execute free of charge any rectification work ordered by the Architect as a result of such tests and inspections where these indicate non-compliance with Statutory Regulations. Some of these tests may take place after the issue of Practical Completion of the Main Contract and the Contractor shall make all allowances in this respect.

The Contractor shall be responsible for the submission of all necessary forms and shop drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted to and kept by these Authorities.

The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the Architect for checking before submission.

The Contractor shall allow for at least two submissions of complete sets of shop drawings to the Authorities, one to be made within six months after the award of the Contract but not less than six weeks before the inspection. The Architect may at his discretion instruct the Contractor for additional submissions to the Local Authorities whenever necessary.

The Contractor shall notify the Architect at least seven days in advance of his application for local Authority tests and inspections. On receipt of a confirmed date for test and inspection the Contractor shall inform the Architect without delay.

9.4 FINAL ACCEPTANCE TESTS

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the Architect.

Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

9.5 REJECTION OF INSTALLATION / PLANT

Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the Architect either in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the Architect so as to comply with the Authority's

requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Authority/Architect.

After works have been accepted, the Contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the Architect/Employer.

9.6 WARRANTY AND HANDOVER

The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Owner.

9.7 HANDING OVER OF DOCUMENTS

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Owner's site representative and all testing and commissioning documents shall be handed over to the Owner's site representative.

The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Owner's site representative.

9.8 PIPE COLOUR CODE:

S.No.	Pipe Lines	Ground Colour	Base Colour	First Colour Band	Second Colour Band
1.	Fire System			Post Office Red	

10.0 CHECK LIST FOR COMMISSIONING

Fire Protection System

- a. Check all hydrant & other valves by opening and closing. Any valve found to be open shall be closed.
- b. Check all clamps, supports and hangers provided for the pipes.
- c. All the pump sets shall be run continuously for 30 minutes (with temporary piping back to tank from the nearest hydrant, using canvas hose pipes).
- d. Fire Hydrant System - Pressurise the fire hydrant system by running the jockey pump and after it attains the shutoff pressure of the pump, then

Open bypass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the preset pressure. If necessary adjust the pressure switch for the jockey pump. Close by-pass valve.

Open hydrant valve and allow the water to flow into the fire water tank in order to avoid wastage of water. The main fire pump shall cut-in at the preset pressure and shall not cutout automatically on reaching the normal line pressure. The main fire pump shall stop only by manual push button. However the jockey pump shall cut-out as soon as the main pump starts,.

Operate booster pump continuously for 30 minutes with piping back to underground tanks from the hydrant nearest to plant room.

Check each landing valve, male and female couplings and branch pipes, for compatibility with each other. Any fitting which is found to be incompatible and do not fit into the other properly shall be replaced by the Contractor. Each landing valve shall also be checked by opening and closing under pressure.

Check air cushion tanks on the terrace for proper functioning.

11.0 SPECIFICATIONS OF PRESSURE GAUGE

- a) Type : Bourdon - for pressure above 1.0 kg/cm²
- b) Sensing Element Material : Bourdon - AISI 316 SS
- c) Movement material : AISI 304 SS
- d) Case Material : Die cast Aluminum, stove enameled, black
Finish, threaded bezel ring, clear glass cover
Conforming to NEMA 4 / IP-65
- e) Dial Size : 150 mm
- f) Range : 0 to 15 kg/cm²
- g) Scale : Black lettering on white background
In 270 Deg. arc.
- h) Range Selection : Normal process pressure 70 percent of range
approximately.
- i) Over range Fighting : 125% of maximum range by internal stop. External stop at zero.
- j) Adjustment : External micrometer screw for zero adjustment. Internal micrometer screw
for range adjustment.
- k) Element connection : Brazing for range below 40 kg/cm²
- l) Process connection : 1/2" NPT (M) bottom connection for Local mounting.
- m) Performance : Accuracy: ± 1.0 percent of span
- n) Operating ambient : 70 Deg. C (maximum continuous)
temperature
- o) Safety feature : Neoprene safety diaphragm at the back
- p) Accessories : a) Pipe union b) Snubber for pulsating fluid applications. c) 2-
valve manifold. d) Micrometer zero adjusting screw.
- q) Codes and Standards : a) ASME PTC 19.2 (1964)
b) IS-3624 - 1979

12.0 SPECIFICATIONS OF VALVES

- a) Manufacturer : As per approved make
- b) Applicable standard :
- i) Gate Valve : As per IS: 780/IS 2960
- ii) Globe Valve : As per IS: 778
- iii) Check Valve : As per IS: 5312
- c) Pressure Rating : PN 16 valve flanges drilled to ANSI B 16.5 ASA 150
lbs rating

d)	Method of Actuation	:	Hand wheel operated
e)	Construction		
i)	Stem type	:	Non-rising
ii)	Body and bonnet connection	:	Bolted type
iii)	Seat ring renewable?	:	Yes
f)	Material of Construction		
i)	Body / Bonnet & Cover	:	Cast Iron as per IS-210
ii)	Wedge / disc.	:	S.S. as per AISI – 410
iii)	Seating surface stellite?	:	Yes
iv)	Hinge Pin (for check valve)	:	S.S. as per AISI – 410
v)	Stem (for gate & Globe valve)	:	S.S. as per AISI – 410
vi)	Back seat / ring	:	S.S. as per AISI – 410
vii)	Hand wheel	:	Cast Iron
viii)	Bolts & Nuts	:	Carbon steel as per IS: 1367
ix)	Gaskets	:	Compressed Asbestos
x)	Gland Packing	:	Compressed Asbestos
xi)	Counter Flange	:	M.S. Dimensions as per ANSI B16.5
g)	Working Pressure	:	7.0 kg/cm ²
h)	Hydrostatic test pressure	:	11.5 kg/cm ²
i)	Inspection and Tests		
i)	Quality surveillance by Owner	:	Yes
ii)	Hydrostatic test certificate required	:	Yes
iii)	Material Test Certificate required	:	Yes

12.0 DIVISION OF WORK

Scope of Fire Fighting System Contractor	By Others
<p>Supply,Installation, testing and commissioning of :</p> <ul style="list-style-type: none"> a. Electric Motor Fire Pumps b. Diesel Engine Driven Standby Fire Pump c. Electric Motor Driven Jockey Pump. d. Supply of all pumps e. Supply, installation, testing and commissioning of the pump control panel with cabling & earthing upto motors. f. Supply, installation, testing and commissioning of cabling of flow switches and their control panel. <p>Supplying, installation, testing and commissioning of:</p> <ul style="list-style-type: none"> g. Pressurized mains for fire fighting, including external pipes and internal piping h. Yard Hydrants, Landing valves, sprinkler heads, hoses, valves, hose cabinet, flow switch, pressure switch etc. i. Painting, coating on piping, equipments, structural supports j. Excavation for laying pipes construction of valve chamber, providing of R.C.C. Hume pipes. 	<ul style="list-style-type: none"> a. Foundation for Pumps. b. R.C.C.Fire water storage under ground and over head tank c. Bringing power up to panel

Approved Make List for Fire Fighting					
SOR ITEM					
S.no.	Item	Make			
1	MS	Tata Steel	Jindal (Hisar)		
2	M.S fitting	Unik	Zoloto	Jainsons	
3	Forged Steel Fittings	True Forge	VS Forge	Diecast	Forged
4	Butterfly Valve (C.I.)	Audco	Sarkar	Leader	
5	Ball Valve (SS or CS)	AUDCO	Leader	Zoloto	KSB
6	GM Landing Valve(ISI Mark) (Single Outlet/Double Outlet)	Minimax	Newage	Safe Guard	Firex
7	Gun Metal Branch Pipe with Nozzle	Minimax	Newage	Safe Guard	Firex
8	Male/Female Coupling(GM)	Minimax	Newage	Safe Guard	Firex
9	Hose Reel Drum	Minimax	Newage	Safe Guard	Firex
10	Shut off Nozzle	Minimax	Newage	Safe Guard	Firex
11	Fire Man Axe	Minimax	Newage	Safe Guard	Firex
12	GM Two Way/Three Way/Four Way Collecting Head	Minimax	Newage	Safe Guard	Firex
13	GM Draw out Connection (Suction Hose Coupling)	Minimax	Newage	Safe Guard	Firex
14	20 mm dia rubber pipe for hose reel	Dunlop	Good year	Jyoti	Padmini
15	Pressure switch	Danfoss	Switzer	Indfoss	System Sensor
16	Anti corrosive pipe treatment (As per IS:10221 – 1982)	Pypkote (IWL)	Coatek		
17	RRL Hose/ C.P.Hose	Newage	Safex	CRC	Padmini
18	Mechanical Seal	Sealol	Burgman	Hindustan	
19	Foot Valve	Kirloskar	Sarkar	Kalpana	Venus
20	Dash Fasteners	Hilti	Fisher		
21	Paint Primer	Asian	Goodlac Nerolac	Berger	Jenson Nicholson
22	Enamel Painting of pipes etc.	Asian	Goodlac Nerolac	Berger	Jenson Nicholson
23	Welding Electrodes	Advani Oerlikon	Esab	D&H Secheron	
24	Deluge Valve	HD	Viking	Tyco	
25	Pendant/Upright / Powder coated Pendant Sprinkler Heads / Spray Nozzle (UL Listed)	Tyco	Spray Safe	Viking	HD.
26	Powder coated sprinkler rosette	Tyco	Spray Safe	Viking	HD.
27	Concealed Sprinkler	Tyco	Spray Safe	Viking	HD.
28	Flow Switch	Switzer	SystemSensor	Potter	Honeywell
29	Exit Sign	Glow Light	Equivalent		
NOTE :					
All The materials to be ISI marked.					
The materials shall be only of the approved makes as specified in this .					
The Contractor shall submit samples of all the makes as specified in this list and the Consultant / Owner shall have the power to select any of them.					
Consultant/ AKVN decision in this regard shall be binding on the Contractor.					
In case any material is not available for any one or all of these approved makes the Consultant/ Owner shall select and approve alternative make(s).					

Approved Make List for Fire Fighting					
NON SOR ITEM					
S.no.	Item	Make			
1	Fire Pumps	Armstrong	Grundfos	Kirloskar	M&P
2	Jockey Pumps	Armstrong	Grundfos	Kirloskar	M&P
3	Motor	Kirloskar	Siemens	Crompton	ABB
4	Diesel Engine	Clarke	Caterpillar	Kirloskar	Cummins
5	GI Pipes	Tata Steel	Jindal (Hisar)		
6	G.I fitting	Unik	Zoloto	Jainsons	
7	Forged Steel Fittings	True Forge	VS Forge	Diecast	Forged
8	Dual Plate type NRV (C.I.)	Sarkar	Venus	Leader	Advance
9	Non Return Valve (GM)	Leader	Zoloto	RB	
10	Gun metal Gate valves	Leader	Zoloto	RB	
11	Gun Metal/C.I. Air release valve	Leader	Oven Trop	Zoloto	Newage
12	Pressure Gauges	Fiebig	H Guru	Waree	
13	Suction Strainers	Safeguard	Dashmesh	Jaypee	
14	Fire Extinguishers (ISI Marked only)	Minimax	Cease Fire	Kidde	Firex
15	Antivibration mounting	Resistoflex	Dunlop	Kanwal	Welcom Engg
16	Installation control valve	HD	Viking	Tyco	
17	Annunciator Panel for Sprinkler Panel	PCD	Safeway	Agni	
18	Electrical Panel	Arrow Engineers	Tricolite	Adlec	Sudhir
19	Power Cables & Control Cables	Polycab	RPG	Universal	Nicco
20	PVC insulated copper wires	Finolex	National	Skyline	
21	Single phase preventor	L&T	Siemens	ABB	
22	Relays	L&T	Alstom	Siemens	
23	Indicating Lamps	L&T	GE	BCH	Siemens
24	Lugs	Dowell	Lotus		
25	Push buttons	L&T	Siemens		
26	Fuses & fuse bases	L&T	GE		
27	Current Transformer/Voltage Transformers	Kappa	Automatic Electric	Indcoil	
28	Timers	L&T	BCH	Siemens	G.E. Power Contracts
29	Time delay relay/limit switch	Cutler Hammer	L&T		
30	Controls	Honeywell	Staefa	Penn	Danfoss
31	Starters/Switches/Contractors	L&T	Siemens	GE	
32	Changer over switches	HPL Socomec	H.H. Elcon	C&S	L&T
33	Annunciator	Minilec	Equivalent		
34	ACB/MCCB	L&T	Siemens	Merlin Gerin	
35	Miniature Circuit Breakers	L&T(Hager)	GE	MDS	Siemens
36	Terminals	Elmex			
37	Conduits	Precision	BEC	AKG	
38	Earth Leakage Relay	PIC Make			

39	Battery Charger	AE	Chhabi Electric	Waves Electronics	
40	Battery	Exide	Standard		
41	Selector switch	Kaycee	L&T		
42	Indicating instruments	AE	Rishabh	Meco	
43	Cable glands	Stripwell	Comex		
44	(Single/Double Compression)				
45	Bimetallic Crimping type lugs	Dowells			
46	Water flow meter	ABB	B meter	Scambler	Tyco
NOTE :					
All The materials to be ISI marked.					
The materials shall be only of the approved makes as specified in this .					
The Contractor shall submit samples of all the makes as specified in this list and the Consultant / Owner shall have the power to select any of them.					
Consultant/ AKVN decision in this regard shall be binding on the Contractor.					
In case any material is not available for any one or all of these approved makes the Consultant/ Owner shall select and approve alternative make(s).					

ANNEXURE – E6

HVAC WORK

For all SOR items refer MPPWD SOR 2014 with effective from 1 August 2014 / NBC/ CPWD with all amendment up to date.

TECHNICAL SPECIFICATIONS OF HVAC

1. SPECIFICATION WATER COOLED SCREW CHILLER:

1.1. SCOPE OF WORK:

The scope of this section comprises the supply & commissioning of water cooled screw chilling unit conforming to these specifications and accordance with the requirement of drawing and of schedule of quantity. The chilling machine shall be of approved make consisting of the following:

- Pair of Helical Rotors
- Electric Motor
- Shell & Tube type Water Cooled Condenser
- Shell & tube type water chiller
- M.S. foot mounting, plate with cushy foot mounting
- First charge of refrigerant and oil
- Copper Refrigerant piping and control
- Factory installed electrical panel including star delta starter and isolating switch.
- Microprocessor motor control with multiple displays.
- Refrigerant R-134a only.

1.2. GENERAL:

Each unit will be completely factory-assembled including evaporator, condenser, sub cooler (if specified), oil separator, compressor/s, motor, lubrication system, micro-computer control center, and all interconnecting unit piping, wiring and accessories. The machine shall be ARI certified from USA/Europe.

Performance will be certified in accordance with ARI Standard 550-98.

1.3. COMPRESSOR:

The compressor will be an hermetic/semi hermetic, helical rotary screw type. The compressor housing will be of cast iron, precision machined to provide minimal clearance for the rotors. The rotors will be manufactured from forged steel and use asymmetric profiles operating at a maximum speed of (2975 RPM/50 Hz). The compressor will incorporate a complete anti-friction bearing design to reduce power and increase reliability; four separate cylindrical roller bearings to handle radial loads; and two 4-point angular contact ball bearings to handle axial loads. The compressor will have an internal oil reservoir to assure a constant supply of oil to the bearings at all times. A spring actuated positive seating check valve will be incorporated in the compressor housing to prevent rotor backspin during shutdown. The shaft seal will be a spring-loaded, carbon ring type with precision lapped collar cooled by low pressure oil.

Capacity control will be achieved by use of a slide valve to provide fully modulating control from 100% to 25% of full load. The slide valve will be actuated by oil pressure, controlled by external solenoid valves through the micro-computer control center. The unit will be capable of operating with lower temperature cooling tower water during part-load operation in accordance with ARI Standard 550.

1.4. MOTOR DRIVELINE:

The motor will be 2-pole, continuous duty, squirrel cage induction type, and will have an open drip-proof enclosure for open type compressor and refrigerant cooled for Semi Hermetic Compressor.

Motor full-load amperes at design conditions will not exceed motor nameplate (FLA). Motor will be designed for use with star delta starter. Motor will be factory-mounted and directly connected to the compressor to provide compressor/motor alignment. Star delta starter shall also be factory mounted.

1.5. LUBRICATION SYSTEM:

An adequate supply of oil will be available to the compressor at all times. During startup and shut down, this will be achieved by oil reservoirs in the compressor, or by prelude oil pump operation. During operation, oil will be delivered by positive system pressure differential or full-time operation of an oil pump.

An immersion oil heater will be provided, (temperature actuated), to effectively remove refrigerant from the oil. An external, replaceable-cartridge, oil filter will be provided, along with manual isolation stop valves for ease of servicing. An oil ejector will be provided to automatically remove oil which may have migrated to the evaporator, and return it to the compressor. The oil separator will be of a horizontal design with no moving parts, and will provide effective oil separation before the refrigerant enters the heat exchangers. The oil separator will be designed, tested, and stamped in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII - Division 1. A refrigerant-cooled oil cooler will be provided to allow operation of the chiller over the full range of operating conditions.

1.6. EVAPORATOR:

Single Evaporator will be of the shell-and-tube type DX; flooded type designed for 300 psig working pressure on the refrigerant side, and will be tested at 450 psig. Shell will be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than 1200 mm apart. The refrigerant side will be designed in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII - Division 1. Tubes shall be high-efficiency, internally and externally enhanced type having plain copper bands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube will be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable. Water velocity through the tubes will not exceed 12 FPS. Liquid level sight glasses will be located on the side of the shell to aid in determining proper refrigerant charge. The evaporator will have a refrigerant relief device to meet the requirements of the ASHRAE 15 Safety Code for Mechanical Refrigeration including Anti-freeze thermostat & cooling thermostat.

Water boxes will be removable to permit tube cleaning and replacement. Stub out water connections having mild steel flanges will be provided. Vent and drain connections with plugs will be provided on each water box/pipe. Chiller outlet pipe shall be provided with bellow type water flow switch to prevent compressor startup till full water flow is established.

1.7. CONDENSER:

Condenser will be of the shell-and-tube type, designed for 300 psig working pressure on the refrigerant side, and be tested at 450 psig. Shell will be fabricated from rolled carbon steel plate with fusion welded seams, have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than 1200 mm apart. A refrigerant sub cooler will be provided for improved cycle efficiency. The refrigerant side will be designed, in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII - Division 1. Tubes shall be high-efficiency, internally and externally enhanced type having plain copper bands at all intermediate tube supports to

provide maximum tube wall thickness at the support area. Each tube will be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable. Water velocity through the tubes will not exceed 12 FPS. The condenser will have refrigerant relief devices to meet the requirements of the ASHRAE 15 Safety Code for Mechanical Refrigeration.

Water boxes will be removable to permit tube cleaning and replacement. Stub out water connections having mild steel flanges will be provided. Vent and drain connections with plugs will be provided on each water box. Separate service valves shall be provided for circulation of descaling chemical for descaling process.

Condenser outlet pipe shall be provided with bellow type water flow switch to prevent compressor start up till full water flow is established.

1.8. REFRIGERANT SYSTEM:

Refrigerant flow to the evaporator will be metered by a single/multiple fixed orifice with no moving parts. The condenser shell will be capable of storing the entire system refrigerant charge during servicing. Isolation from the rest of the system will be by manually operated isolation valves located at the inlet and outlet of the condenser. Additional valves will be provided to facilitate removal of refrigerant charge from the system.

1.9. MICRO-COMPUTER CONTROL CENTER:

Each unit will be furnished complete with a micro-computer control center in a locked enclosure, factory-mounted, wired and tested. The control center will include a 40-character alphanumeric display showing all system parameters in the English language with numeric data in English units.

Digital programming of essential set points through a color coded, tactile-feel keypad will include: leaving chilled water temperature; percent current limit; pull down demand limiting; seven-day time clock for starting and stopping chiller, pumps, and tower (complete with holiday schedule); and remote reset temperature range.

All safety and cycling shutdowns will be annunciated through the alphanumeric display and consist of day, time, cause of shutdown, and type of restart required. Safety shutdowns will include: high condenser pressure; low oil pressure at compressor; clogged oil filter; high oil temperature; high oil pressure; high compressor discharge temperature; low evaporator pressure; motor controller fault; and sensor malfunction. Cycling shutdowns will include: low water temperature; cooler/condenser water flow interruption; power fault; internal time clock; anti-recycle and cooling thermostat.

System operating information will include: return/leaving chilled water temperatures; return/leaving condenser water temperatures; evaporator/condenser refrigerant pressures; oil pressures at compressor and oil filter differential; percent motor current; evaporator/condenser saturation temperatures; compressor discharge temperature; oil temperature; percent slide valve position; operating hours; and number of compressor starts. Security access will be provided to prevent unauthorized changing of set points, and to select local or remote control of the chiller. Panel shall be designed for multiple restart.

The control center will be able to interface with a building automation system to provide remote chiller start/stop; reset of chilled water temperature; reset of current limit; and status messages indicating chiller is ready to start, chiller is operating, chiller is shut down on a safety requiring reset, and chiller is shut down on a recycling safety.

1.10. CHILLER INSULATION:

Factory-applied, anti-sweat insulation will be attached to the cooler shell, flow chamber, tube sheets, suction connection, and (as necessary) to the auxiliary tubing. The insulation will be a flexible closed

air cell nitrite rubber (flame retardant with no smoke, class O type) applied in two layers, each 20mm thick, with joints staggered. Insulation will be applied with vapour proof adhesive. Insulation of water boxes and nozzles shall also be provided as the chiller shell. The insulation will normally prevent sweating in environments with relative humidity up to 75% and dry bulb temperatures ranging from 50 to 90°F.

1.11.COMPRESSOR MOTOR STARTER:

Factory mounted Star Delta starter with NEMA 1 enclosure suitable for pad mounting. A 14-gauge (minimum) steel terminal box with gasket front access cover will be provided for field-connected conduit. The chiller micro-center control panel shall provide Overload/over current protection. The starting current of the motor should not exceed 2 to 2.2 times the FLA of the motor.

1.12.PIPING REQUIREMENTS – INSTRUMENTATION AND SAFETIES

- 1.12.1. The contractor shall supply and install pressure gages in readily accessible locations in piping adjacent to the chiller such that they can be easily read from a standing position on the floor. Gages shall be very accurate. Scale range shall be such that design valves shall be indicated at approximately mid-scale.
- 1.12.2. Gages shall be installed in the entering and leaving water lines of the cooler and condenser.
- 1.12.3. H.V.A.C. contractor shall supply & install flow detection devices in chilled water and condenser water piping. Switches shall make contact when flow is established. Flow switches shall be installed in horizontal runs at least 5 pipe diameters down-stream from any bend or tee.

1.13.Insulation

- 1.13.1. Chilled water piping and cooler water boxes shall be installed by the contractor.
- 1.13.2. Chiller shall be insulated at factory. Final layer of insulation shall be installed at the job site by the contractor .
- 1.13.3. Chiller insulation shall confirm to UL standard 94, classification 94 HBF and should be suitable for positive temperature operation.

1.14. Vibration isolation

Chiller manufacturer shall furnish neoprene isolator pads for mounting equipment on a level concrete surface.

1.15.START-UP

- 1.15.1. The manufacturer shall provide a factory trained representative, employed by the chiller manufacturer, to perform the start-up, operation and maintenance manual provided by the chiller manufacturer.
- 1.15.2. After the above services have been performed, the same factory trained, representative shall be available for a period of class room instruction (not to exceed 4 hours) to instruct the chiller owner's personnel in the proper operation and maintenance of the chiller.
- 1.15.3. Manufacturer shall supply the following literature-
 - i. Start-up, operation and Maintenance Instructions.
 - ii. Installation Instructions
 - iii. Field Wiring Diagrams
 - iv. Maintenance manual showing maintenance based on calendar basis and hourly basis.

1.16.FACTORY TESTING:

The chillers shall be factory run tested on simulated operating conditions site in manufacture factory. The inspection test may be witnessed by client or repetitive person.

Anyone machine of each variant would be run tested generally as per ARI 550.for other machines test certification may be enclosed. Energy balance and operating parameters on duty parties will be witnessed.

1.17.MISCELLANEOUS ITEMS:

Serrated rubber pads for field mounting under unit feet for vibration isolation shall be supplied by the contractor.

1.18.EXECUTION START-UP

Units shall be either factory charged or charged at site with the proper quantity and type of refrigerant and oil.

Start-Up Services: Provide for as long a time as is necessary to ensure proper operation of the unit, but in no case for less than two full working days. During the period of start-up, the Start-up Technician shall instruct the Owner's representative in proper care and operation of the unit.

1.19.TECHNICAL/ OPRATIG DATA OF THE SCREW CHILLER:

a) Refrigeration capacity	:	270 TR (Multi circuit)
b) Chilled Water inlet temperature	:	12.2°C / 54° F
c) Chilled Water outlet Temperature	:	6.67°C / 44° F
d) Fouling Factor Chiller (FT2 hr °F/BTU)	:	0.0005
e) Condenser water inlet temperature	:	32.2°C / 97° F
f) Condenser water outlet Temperature	:	36.4°C / 90° F
g) Fouling Factor Condenser (FT2 hr oF/BTU)	:	0.001
h) IKW/TR (at full load)	:	0.69
i) NPLV(KW/TR)	:	0.51

Water Chilling Machines shall be tested at works as per ARI standard 550-98 & detailed report submitted with individual machines on delivery. The test results shall match technical data earlier confirmed by vendor.

1.20.BUILDING AUTOMATION SYSTEM:

The microprocessor of chiller shall compatible with Modbus /Bacnet/Ethernet. All necessary communication protocol required by BMS SYSTEM for with facing shall be provided with the vendor.

2. PUMPS:

2.1.SCOPE:

The scope of this section comprises the supply, erection, testing and commissioning of water pumps conforming to these specifications and in accordance with requirements of schedule of quantities.

2.2.TYPE:

All water pumps, for air conditioning applications shall be of approved make.

The equipment shall be capable of developing the required total head at rated capacity. The pumps shall be suitable for parallel operation and should not overload in single pump operation. The pumps shall run smooth without undue noise and vibration. The magnitude of peak to peak vibration at shop shall be limited to 75 microns at the bearing housing. After installation at site the magnitude of vibration shall be limited to 50 micron.

2.3.HORIZONTAL/ RAIDIAL SPLIT CASING / END SUCTION CENTRIFUGAL PUMPS (LONG COUPLED)

Construction of pumps Horizontal split as per BIS 1520 & of end suction pumps - BIS 28858.

a) Casing:

Pump casing shall be close-grained cast iron of heavy section, split-casing making possible complete servicing of rotating parts without disconnecting piping or motor connection. Motor to pump connection shall be done with spacer type coupling. Suction passages shall be of volute form promoting smooth entry to impeller and increased efficiency.

b) Impeller:

Impeller shall be **Bronze**, double suction, enclosed type and hydraulically balanced so as not to cause any vibration during operation. Impeller shall be securely keyed to the shaft. Means shall be provided to prevent loosening during operation including rotation in reverse direction. Impeller fastening nuts (if provided) shall be of cap type and shall tighten in the direction of normal rotation for end suction - double shrouded single entry, radial flow hydraulically balanced.

c) Wearing Rings:

Wearing rings shall be of renewable type. These shall be held in place by screwing against rotation, press fit and locked with pins, flanged and screwed.

d) Shaft:

Shaft shall be made of stainless steel 316, protected by S.S. sleeves. It shall be finished to close tolerance at the impeller, coupling and bearing diameters. The impellers and shaft sleeves shall be firmly secured to the shaft by key/nuts.

The shafts size shall be calculated on the maximum combined shear stress. This shear stress shall not exceed 30 per cent of the elastic limit in tension or 18 percent of ultimate tensile strength whichever is lower.

e) Shaft Sleeves:

The pump shall be equipped with mechanical seals. Shaft sleeves shall be of gun metal, provided to protect the shaft. Shaft sleeves shall be securely locked or keyed to the shaft to prevent loosening. Rotating shaft and shaft sleeves shall be machined and assembled for concentric rotation.

f) Bearings:

- i) The bearings may be ball, roller or sleeves type. Provision shall be made to take axial and radial loads.
- ii) Where there is a possibility of liquid entering the bearing, the pump shall be provided with suitable preventive arrangement such as water deflectors.
- iii) Bearings shall be easily accessible without disturbing the alignment of the pump.

g) Couplings:

- h) Pumps shall be furnished complete with spacer type couplings (love-joy coupling), to permit disassembling, without disturbing pump driver. Coupling guards, made of expanded metal and bolted to the base plate, shall be furnished for all coupled pumps.

i) Base Plates:

The common base plate for pump and motor shall be in one place and it shall be made of cast iron or welded steel construction. Suitable holes shall be provided for grouting and they shall be so located that the base can be grouted in place without disturbing the pump and motor. All pumps and motors shall be properly aligned, bolted and doweled to the base plates by

contractor. Adequate space shall be provided between pump drain connections and base plate for installation of minimum 15mm drain piping. Pumps shall be supplied with suitable drain pans or drain rim type base plates with trapped drain connections.

j) Installations:

Pumps Shall Installed as per the manufacturer's recommendation. The pump & motor shall be installed on floating foundations or a common mild steel base frame grouted to concrete foundation, which in turn are mounted on vibration isolators. The floating frame & vibration isolator and concrete foundation shall be supplied by the contractor. Pumps shall be supplied completely assembled on base frame. The arrangement shall be shown in shop drawings.

2.4. LUBRICATION:

Upon installation of the complete system and before testing, the pump shall be lubricated in strict accordance with the manufacturer's instructions.

2.5. PUMP ALIGNMENT:

All pumps prior to testing shall be aligned with a dial indicator within 0.05mm.

2.6. PAINTING:

All pumps, motors and bases shall be supplied with approved finish. Shop coat of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the adjoining areas.

2.7. PERFORMANCE DATA:

Pump performance curves and power consumption with operating points clearly indicated shall be submitted, and verified at the time of testing and commissioning of the installation.

2.8. VARIABLE SPEED PUMPING SYSTEM:

Variable speed pumping system should provide stable and predictable flow rate over a wide variation of head pressure dedicated for HVAC application including the following:-

- 2.8.1. Shall incorporate a starter to keep starting current within full load current of the motor.
- 2.8.2. Shall conform to ISO 9001.
- 2.8.3. Shall be CE marked for compliance with both LV & EMC directives.
- 2.8.4. Shall have built-in chokes (harmonic filters) both on positive and negative rails of DC link of FC for harmonic suppressions.
- 2.8.5. Shall provide full motor rated BHP without any de-ration at all speeds (0 to 100%).
- 2.8.6. The frequency convertor (F.C.) shall convert Local voltage V + 10%, 3 phase, 50 Hz, utility power supply to an adjustable output voltage and frequency. The FC must be capable of delivering full true RMS output voltage to the motor equal to the mains input voltage to FC at full load and speed and should not cause any de-ration of the motor.
- 2.8.7. The voltage to frequency ratio shall be automatically decided by the FC based on the torque requirements of centrifugal pump. It should not be set a constant V/F ratio, to prevent damage to connected equipment and to optimize energy usage.
- 2.8.8. The FC shall work in conjunction with any standard design squirrel cage induction motor and shall not require the motor to be de-rated or cause the motor temperature to rise above the class „B“ rise expected on normal mains operation. The motor shall not require an external blower even at slow speed running.

Full motor load (kW) and torque shall be available throughout class B temperature rise and certification provided.

However if VFD manufacturer recommend inverter grade motors to suit their drive then HVAC contractor to include the cost of inverter motors wherever applicable and no extra payment will be made on this account.

- 2.8.9. Full output torque shall be maintained in the ambient conditions of + 45oC and 95% RH without any de-rating.
- 2.8.10. The control system shall include as a minimum, the programmable logic pump controller, adjustable frequency drive (s) and remote sensor/transmitters as indicated on the drawings. Provide additional items as specified or as required to properly execute the sequence of operation.
- 2.8.11. The variable speed pump logic controller, adjustable frequency drives (s), AFD by pass and remote sensor/transmitter (s) shall be individual components.
- 2.8.12. Pump logic controller, adjustable frequency drives, sensor/transmitters and related equipment shall be installed by the HVAC Contractor as shown on the drawing.
- 2.8.13. Line voltage power wiring shall be installed by the electrical contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.
- 2.8.14. Low voltage (24 VDC and 115 VAC) wiring shall be installed by the controls contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.
- 2.8.15. Enclosed shall be of IP-54 or IP-20 along with suitable panel and ventilation system.
- 2.8.16. F.C. (Frequency Converter) supplier shall be able to provide on request, a detailed harmonics analysis to evaluate the anticipated THD (Total Harmonic Distortion).

2.9.Components:

2.9.1. Pump Logic Controller:

- i. The Technologic pump logic controller assembly shall be listed by and bear the label of Underwriter's Laboratory, Inc. (UL). The controller shall meet part 15 of FCC regulations pertaining to class A computing devices. The controller shall be specifically designed for variable speed pumping application.
- ii. The controller shall function to a proven program those safeguards against damaging hydraulic conditions including:
 - Motor overload
 - Pump flow surges
 - Hunting
 - End of Curve
 - System over Pressure
- iii. The pump logic controller shall be capable of receiving up to 3 remote process variable signals. It will then select the analogue signal that has deviated the greatest amount from its set point. This selected signal will be used as the command feedback input for a hydraulic stabilizing function to minimize hunting. Each input signal shall be capable of maintaining a different set point value. Controller shall be capable of controlling up to three pumps in parallel.

- iv. The pump logic controller shall be capable of an additional analog input for a flow sensor. This input shall serve as the criteria for the end of curve protection algorithm.
- v. The hydraulic stabilizer program shall utilize a proportional-integral-derivation control function. The proportional, integral and derivative values shall be user adjustable over an infinite range.
- vi. The pump logic controller shall be self prompting. All messages shall be displayed in plain English. The operator interface shall have the following features:
 - Multi-fault memory and recall.
 - On screen help functions
 - LED pilot lights and switches
 - Soft-touch membrane keypad switches.
- vii. The readout shall be two lines of forty 0.25" backlit LCD super twist characters capable of displaying the following values:

Differential pressure in PSIG

- Pressure in PSIG
 - Flow in GPM
 - Temperature in degrees F or C
 - Differential temperature in degrees F or C
- viii. The following communication features shall be provided to the BAS.
 - Remote system start/stop
 - Failure of any system component
 - Process variable
 - AFD speed

2.9.2. Adjustable Frequency Drive:

- i. The adjustable frequency drive (s) shall be pulse width modulation (PWM) type, microprocessor controlled design.
- ii. The AFD including all factory installed options shall have CSA approval.
- iii. Enclosure shall be NEMA 1 ventilated for installation as a wall mounted or free-standing unit, depending on the Amp-rating. A hand-off-auto switch and speed potentiometer shall be functional via AFD key pad.
- iv. AFD shall utilize a diode bridge rectifier to convert three phase AC to a fixed DC voltage. Power factor shall remain above 0.98 regardless of speed or load. AFDs employing power factor correction capacitors shall not be acceptable.
- v. Insulated gate bipolar transistors shall be used in the inverter section to convert the fixed DC voltage to a three phase, adjustable frequency, AC output. An internal line reactor shall

be provided to lower harmonic distortion of the power line to increase the fundamental power factor.

- vi. The AFD shall be suitable for elevations to 3300 feet above sea level without derating. Maximum operating ambient temperature shall not be less than 104 degrees F. AFD shall be suitable for operation in environments up to 95% non-condensing humidity.
- vii. The AFD shall be capable of displaying the following information in plain English via an alphanumeric display:
 - Frequency
 - Voltage
 - Current
 - Energy consumed in Kilowatts per hour
 - Power consumed by motor in kW.
 - Fault identification
 - Percent torque
 - Percent power
 - RPM
 - Run time of motor hour.

2.9.3. Sensor/Transmitters:

Provide differential pressure sensor transmitter(s) as required at site. Unit shall transmit an isolated 4-20 mA DC signal indicative of process variable to the pump logic controller via standard two wire 24V DC system. Unit shall have a corrosion resistant steel body with 1/8" NPT process connection. It shall have a NEMA 1 electrical enclosure capable of withstanding 450 PSI static pressure. Accuracy shall be within 0.5% of full span.

2.9.4. Sequence of Operation:

The system shall consist of a technologic pump logic controller, one duty pump/AFD set, with duty standby pump selection, automatic alternation and automatic transfer to the standby pump.

The pumping system shall start upon the closure of customer's contact when the pump logic controller Mode of Operation selector switch is in the REMOTE position.

When the pump logic controller selector switch is in the LOCAL position, the pumping system shall operate automatically.

Sensor/transmitters shall be provided as indicated on the plans.

Each sensor/transmitter shall send a 4-20mA signal to the technologic pump logic controller, indicative of process variable condition.

The Technologic pump logic controller shall compare each signal to the independent, engineer/user determined set points.

When all set points are satisfied by the process variable, the pump speed shall remain constant at the optimum energy consumption level.

The technologic pump logic controller shall continuously scan and compare each process variable to its individual set point and control to the least satisfied zone.

As the worst-case zone deviates from set point, the pump logic controller shall send the appropriate analog signal to the AFD to speed up or slow down the pump/motor.

The redundant variable speed system shall be started through the pump logic controller.

In the event of a system differential pressure failure due to a pump or AFD fault, the pump logic controller automatically initiates a times sequence of operation to start the redundant pump/AFD set in the variable speed mode.

In the event of the failure of a zone sensor/transmitter, its process variable signal shall be removed from the scan/compare program. Alternative zone sensor/transmitters, if available, shall remain in the scan/compare program for control.

The zone number corresponding to the failed sensor/transmitter shall be displayed on the operator interface of the pump logic controller.

In the event of failure to receive all zone process variable signals, the AFD shall maintain 100% speed, reset shall be automatic upon correction of the zone failure.

Pump or AFD fault shall be continuously scrolled through the display on the operator interface of the pump logic controller until the fault has been corrected and the controller has been manually reset.

2.10. Vertical Split Pumps Suitable For Variable Speed :

Pumps shall be base mounted, single stage, end suction design with a foot mounted volute to allow servicing of the impeller and bearing assembly without disturbing piping connections.

Pump volute shall be class 30 cast iron with integrally cast pedestal support feet. The impeller shall be cast bronze enclosed type, dynamically balanced, keyed to the shaft and secured by a locking cap screw.

The liquid cavity shall be sealed off at the pump shaft by an internally flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225° F. A replaceable bronze shaft sleeve shall completely cover the wetted area under the seal.

Pump shall be rated for minimum of 175 PSI working pressure. Volute shall have gauge tapings at the suction and discharge nozzles and vent and drain tapings at the top and bottom.

Base plate shall be of structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Grouting area shall be fully opened. A flexible type, centre drop-put design coupler, capable of absorbing torsional vibration shall be employed between the pump and motor. Coupler shall be shielded by a coupler guard securely fastened to the base.

Motor shall be energy efficient, totally enclosed fan cooled, Class 'F' insulation and suitable for operation on AFD (only for secondary side). Motor shall be specially designed for quiet operation and its speed shall not exceed 2900 max. RPM. The motor rating shall be such as to ensure non-overloading of the motor throughout its capacity range. Motor shall be suitable for 415 + 10% volts, 3 phase, 50 cycles AC power supply.

2.11. VIBRATION ISOLATION PADS:

Isolation Pad for Pump foundation is to be provided. VI pads shall be serrated rubber pads and shall be provided in two layers with G.I sheet sandwiched in between.

2.12. TESTING:

Pump performance shall be computed from the pump curves provided by manufacture.

3. COOLING TOWERS :

3.1. SCOPE:

The scope of this section comprises the supply, erection, testing and commissioning of cooling towers in accordance with requirements of drawings and of the schedule of quantities.

3.2. TYPE:

Cooling towers shall be FRP, induced draft type or in accordance with requirements of drawings and of the Schedule of Quantities.

3.3. FRP INDUCED DRAFT COOLING TOWERS:

Fibre reinforced plastic cooling towers shall be suitable for outdoor use. Tower shall be vertical, induced draft, counter flow type, fibre reinforced plastic construction, in circular, square or bottle shape, complete with fan, motor, surface and spray sections, G.I ladder eliminators, automatic controls and sound attenuation equipment where called for in Schedule of Quantities.

3.3.1. Capacity:

The cooling tower capacities shall be as per the Drawings and Schedule of Quantities.

3.3.2. Side Casing:

This shall be made out of FRP with both side smooth surface for minimum resistance to air flow. It shall have sufficient structural strength to adequately withstand high wind velocities and vibration. The casing shall be installed on the fibre glass reinforced basin. The tower supporting structure shall be made out of hot dipped galvanized steel frame.

A hot dip galvanized expanded metal mesh screen shall protect the air intake. Sufficient clearance between casing and water basin shall be provided to enable servicing and periodically cleaning.

3.3.3. Cold Water Basin:

Cold Water Basin shall be of fiberglass reinforced plastic deep sump on which cooling tower super structure shall be supported. Suction tank with easily removable double brass strainers shall be provided with this tank, if separately specified in schedule of quantities. The required dimensions should be provided by contractor in technical information in order to construct foundation /pedestals as required.

Basin fittings shall include the following:

- i) Bottom outlet.
- ii) Suction screen assembly bolted to the casing.
- iii) Drain connection at underside of suction side.
- iv) Overflow connection bolted to inside of casing side.
- v) Built in bleed off attached to inlet header & connected to overflow pipe.

- vi) Brass ball type automatic make up water valve.
- vii) Quick fill connection to inside of casing side with stop valve. Stop valve is to be provided.
- viii) Equalizing connection.

3.3.4. Distribution System:

Hot water distribution shall be discharged onto a basin & allowed to flow down on PVC fill through distributors, by gravity. Depth of hot water basin shall be adequate to avoid water overflow.

3.3.5. Filling:

Filling shall be made of corrosion proof and rigid PVC fill in honeycomb design and arranged in circular form to facilitate easy replacement. They shall be arranged in such a manner so as to ensure negligible resistance to air flow and to eliminate back water spots and prevent fouling through scales that may form. In order to reduce carry over losses through entrainment of moisture drops in air streams, multiple drift eliminators shall be installed.

3.3.6. Mechanical Equipments:

Fan shall be of the propeller type, cast aluminium, low weight rotor fitted with multiple aerofoil blades. The entire fan assembly shall be statically and dynamically balanced. Fan shall be directly driven by a $415 \pm 10\%$ volts, 3 phase, 50 cycles AC supply electric motor. Fan motor shall be of totally enclosed, fan cooled weather proof construction, designed and selected to operate in humid air stream. The fan motor shall be flange mounted all weather proof suitable for outdoor installation. Fan shall be protected by fan guard & shall be easily accessible for inspection and maintenance. A spray galvanised service ladder shall also be provided for maintenance. The mechanical equipment assembly shall be adequately supported on a rigid steel base welded to tubular support assuring vibration free support.

Motor shall be mounted directly on fan through common shaft or shall be belt driven to suit required fan rpm.

3.4. PAINTING:

The exterior steel surfaces of all towers shall be given two coats of paint of approved finish. If these shop coats become marred during shipment or erection, the affected areas shall be cleaned off with mineral spirits, wire brushed and spot primed then coated with enamel paints of matching shades. FRP towers shall be provided of color approved by Architect.

3.5. PERFORMANCE DATA:

Complete performance ratings and power consumption at varying loads and outdoor wet bulb temperatures, shall be submitted with the tender and verified at the time of testing and commissioning of the installation.

4. AIR HANDLING UNITS:

DOUBLE SKIN AIR HANDLING UNITS (Also Fan Sections)

4.1. SCOPE:

The scope of this section comprises the supply, erection, testing and commissioning of double skin air handling units, conforming to these specifications and in accordance with requirement of drawings and of the Schedule of Quantities.

4.2. TYPE:

The air handling units shall be double skin construction of approved make having filter section with filters coil section with chilled/ hot water coil with insulated condensate drain pan, and centrifugal

fan. Units shall be of the arrangement as mentioned in the Drawings and mentioned in Schedule of Quantities.

4.3. CAPACITY:

The air moving capacities and maximum motor horse power shall be as mentioned Drawings and in Schedule of Quantities.

4.4. HOUSING/CASING:

The housing/casing of the air handling unit shall be of double skin construction. The housing shall be so made that it can be delivered at site in total/semi knock down conditions depending upon the locations. The Frame work shall be of Extruded Aluminum hollow sections with thermal barrier. The entire frame shall be assembled using mechanical joints to make a sturdy & strong frame work for various sections.

Double skin panels shall be made of 0.63 mm thick plain galvanized preplasticised on outside and 0.63 mm thick plain Galvanised sheet inside with P.U. foam of 38 Kg/m³ density (min) insulation injected in between two turned finished

panels of 25 mm /45-48 mm thickness. These panels shall be bolted from inside / outside on to the frame work with soft rubber gasket in between to make the joints air tight.

Frame work for each section shall be bolted/screwed together with soft rubber gasket in between to make the joints air tight. Suitable doors with aluminium die cast hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on extruded Aluminium channel frame work.

Drain Pan shall be constructed of 18 G stainless steel SS 304 with slope on all sides, leading to a common drain point so as to facilitate fast removal of condensate. The drain pan shall be of single piece construction with minimum joints. All joints will be properly welded & be leak proof. Necessary supports will be provided to slide the coil in the drain pan. Drain outlet shall be provided on one side of drain pan as required by site conditions.

Damper shall be opposed blade double skinned airfoil aluminium to be provided to discharge side section with integral gasket and assembled within a rigid extruded aluminium alloy frame. All linkages and supporting spindles shall be made of aluminium or nylon, supported in Teflon bushes. Spindle shall be provided with a bake lite knob for locking the damper blades in position. Linkages shall be extended wherever specified for motorized operation. Damper frames shall be sectionalized to minimize blade wrapping. Air leakage through dampers when in the closed position shall not exceed 1.5% of the maximum design air volume flow rate at the maximum design air total pressure. Inspection window shall be provided for inspection during running conditions. Inspection door with proper handles shall be provided on the motor side for its easy removal. It should be interlocked to a limit switch which will start the lighting which the cover is open when the cover is open it should be interlocked with motor so as to trip it if cover is opened.

4.5. MOTOR AND DRIVE:

Fan motors shall be 415 +/- 10 volts, 50 cycles three phase AC supply squirrel cage, TEFC motors. Motors shall be specially designed for quiet operation and motor speed shall not exceed 1450 RPM. Fan motors shall be mounted inside the AHU casing on slide rails for easy belt tensioning. Drive to fan shall be provided through belt-drive with a standard belt guard housing the belt and adjustable pulley sheave. Belts shall be of the oil-resistant type.

4.6. FAN:

Fan wheel and housing shall be fabricated from heavy gauge steel. Fan wheels shall be of the double width, double inlet forward / backward curved (as specified in BOQ) multi- blade type enclosed in a housing and mounted on a common shaft. Each AHU shall have single short shaft fan

(multiple fans in one AHU will be used only after prior approval of consultant.) Fan housing shall be made of die-formed steel sheets with stream lined inlets and guide vanes to ensure smooth air flow into the fans. Bearings shall be pre-lubricated sealed for life type. Bearings shall be mounted externally for servicing without dismantling of the unit. All rotating parts shall be statically and dynamically balanced. Fan speed shall not exceed 1000 RPM and maximum fan outlet velocity shall be within 550 meters per minute (1800 FPM). The fan shall be mounted on spring woods/cushy foot mounts. It shall be connected to AHUs horizontal by means of flexible double folded cloth/eq. flexible material.

Maximum fan outlet velocity : 9.14 m/sec (1800 fpm)

Maximum fan speed for DIDW forward/break ward curved centrifugal fan :

a. Fan above 450 mm dia : 1000 RPM

b. Fan up to and including 450 mm dia : 1450 RPM

Maximum fan motor speed of DIDW fans : 1450 RPM

In case of AHUs with higher static pressure and those having, back ward curved fans, higher RPM may be accepted, after approval from consultant.

4.7. COOLING COILS:

Chilled water/hot water coils shall have 12.5/15 mm dia tubes min. 27 gauge thick with aluminium fins firmly bonded to copper tubes by mechanical expansion of copper tubes assembled in stainless steel frame cooling coil shall be integrally

finned type. Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across each coil shall not exceed 500 to 550 feet per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21 Kg./Sqcm. air pressure while submerged in water. Tube shall be mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 11 to 13 fins per inch (4-5 FINS/CM). Coil shall have copper header with M.S. adopter.

Minimum spacing between two sets of coils in series shall be 450 mm. The number of shall be as per BOQ.

Coils in Two banks (one above another) shall have an additional stainless steel flat drain pan between two banks, which will drain to main drain pan below through rigid pipes.

4.8. FILTER:

Each unit shall be provided with a factory / assembled filter section containing washable expanded viscous metal or dry synthetic media type air filters having extruded aluminum frame. The media shall be supported with aluminum mesh on sides. Filter Media is 100% non-woven electronically enhanced synthetic media. The media is supported by an expanded metal continuously laminated on the air leaving side to provide pleat stability while eliminating flutter. Pleat design is a V-Pleat configuration that aids in reducing pressure drop and energy costs and allows total media usage, providing maximum airflow. Frame shall be two-piece construction, made of a heavy duty 24 point moisture resistant material. Diagonal and horizontal support members shall be bonded to the media on both sides.

4.8.1. Pre Filter (EU 4)/10 Micron

Pre-Filters shall be washable HDPE type in AL •frame construction and shall be 50 mm thick. Filter shall be rated either as class 1 or class 2 in accordance with .J S UL900. The filters shall be with 90% efficiency down to 10 microns, and the design velocity across the filter shall not exceed **1.8**

meters per second. The pressure drop through the filter shall not exceed 5.0 mm while clean. Filter shall be supported by a wire mesh and frame. All filters should be complying EN779 :201 1, EN 1822 as applicable.

4.9.ISOLATOR:

Vibration isolators shall be provided in all floor mounted air handling units and AHU mounted within the ceiling space shall be hung through vibration isolation suspensions.

4.10.ACCESSORIES:

Each air handling unit shall be provided with Auto air vent at high point in the cooling coil and drain plug in the bottom of the coil. In addition, the following accessories may be required at air handling unit, their detailed specifications are given in individual sections, and quantities separately in Schedule of Quantities.

- a) Fixing of motorized three/two way valves located in chilled water / Hot water lines connecting to the coil. This valve shall be operated by the cooling sensor and shall control the flow of chilled water (to be priced separately).
- b) Insulated butterfly valves/balancing valves, `Y' strainer, Flanges and condensate drain piping, upto sump or floor drain in air handling unit room, as described in section "Piping". (to be priced separately).
- c) Temperature gauges and pressure gauges (with cocks) within gauge ports in chilled water supply and return lines. (to be priced separately).
- d) Weather Proof light in Fan Section.
- e) Limit Switch.
- f) Wire Guard.

4.11.PAINTING:

Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.

4.12.PERFORMANCE DATA:

Air handling units shall be selected for the lowest noise level of the equipment. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted with the tender or during execution stage and verified at the time of testing and commissioning of the installation.

4.13.TESTING:

Capacity of various air handling unit models shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements will be taken by accurate flow measuring device and temperature measurements drive and temperature measurements will be taken by accurately calibrated mercury-in glass thermometers. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

NOTES:

- i. Wherever there is space constraint for installing the AHUs, the AHUs may be provided with two fans (instead of one) connected to single shaft, with a single drive motor.
- ii. AHUs having mixing box, TFA AHUs and any other AHU not surrounded by return air, will be provided with thermal break profiles.
- iii. Roof mounted AHUs and those AHUs which are exposed to atmosphere, shall be provided with reinforced, weather proof canopy of thick GSS sheets, having same finish as AHU outer skin.

5. FAN COIL UNIT

The Fan Coil Units will be made out of GI sheet steel with forward curved fan and three row chilled water coil. The entire FCU will be powder coated and will be provided with filter box. The FCU will also be provided with auxiliary drain pan (sand witted insulated). The drain connection will be made from both the drain points of main drain tray and the auxiliary drain pan. The construction drawing of the FCU will be approved by the Consulting Engineer / Employer and the successful tenderer will have to take specific approval as regards to the installation & various connections from the Consulting Engineer. All the FCUs being installed, as exposed units should be provided with decorative, powder coated extruded sectioned aluminum grille with approved colour shade. The grilles for the FCU shall be measured separately and paid. The FCU should be designed in a manner that the drain tray is housed within the body of FCU. The FCU shall be front accessible type and of draw through type construction.

6. EXPANSION TANK & AIR SEPARATOR:

6.1. Closed Expansion Tank:

The tank shall be precharged steel expansion tank with replaceable heavy duty but rubber bladder. The tank shall have a 1-1/2 in. NPT system connection, 3/4 in drain, and a .303-32 charging valve connection (standard tire valve) to facilitate the on-site charging of the tank to meet system requirements. The tank must be constructed in accordance with section VII of the ASME Boiler and Pressure Vessel Code and stamped 125 PSI working pressure.

The tank shall be fitted with lifting rings and a floor mounting skirt for vertical installation.

6.2. Centrifugal Air Separator:

The unit shall have flanged or grooved inlet and outlet connections tangential to the vessel shell. Vessel shell diameter shall be three times the nominal inlet/outlet pipe diameter.

The unit shall have an internal stainless steel air collector tube with 5/32" diameter perforations and 63% open area designed to direct accumulated air to the compression tank via an NPT connection at top of unit.

7. VENTILATION FANS

7.1. SCOPE:

Scope of this section comprises of supplying, erection, testing and commissioning of following type of fans.

- a) Centrifugal Fans SISW/DIDW

b) Axial fans (Vane axial/tube axial)

The above fans shall be as indicated on drawings and mentioned in schedule of quantities.

7.2. CENTRIFUGAL FANS (FAN SECTION WITH CASING SAME AS AHU HOUSING)

7.2.1. Scroll:

Casing shall be welded construction fabricated with 2mm M.S. sheet (or as per manufactures standard, in case of imported fans) with spray galvanization. Minimum zinc deposition shall conform to class III of IS: 277.

The minimum thickness of casing shall not be less than 2 mm. The fan scroll shall be attached to the side plate by means of continuous lock seam.

18 gauge galvanized wire mesh inlet screens of 25 mm sieves shall be provided on both inlets if fan is without enclosure. Housing shall be provided with standard cleanout, safety screen, and door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

7.2.2. Impeller:

The impeller shall have die-formed, forward/backward curved blades(as mentioned in B.O.Q), welded to the rim and back plates to have a non-over loading characteristic of the fan. Rim shall be spun to have a smooth contour. If required, intermediate stiffening rings shall be provided. Shaft sleeves shall be furnished wherever required. The impeller, pulley and housing shall be statically and dynamically balanced. Fan velocity shall not exceed 1800 FPM and maximum fan outlet speed of 1000 RPM. However higher RPM shall be acceptable for applications of higher static pressures.

7.2.3. Shaft:

Shaft shall be constructed of SAE 1040 steel turned, ground and polished. Shaft shall not pass through first critical speed through the full range or specified fan speeds.

7.2.4. Bearings:

The bearing shall be self-aligning, heavy duty ball, roller or sleeve bearings. Bearing shall be selected for quiet operation and shall be grease packed, sealed for life, pillow block type.

7.2.5. Inlet cones & guard:

Inlet cones shall be spun to have a smooth contour. Inlet screen if provided shall be of galvanized wire mesh of 25 mm square.

7.2.6. Base Plate:

Base plate shall be provided for each fan GSS. Base for both fans and motor shall be built as an integral part and shall be mounted on a concrete foundation through metallistic vibration isolators. The concrete foundation shall be at least 150 mm above the finished floor level and shall be further isolated from structural floor through 25 mm thick layers of sand all around topped with bitumen & sandwiched ribbed rubber pads.

7.2.7. Motor:

Fan motor shall be of squirrel cage type totally enclosed fan cooled motor, suitable for 415/220± 10% volts, 50 Hz, 3 phase/1 phase. Horse power indicated on the name plate of motor shall be more than brake horse power by at least 10%. Motor R.P.M. shall not exceed 1500 RPM. The fan motor

combination selected for the particular requirement shall be of the most efficient type (i.e smallest horse power) so that power consumption and noise level may be minimized. Wherever the fan motor is to be used with a VFD, The fan motor shall be suitable for operation with VFD. The fan motor shall be suitable for higher as well as lower speed of motor with VFD Without rise in temperature. If required, the contractor shall supply inverter grade motor. The cost of inverter grade motor shall be included in the cost of fan. Nothing extra shall be paid on this account.

7.2.8. Drive:

The fan shall be provided with oil resistant type V-belts. All belts shall be selected for 150% rated HP. V-belts shall be supplied with removable belt guards that do not impede the air flow to the fan inlet. There shall be a minimum of two belts per drive.

7.2.9. Vibration Isolation :

Fan with motor (or housing) shall be mounted on a concrete foundation through metallistic vibration isolation cushy foot mountings.

7.3. AXIAL FLOW FANS:

Axial flow fan shall be of vane axial type and shall be suitable for mounting in duct or wall/floor/slab as required/indicated in the tender drawings.

7.3.1. Impellers:

Single piece cast aluminum or steel impeller shall be with GRP/GRN/aluminium alloy blades of aerofoil design to give maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Single piece fan and hub shall be statically and dynamically balanced. Maximum clearance between blade tip and the fan housing at the specified speed shall be 5 mm. Impeller blades shall be whirl tested to a speed 25% above the design operating speed. Extended grease leads for external lubrication shall be provided. The fan blade shall be adjustable type so that actual air flow can be achieved at site as per indicated in drawings & BOQ.

7.3.2. Casing:

Casing shall be constructed of 14 gauge sheet steel, properly reinforced for rigidity. Fan casing, motor mount and straightening vanes shall be of welded steel construction. Motor mounting plate shall be minimum 20 mm thick and machined to receive motor flanges. Casing shall be provided with two nos., wide, hinged doors which open easily. Inspection doors with handle and neoprene gasket shall be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspensions shall be welded to casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bondorized, primed and finish coated with enamel paint. Housing shall be mounted on adequate quantity of metallistic vibration isolators.

7.3.3. Motor:

Motor shall be squirrel cage, totally enclosed, fan cooled, and constant speed, suitable for $415 \pm 10\%$ volts, 50 Hz, 3 phase power supply, and Motor nameplate horsepower shall be more than brake horse power by a minimum of 10%. Motor speed shall not exceed 1450 RPM. The fan and motor combination selected for particular requirement shall be of the most efficient type so that sound level and energy consumption is minimum. Motor conduit box shall be mounted on exterior of the casing. Wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit. In case of corrosive/inflammable air, the motor shall be isolated from air passage. For exhaust of

Smoke/Inflammable air, fans shall be of 2 hrs fire rating. Motor shall be of high temperature resistance Class „H“.

7.3.4. Drive:

i) Duct/Wall mounted fan:

For duct/wall mounted fans the impeller shall be mounted directly on the motor. Drive unit and impeller shall be totally enclosed inside the duct.

ii) Floor/ceiling mounted fan:

The fan shall be provided with belt drive and adjustable motor sheave, standard sheet steel belt guard with vented front for heat dissipation. Belt shall be of the oil resistant type.

iii) Vibration Isolation:

Base shall be provided for each fan. Base for both fan and motor shall be built as an integral part and shall be mounted on a concrete foundation through vibration isolators or Metallistic cushy foot mountings. The concrete foundations shall be at least 15 cm above the finished floor level and shall be further isolated from the structural floor through 5 cm. thick layers of sand all around with sandwiched ribbed rubber pads. Ceiling hung fan shall be provided vibration isolation suspension (VIS) in each of suspender.

7.4. PERFORMANCE DATA:

All fans shall be selected for the lowest operating noise level. Capacity rating, power consumption with operating points clearly indicated, shall be submitted, and verified at the time of testing and commissioning of the installation.

7.5. TESTING:

Capacity of all fans shall be measured by Velometer. Measured air flow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

8. PIPING & VALVES:

8.1. SCOPE:

The scope of this section comprises the supply and laying of pipes, pipe fittings and valves, testing and balancing of all water and refrigerant piping required for the complete installation as shown on the drawings. All piping inclusive of fittings and valves shall follow the applicable Indian Standards.

8.2. CHILLED WATER PIPING:

8.2.1. All chilled water and condenser water pipes and fittings shall be of , MS class `C' (heavy class) conforming to BIS 1239 Latest & revision for pipe size upto 150mm dia and for pipe size 200mm dia and above shall be as per BIS 3589 having minimum 6mm thickness. All jointing in the pipe system shall generally be by welding, unless otherwise mentioned, or directed at site. All welding shall be done by qualified welders and shall strictly conform to Indian Standards code of procedure for manual metalarc welding of Mild steel as per BIS 823.

8.2.2. All pipes and their steel supports shall be thoroughly cleaned and given one primary coat of red oxide paint before being installed. All chilled water piping will rest on treated teakwood blocks neatly machined to the radius of pipes and seated on MS angles/channel and support Rods. All welded piping shall be subjected to the approval at site.

- 8.2.3. Fittings shall be of malleable casting of pressure rating suitable for the piping system. Fittings used on welded piping shall be weldable type.
- 8.2.4. Tee-off connections shall be through equal or reducing tees, otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.
- 8.2.5. Ball valve, Butterfly valves, globe valve, conforming to the following specifications, shall be provided as shown on drawings:

Size	Construction	Ends
15 to 40 mm	Gun metal Body, Steel spindle	Screwed, ends
50 mm and above	Body cast iron spindle and valve seat of Bronze or Gun metal. (in case of butterfly valve)	Flanged

- 8.2.6. All valves shall be heavy duty conforming to CPN 10 to 16 rating as per mention on BOQ. Valves shall have non rising spindles unless otherwise specified and shall be suitable for minimum 16 Kg. per sq. cm. gauge working pressure.

Butterfly valve shall perform the function of isolating valves also , Butterfly valves shall have cast iron body with black nitrile seat. All Butterfly valves shall be provided with lever locking devices and valves above 250 mm dia shall be gear driven. The Butterfly valve shall as per CPN 16 rating.

All AHU's shall be provided with balancing/ control valves with built in pressure drop measuring facility.

- 8.2.7. Flanges shall be as per ASA-150. The supply of flanges shall also include supply of bolts and nuts and suitable nitrile rubber & rubber insertion gaskets (minimum 3mm thick).
- 8.2.8. **Non-return (check) valves shall be provided as shown on the drawings, conforming to BIS 778 and IS 5312 (Part I) and in accordance with the following specifications.**

Size	Construction	Ends
10 to 40 mm	Gun Metal	Screwed
50 mm and 150	Cast Iron/Gun Metal	Flanged plate
200mm to 450 mm	Body casting iron, plate	Flanged carbon steel with 13% chrome overlay

The spring and hinge/stop pin shall be SS 304 and bearing fire material. Valves shall suitable for not less than 10 Kg per Sqcm gauge working pressure.

Non-return valves shall be leader, Kirloskar, Bankim-Sarkar or approved equal. Dual Plate Swing type check valves shall normally be used in all water services. Lift type valves may be used in horizontal runs. Valves shall be suitable for minimum 16 Kg per sq.cm. gauge working pressure.

- 8.2.9. Strainers shall be of 'Y' type or pot strainers or Suction Guides cum Strainers as shown on the drawings, with cast bodies designed for the test pressure specified for the gate valves. Strainers shall have bronze screen with 3mm perforations. Screen shall be removable and replaceable without disturbing of the main pipes. All strainers shall be provided with equal size isolating gate, butterfly valves with non rising spindle so that the strainer may be cleaned without

draining the system. Strainers shall be provided on the inlet side (at suction) of each pump, and where shown on the drawings. Suction guides with SS queen of 135 mesh shall be provided on all pump suction.

- 8.2.10. All chilled water piping and fitting shall be pressure tested, then insulated as described under the section "Insulation".
- 8.2.11. After all chilled/condenser water piping has been installed. The piping system shall be thoroughly cleaned strainers shall be cleaned once again after flushing of lines. Pressure testing shall be carried out on all piping. Test pressure shall be maintained for minimum continuous 24 hours without any drop in pressure.. The piping fittings & supports shall be painted with one coat of red oxide primer & two finish coats of 3 mils each of approved color of synthetic enamel paint conforming to IS 2379. The direction o flow of fluid in the pipes shall be visibly marked with identifying arrows.
- 8.2.12. Auto Air Vent/Drain valve of suitable size shall be provided in the Chilled/Condenser water piping at highest point and at lowest points in the risers respectively. AAV& drain valves shall also be provided at other locations where required.

8.3. COLD WATER AND DRAIN PIPING:

- 8.3.1. All pipes to be used for cold water (makeup), drain, and condensate drain shall be approved make and fittings of 6 KG / CM2 pressure rating Rigid PVC Pipes.
- 8.3.2. Condensate from the evaporator unit shall be drained through properly installed drain piping designed to prevent any accumulation of condensate in the drain pan. Drain piping shall be made of 20mm dia /25mm dia / 32mm dia / 40mm dia / 50mm dia rigid PVC pipe of 6 Kg/Sq cm. pressure rating with water tight threaded connections, leading from the room unit to a suitable drain point. Complete drain piping shall be made leak proof and water tight by means of precise installation and the use of leak proof sealant/adhesives. Insulation of drain piping by 6 mm thick Nitrile Rubber „0□ class pipe section.
- 8.3.3. Coldwater piping within the building may also be insulated.

8.4. PIPING INSTALLATION:

- 8.4.1. Tender drawings indicate schematically the size and location of pipes. The contractor, on the award of the work, shall prepare detailed working drawings, showing the cross-section, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air auto vent valves, and all pipe supports. He must keep in view the specific openings in buildings and other structures through which pipes are designed to pass.

- 8.4.2. Piping shall be properly supported on, or suspended from, stands, clamps, hangers as specified and as required. The contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers, and be responsible for their structural sufficiency.
- 8.4.3. Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finish coated black. Where pipe and clamps are of dissimilar materials, a gasket shall be provided in between spacing of pipe supports shall not exceed the following:

Pipe Size	Spacing between supports
Upto 12mm	1.5 meter
15 to 25mm	2.0 meter
30 to 150mm	2.0 meter
Over 150mm	2.5 meter

- 8.4.4. Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe and with a 15mm thick rubber pad or any resilient material. Where pipes pass through the terrace floor, suitable flashing shall be provided to prevent water leakage. Risers shall have a suitable clean out at the lowest point and air vent at the highest point.
- 8.4.5. Pipe sleeves, 50mm larger diameter than pipes, shall be provided wherever pipes pass through walls and slabs, and annular space filled with fiberglass and finished with retainer rings.
- 8.4.6. Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 14 gauge metal sheets shall be provided between the insulation and the clamp, saddle or roller, extending at least 15cm on both sides of the clamp, saddles or roller.
- 8.4.7. All pipe work shall be carried out in workmen like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organized, in consultation with other agencies work, so that laying of pipe supports, pipe and pressure testing for each area shall be carried out in one stretch.
- 8.4.8. Cut-outs in the floor slab for installing the various pipes are indicated in the drawings. Contractor shall carefully examine the cut-outs provided and clearly point out where ever the cut- outs shown in the drawings, do not meet with the requirements. Workable alternatives may be suggested in such cases.
- 8.4.9. The contractor shall make sure that the clamps, brackets, clamps saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes, and include expansion Loop where required.
- 8.4.10. All pipes shall be accurately cut to the required sizes in accordance with IS 554 and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely. In other locations, concentric reducers may be used.
- 8.4.11. Flanged inspection pieces 1.5 meters long, with bolted flanges on both ends, shall be provided no more than 30 meters centers wherever shown in approved for construction to facilitate future cleaning of all welded pipes.
- 8.4.12. Auto Manual air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15 mm pipe size and shall be associated with an equal size gate valve.

Discharge from the air valves shall be piped through an equal sized mild steel or galvanized steel pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.

8.4.13. Pressure gauges as specified under section "Automatic Controls and Instruments", shall be provided at the suction and discharge of chilled water/condenser water pumps supply and return at air handling units, at chillers and at condensers, as shown on the drawings and included in schedule of quantities. Care shall be taken to protect pressure gauges during pressure testing.

8.4.14. Temperature gauge as specified under section "Automatic Controls and Instruments" shall be provided at each Air handling unit's Supply / Return Chilled water line, at chillers, and condensers, as shown on drawings and included in schedule of quantities.

8.4.15. **PASSIVATION OF WATER PIPING**

The M. S. pipe line should be passivated by following method-

- Rinse the M. S. pipe line with water 4 times to remove all dust & dirt.
- Circulate mild solution (@5%) of Sulphuric acid or oxalic acid for 24 HRS.
- Rinse the M. S. pipe line with water to remove the acid content. Circulate mild solution (@2%) of Caustic soda for 24 HRS and rinse the line with water.
- Circulate solution of SODIUM HEXA META PHOSPHATE in ratio of 10 Gm. per Liter for 12-14 hours.

- Drain the solution and check the pipe surface. If found O. K. fill the line again and drain again before final charging of fresh soft water.
- A required dosing of Anti-Oxidant is required to add periodically.

The sample of water which will be used for the chilled water system shall be analyzed by the successful contractor free of cost. The analysis report shall be submitted to PMC / Owners / Owner's representative with the recommendation as to any changes in water input is required.

8.5. TESTING & BALANCING:

8.5.1. All piping shall be tested to hydrostatic test pressure of at least two and half times the maximum operating pressure, but minimum not less than 10 Kg per sq.cm. gauge for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified contractor shall get such rectification approved at site.

8.5.2. Piping repaired subsequent to the above pressure test, shall be re-tested in the same manner.

8.5.3. System may be tested in sections and such sections shall be securely capped, then retested for entire system.

8.5.4. The contractor shall give sufficient notice to all other agencies at site, of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by Owner's site representative.

8.5.5. The Contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. In case of improper circulations, the contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications. Including the tearing up and re-finishing insulation of floors and walls as required false ceiling.

8.5.6. The contractor shall provide all materials, tools, equipment, instruments, services and labour required to perform the test and to remove water resulting from cleaning and after testing.

- 8.5.7. After completion of the installation, all water system shall be adjusted and balanced to deliver the water quantities as specified, quoted or as directed, to individual air handling units and fan coil units cooling coil.
- 8.5.8. Water circuit shall be adjusted by balancing cocks provided for balancing; these shall be permanently marked after balancing is completed so that they can be restored to their correct positions, if disturbed.
- 8.5.9. Complete certified balancing report shall be submitted for evaluation and approval. Upon approval, four copies of the balancing report shall be submitted with complete drawings and documents.
- 8.5.10. Painting of condenser water pipes as per approved color.

9. AIR DISTRIBUTION SYSTEM:

9.1. GENERAL:

Ducts shall be made of either galvanized steel sheet as specified in the BOQ and confirm to BIS 655, BIS 277, BIS 737 & SMACNA .The ducts shall be factory made as per list of makes. The galvanized steel sheet shall confirm to IS-277. Aluminium sheet shall confirm to IS-737 the duct construction shall be as follows-+

9.2. RAW MATERIALS:

Galvanizing shall be Class VII – light coating of zinc, nominal 180gm/sq.m surface area and Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

For Ducts with external SP upto 250 Pa (ESP upto 25mmWg)

Rectangular	Pressure 250 Pa		
Ducts G. S.	Duct Section Length 1.2 m (4 ft)		
Maximum Duct Size	Gauge	Joint Type	Bracing Spacing
1–500 mm	26	C&S Connector	Nil
501 – 750 mm	26	C&S Connector	Nil
751 – 900 mm	26	TDF Flange	Nil
901 – 1200 mm	24	TDF Flange	Nil
1201 – 1500 mm	22	TDF Flange	Nil
1501 – 1800 mm	22	TDF Flange	JTR or ZEE BAR
1801 – 2100 mm	20	TDF Flange	JTR or ZEE BAR

2101 – above

18

TDF Flange

JTR or ZEE
BAR

Sheet metal ducts shall be fabricated out of galvanized steel sheets conforming to BIS 655, BIS 277, BIS 737 & SMACNA. Sheets used shall be produced by Hot dip process and galvanizing shall be Class VIII- Minimum Average Coating as per BIS 277: 1992.

9.3. HANGERS FOR DUCT:

Duct Size (mm)	Spacing (M)	Size of MS angle (mm x mm)	Size of rod dia (mm)
Upto 750	2.5	40 x 3	10
751 to 1500	2.0	40 x 3	12
1501 to 2250	2.0	50 x 3	15
2251 to above	2.0	50 x 3	15

9.4. FABRICATION:

All ducts shall be factory fabricated complete with joints and supports and installed in workman like manner, generally conforming to IS 655. Round exposed ducts shall be die formed for achieving perfect circle configuration.

- a) Ducts so identified on the drawings shall be acoustically lined with thermal insulation as described in the section 'Insulation' and as indicated in schedule of quantities. Duct dimensions shown on drawings are overall sheet metal dimensions inclusive of the acoustic lining, where required and indicated in schedule of quantities.
- b) Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made air tight.
- c) All exposed ducts within conditioned spaces shall have slip joints - no flanged joints. The internal ends of slip joints shall be made in the direction of air flow.

Exposed ducts, where required or as indicated in Schedule of quantities, shall be painted with two coats, of enamel paint of approved colour. Ducts and accessories within ceiling spaces, visible from air conditioned areas shall be provided with two coats of mat black finish paint.

- d) Changes in dimensions and shape of ducts shall be gradual. Curved elbows, unless otherwise indicated, shall have a centre line radius equal to one and a half times the width of the duct. Air turns vanes shall be installed in all bends & elbows, arranged to permit the air to make the turn without appreciable turbulence. Suitable vanes shall be provided in duct collar to have uniform/ proper air distribution.
- e) Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles of sample size to keep the ducts true to shape and to prevent bulking, vibration or breathing.

- f) All sheet metal connections, partitions and plenums required to confine the flow of air to and through 18g GI/16 gauge aluminium, thoroughly stiffened with 25mm x 25mm x 3mm angle iron braces and fitted with all necessary doors as required to give access to all parts of the apparatus. Access Doors shall be not less than 45cm x 45cm in size. VCDs shall be provided to balance air quantity in each branch.

9.5. INSTALLATION:

All ducts shall be installed generally as per the drawings and in strict accordance with approved shop drawings to be prepared by the Contractor.

- i) The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent, of these specifications and drawings. The work shall meet with the approval of Owner's site representative in all its parts and details.
- ii) All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstructions in the building, whether or not the same are shown on the drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes, and/or conduits, the ducts shall be transformed, divided or curved to one side, the required area being maintained, all as per the site requirements.
- iii) If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available, in accordance with other services and as per approval of Owners site representatives, so as to meet desired conditions.
- iv) All duct work shall be independently supported from building structure. All horizontal ducts shall be rigidly and securely supported, in approved manner with trapeze hangers formed of MS rods and angle iron under ducts at not greater than 2 meter centres. All vertical duct work shall be supported by structural members at each floor. Air conditioning contractor shall supply and install 50mm cube MS boxes with 10mm dia steel rod passing through box, all given two coats of red oxide paint, the MS rod tied with reinforcement bar at point of suspension shall be neatly exposed and opening subsequently filled with plastic compound after duct hangers are installed.
If duct is passing through in such areas where space between ceiling slab to false ceiling is more than 1500 mm than duct should be supported by wall mounted brackets of 40 x 40 x 3 mm angle.
- v) Ducting over furred ceiling shall be supported from the slab above, or from beams, after obtaining approval of Owner's site representative. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other contractors on the building.
- vi) Where metal ducts or sleeves terminate in wood work, tight joints shall be made by means of closely fitted heavy flanged collars. Where ducts pass through brick or masonry opening and wooden frame work shall be provided within the opening and crossing ducts provided with heavy flanged collars on each side of wooden frame work, so that duct crossing is made leak-proof.
- vii) All ducts shall be totally free from vibration under all conditions of operation. Whenever duct work is connected to fans, air handling units or blower coil units that may cause vibrations in the ducts, ducts shall be provided of closely woven, rubber impregnated double layer asbestos/canvas or neoprene coated fibre glass fire resistant flexible connection. The flexible connections located close to the unit, in mutually perpendicular directions. The flexible sleeve at least 10cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting duct work rigidly held by independent supports on both ends. The flexible connection shall be suitable for pressures at the point of installation.

- viii) Air conditioning unit and exhaust fans shall be connected to duct work by inserting at air inlet and air outlet a double canvass sleeve. Each sleeve shall minimum 150 mm securely bolted to duct and the connecting duct work rigidly held in line with unit inlet or outlet.

9.6. Mode of Duct Measurement

As per general guidelines of quantity

The periphery of duct piece will be calculated $(A+B) \times 2 \times L = \text{Area}$. Centre length of the piece will be measured. In case of tape the peri. will be worked and on average of both ends and center length of the piece $[(A1+A2)/2 + (B1+B2)/2] \times 2 \times \text{Length}$.

Where A and B are dimension of the piece.

Bends shall consider the center line length for competing area.

9.7. SPLITTERS AND DAMPERS:

All dampers shall be opposed blade type dampers of robust construction and tight fitting. They shall be made of G.S. sheet minimum 16 g thick and shall have brass bushes. The design, method of handling, and control shall be suitable for the location and service required.

Dampers shall be provided with suitable links, levers and quadrants as required for their proper operation control or setting devices shall be made robust, easily operate able and accessible through suitable access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all times. Handles and knobs voided with extended arms to account for insulation thickness.

Dampers shall be placed in ducts and at every branch supply or return air duct connection, whether or not indicated on the drawings, for the proper volume control and balancing of the system.

9.8. MOTORISED COMBINATION SMOKE & FIRE DAMPER:

All supply/return air duct or path at AHU room wall or slab crossing shall be provided motorized combined smoke and fire damper. The fire rating shall be of 90 minutes fire damper blades and outer frame shall be formed of 1.6mm galvanized sheet steel. The damper blade shall be provided spindles in self lubricated bronze bushes, stop seals shall be provided on top and bottom of the damper housing made of 16g galvanized sheet steel. Side seal shall be provided to preventing fine leakages. Fire damper shall be kept open during normal mode with the help of 230 V operated electric actuators spring to providing maximum air passage without creating any noise or actuated either through electric actuator or through UL stamped electro-thermal link. The actuator shall be energized with the help of a signal from smoke detector installed in AHU room / RA duct/damper. The fire damper shall also close due to temp rise in SA. Ducts through the electronic temp sensor factory set at 165 deg F, micro switches with Bakelite base will be provided to stop fan motor & give open & close signal at remote panel in case of closing of motorized damper. In case of power failure the damper shall closed and automatically open (with spring) in case of power is `ON`.

9.9. SUPPLY AND RETURN AIR GRILLES:

Supply and return air grilles shall be anodized extruded aluminium construction with individually adjustable bars as shown on drawings and indicated in schedule of quantities. Supply air grilles shall be removable key operated volume control dampers. Return air grilles shall be similar to supply air grilles but without dampers. All supply and return air grilles behind wooden grilles shall be single deflection type with one way bars only, the supply air grilles being provided with removable key operated volume control dampers. Aluminium supply and return grilles shall be powder coated and to have color of Client's/ Architects choice or extruded aluminium as per bill of quantities.

9.10.SUPPLY AND RETURN AIR DIFFUSERS:

The Supply & return air diffusers shall be of powered coated (approved shade), center core removable type. Supply diffuser to have extruded aluminium blade Box type under dampers.

i. Round or Rectangular Diffusers:

Supply/return air linear diffuser shall be M.S. or Extruded aluminium construction, square, rectangular, or round diffusers with flush fixed pattern or adjustable flow pattern. Diffusers for different spaces shall be selected in consultation with the Architect/Consultants. Supply air diffusers may be equipped with fixed air-distribution grids, removable key-operated volume control dampers, and ant smudge rings as per requirements of schedule of quantities.

ii. Linear Supply air/ Return Air Grilles:

This shall be extruded aluminium construction with fixed horizontal bars at 15 deg inclination and flange on both side. The thickness of fixed bar louvers shall be at least 5.5mm & angle shall be 20mm/30mm inside. The grilles shall be suitable for concealed fixing volume control damper of extruded. Aluminium construction with black anodized finished shall be provided in SA duct collars.

9.11.LINEAR DIFFUSER / SLOT DIFFUSERS:

Liner diffuser shall be extruded aluminium construction multisport type with air pattern controlled provided in each slot. Supply air diffusion shall be provided with volume damper or hit & miss dampers in each slot of the supply air diffuser. Plenum shall be provided for each supply air diffuser.

9.12.The Material of Grilles shall be as follows:

- i. All grilles shall be selected in consultation with the Client/ Consultant. Different spaces shall require horizontal or vertical face bars, and different width of margin frames.
- ii. All grilles shall have a soft, continuous rubber gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers shall not be less than 75 percent.
- iii. Grilles shall be adjustable pattern as each grille bar shall be pivotable to provide pattern with 0 to 100 deg horizontal arc and upto 30 deg C deflection up or down. Bars shall hold deflection settings under all conditions of velocity and pressure. Extruded aluminium grilles shall have fixed bars.
- iv. Bars longer than 45cm shall be reinforced by set-back vertical members of approved thickness.

The material thickness of grills, diffuser, damper shall be as follows:

Diffuser	MS	Aluminium
a)Frame	20 gauge	18 gauge
b)Louvers	20 gauge	18 gauge
Grills :		
a)Frame	20 gauge	18 gauge
b)Louvers	26 gauge	24 gauge
V.C. Damper :		
a) Frame	20 gauge	18 gauge
b) Louver	26 gauge	24 gauge

9.13.Fresh air intake and extract louvers:

All the louvers shall be rain protection type and shall be fabricated from extruded aluminium section. The louvers shall additionally be provided with heavy duty expanded metal (aluminium –alloy) bird screed.

9.14. Testing & Balancing:

After the installation of the entire air distribution system is completed in all respects, all ducts shall be tested for air leaks. Before painting the interiors of conditioned spaces air distribution system shall be allowed to run continuously for 48 hours for driving away any dust or foreign material lodged within ducts during installation.

9.15. Mode of Diffuser & Grill Measurement

As per general guidelines for quantities

For Diffuser: - The neck area shall be considered for purpose of measurement.

Area Less than 1 Sq. ft. shall be paid as unit rate of 1 Sq.ft..

For Diffuser: - Flange face area shall be considered for pane of measurement.

10. THERMAL/ACOUSTIC INSULATION:

10.1. GENERAL:

Scope of this specification comprises of supplying, installing, testing and commissioning of insulation on duct, pumps, chilled water piping, expansion tank, AHU room and duct lining.

This specification covers the technical requirements and essential particulars for the supply, application and finishing of the composite thermal insulation for cold equipment, piping systems, air-conditioning ducts, etc. The scope of supply of the contractor shall include, but not be limited to, the following items:

- Insulation material as specified
- Finishing and cladding/covering, 5 mil fiber glass cloth with one coat of enamel paint.
- Angles, clamps, on PUF gutties chilled water pipes shall be supported.
- Any material as may be required for making the installation of insulation material complete and safe from mechanical damages.

The following are some of the codes and standards relevant to this specification:

EN 14304/ DIN EN 8497 For Flexible Elastomeric Foam Insulation material.

IS 14164 Industrial Application and finishing of Thermal Insulation

Materials at Temperatures above (-) 80° C and up to (+) 700° C

BS 5970 Thermal Insulation of Pipework and Equipment (in the Temperature Range (-) 100° C to (+) 870° C

10.2. MATERIAL

Insulation material shall be Closed Cell Microcellular Elastomeric Nitrile Rubber.

- The Density of Material shall be between 40 to 60 Kg/m3.

- Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.036 W/m²K at an average temperature of 0°C.
- The insulation shall have fire performance such that it passes minimum fire rating Class 1 as per BS 476 Part 7 for

surface spread of flame and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 0 Fire classification as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990.

- Water vapour permeability shall not exceed 0.024 Perm inch (2.48 x 10⁻¹⁴ Kg/m.s.Pa) i.e. Moisture Diffusion Resistance Factor or μ value should be minimum 10,000.
- Material should have FM Global (Factory Mutual) USA approval for fire behavior.
- Insulation material shall have Ultra-Fresh® anti-microbial protection, which is EPA (Environmental Protection Agency), USA approved(or equivalent), as an integral part of insulation that cannot be washed off or worn off as per ASTM G-21 **(whenever asked)**
- It shall give enhanced level of protection against harmful Microbes such as bacteria, mold, mildew and fungi
- Insulation products shall be free from CFC/HCFC, Formaldehyde, Dust & Fibres.

Thickness of the insulation shall be as specified for the individual application.

10.3.DUCT INSULATION (INDOOR)

External thermal insulation shall be provided as follow:

The thickness of Nitrile rubber shall be as shown on drawing or identified in the schedule of quantity. Following procedure shall be adhered to:

- Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work.
- Measurement of surface dimensions shall be taken properly to cut closed cell elastomeric rubbers sheets to size with sufficient allowance in dimension.
- Material shall be fitted under compression and no stretching of material shall be permitted.
- A thin film of Synthetic Rubber based adhesive shall be applied on the metal surface and then on the back of the insulating material sheet.
- When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond. Also care should be taken to prevent the trapping of air bubbles between metal sheets and insulating material sheet.
- All duct flanges should be covered properly with a 150mm wide strip of insulation sheet after gaining uniform height by applying multiples layer of 75mm wide strip of insulation sheet from the both side of flanges.
- All longitudinal and transverse joints shall be sealed with adhesive tapes of 50mm (wide) x 3mm (thick). (as recommended by Manufacturer).
- The adhesive shall be strictly as recommended by the manufacturer.
- The detailed Application specifications are as per the manufacturer's application manual.
- Adhesive should be as recommended by Manufacturer.

10.4.INSTALLATION OF DUCTS EXPOSED DIRECTLY TO SUNLIGHT:

For installations exposed to sunlight specified thickness of insulation sheet with a factory applied black glass fabric covering of 200gsm ±5% should be installed with application procedure same as

Indoor installation and apply two coats of epoxy paint/ Starbond or equivalent after giving 36 hours curing time for the adhesive apply manufacturer's recommended UV/Mechanical Protection. No locally available separate glass fabric shall be allowed for UV protection treatment. Please refer the separate detailed guidelines on UV/Mechanical Protection.

10.5.PIPING INSULATION

All chilled water, refrigerant and condensate drain pipe shall be insulated in the manner specified herein. An air gap of 50 mm shall be present between adjacent insulation surfaces carrying chilled water or refrigerant and also between the insulated surface and the wall to allow natural ventilation without affecting its external surface coefficient of heat transfer. Before applying insulation, all pipes shall be brushed and cleaned. All Pipe surfaces shall be free from dirt, dust, mortar, grease, oil, etc. Thermal insulation shall be applied as follows or as specified in drawings or schedule of quantity:

Insulating material in tube form shall be sleeved on the pipes.

- On existing piping, slit opened tube of the insulating material (slit with a very sharp manufacturer's recommended knife for straight line longitudinal cuts) shall be placed over the pipe and adhesive shall be applied as suggested by the manufacturer.
- Adhesive must be allowed to tack dry and then press surface firmly together starting from butt ends and working towards centre.
- Wherever flat sheets shall be used it shall be cut out in correct dimension. All longitudinal and transverse joints shall be sealed with of 50mm (wide) x 3mm thick adhesive tape The insulation shall be continuous over the entire run of piping, fittings and valves. Multiple layer of Insulation sheet wherever applicable should be applied to stagger all longitudinal & transversal joints.
- All valves, fittings, joints, strainers, etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.

The detailed application specifications are as mentioned separately.

10.6.PUMP INSULATION

Chilled water pump shall be insulated to the same thickness as the pipe to which they are connected and application shall be same as above. Care shall be taken to apply insulation in a manner as to allow the dismantling of pumps without damaging the insulation.

10.7.SHELL INSULATION

The chiller shells shall be factory insulated in accordance with the manufacturer's standards.

10.8.COLD WATER AND EXPANSION TANK INSULATION

Cold water tank, and chilled water expansion tank shall be insulated as per manufacturer's standard

10.9. ACOUSTIC INSULATION

i) MATERIAL:

ACOUSTIC LINING OF AHU ROOM AND LINING OF DUCTS:

For acoustic lining of AHU room/plant room the material shall be resin bonded glass wool of density 32 Kg/m³. All duct up to a distance of 3m from AHU outlet or as shown in the drawing shall be acoustically lined from inside.

ii) Application:

● **AHU/DG Plant Room room acoustic insulation:**

Clean the inner surface of duct which is to be lined with wire brush to remove the dirt.

Fix insulation material of specified thickness covered over-lapped with R P Tissue paper over it and then covering the material with 28 gauge perforated aluminium sheet fixed with the help of self tapping screws and shall be neatly finished to give true surface finish. The overlap at the corner shall not be less than 10mm.

● **LINING OF DUCTS:**

First 3 meter length of supply air duct shall be & Plenum acoustically insulated with 12.5 mm thick fiberglass of density 48 Kg./Cu.M. and covered with 28 G perforated Aluminium sheets from the inside of the duct.

- a) Apply a thin layer of tar paints.
- b) Fix-up fiberglass slabs
- c) Cover-up with perforated Aluminium sheets with the help of G. I. Screw Washers.

10.10. CHILLED WATER & COPPER PIPES INSULATIONS:

Closed Air Cell Flame proof nitrile rubber as per above specification.

i) Application:

All chilled water and refrigerant pipe shall be insulated after pressure testes as follows:-

- Brush and clean all piping and fittings to remove all dust, dirt, mortar and oil and then provide 2 coats of zinc chromate primer of ASIAN Paints or approved equal.
- Apply 2 coats of adhesive compound.
- Apply insulation sheets / insulation tubes over the pipe before the adhesive dries up and seal all longitudinal and transverse joints with adhesive compound approved by manufacturer of insulation wrap 5 mill 500g polythene sheet over the surface with 50 mm overlap in longitudinal and transverse joints. All joints shall be sealed by 75 mm wide PVC adhesive tape.
- Fix 5 TO 7 Mill fiber Glass cloth with suitable approved adhesive overlapping all joints & fitting.
- Finish paint in desired shade.
- Insulation pipes shall be marked with arrows to indicate the direction of flow.

ii) Piping Exposed to Atmosphere:

- The pipes after pressure test shall be cleaned, derusted, phosphate and then coated with epoxy primer or black Japan.

- Apply insulation same as Clause 3.1 (Adhesive where used shall be as approved by insulation manufacturer.)
- Apply UV protection paint (Paint as approved by insulation manufacturer)
- 3 mm thick coat of water proofing compound shallikote shall be applied and wrapped with fibre glass R P Tissue and final coat of 3 mm thick shallikote over the fiberglass R P tissue and allowed to dry.

NOTE: - The insulation shall be cut & applied by installer who is trained and proficient in applying insulation.

10.11. UNDERDECK INSULATION-

The exposed roof shall be insulated with 50 mm thick „TF“ quality expanded polystyrene with 85/20 grade hot bitumen and GI screw washer & GI diagonal wires.

Mode of Measurement – As per general guidelines for quantities

Shall be similar to as explain in duct measurement but considering Thickness of insulation.

However for piping the measurement shall be including bends, tee, fittings etc. but excluding valves which shall be paid as unit rate item of BOQ.

11. I.S. CODES

Following IS CODES will be applicable for the project.

- | | | |
|---------------------|---|---|
| a) IS : 659 - 1964 | : | Safety Code for Air-conditioning. |
| b) IS : 660 - 1963 | : | Safety Code for Mechanical Ref. |
| c) IS : 325 - 1970 | : | Specifications for 3 Ph. Induction Motor. Also confirm to IS : 1231 for Foot Mounted & IS : 2223 for flange mounted motors. |
| d) IS : 2147 - 1962 | : | Degree of protection provided by enclosures for low voltage switch and control gears. |
| e) IS : 3012 - 1965 | : | Code of Practice for installation (PART-I) & maintenance of switchgear. |
| f) IS : 3016 - 1982 | : | Code of Practice for Fire precautions in welding and cutting operations. |
| g) IS : 3615 - 1967 | : | Glossary of terms used in Refrigeration and Air-conditioning. |

IS STD.FOR INSULATION WORK-

- | | | |
|---------------------|---|---|
| h) IS : 4671 - 1984 | : | Expanded Polystyrene For Thermal insulation purposes |
| i) IS : 7240 - 1981 | : | Code of Practice for Application and finishing of Thermal Insulation. |
| j) IS : 1239 | : | Pipes up to 150 MM Dia. |
| k) IS : 3589 | : | Pipes above 200 MM Dia. |
| l) IS : 780/ISI | : | Values of PN 1.6 rating Certificate |

- m) IS :5312/ISI : Check Valves Certificate
- n) IS : 900 : Installation of motor
- o) IS :4064 & 4047 : Switch fuse unit
- p) IS : 2516 : ACB
- q) Relevant ISS : MCCB
- r) IS : 3069 : Glossary of Items symbols & units relating to thermal materials.
- s) IS : 702 : Industrial bitumen.
- t) IS : 655 – 1963 : Ducting work.
- u) IS : 277 : For Sheet galvanising spec.
- v) IS : 3043 -1963 : Earthing.
- w) IS : 3043 : Earth Station.
- x) IS : 732 - 1963 : Testing of Electrical Installation.
- y) IS : 2825 : Unfired pressure vessels.

12. TECHNICAL DATA :
(TO BE FURNISHED ALONG WITH THE TENDER)

12.1. AIR HANDLING UNIT:

- i. Manufacturer :
- ii. Model no. :
- iii. Material/Gauge :
- iv. Inner sheet of casing :
- v. Outer sheet of casing :
- vi. Fan – make :
- vii. Details of Insulation (Material/Thickness) :
- viii. Type of Bearing :
- ix. Dia of Fans (mm.) :
- x. No. of Fans :
- xi. AHU Size - L mm :
- D mm.
- H mm.
- Operating Weight (Kg.) :
- xii. Type of Vibration isolators :
- xiii. Fan Section:**
- Make :
- Type of Fan :

Air Quantity M3/hr. (CFM)	:
Total Static Pressure	:
Fan Speed RPM (normal/critical/maximum)	:
Fan Efficiency	:
No. of Vanes	:
Outlet Velocity mtr/Min	:
xiv.Coils:	
Make	:
Face Velocity (FPM)	:
Material of tubes/fins	:
Face Area (Sq.ft)	:
Dia of tubes (inch)	:
Rows deep	:
Fins/Inch	:
xv.Filters:	
Make	:
Filter medium	:
Material of Frame Work	:
Filter face area Sq.ft	:
xvi.Motors:	
Manufacturer	:
Motor HP	:
Type	:
Class of Insulation	:
Electrical Characteristics	:
Starting Current (Amps)	:
Full Load Current (Amps)	:

Motor Speed RPM :
 Method of Starting :
 Starter manufacturer :

12.2. VENTILATION FANS:

i. Make :
 ii. Type of Fan :
 iii. Type of Drive :
 iv. Air Quantity M³/hr. (CFM) :
 v. Total Static Pressure :
 vi. Fan Speed RPM (normal/critical/maximum) :
 vii. Fan Efficiency :
 viii. No. of Vanes :
 ix. Outlet Velocity mtr/Min :
 x. Noise Level DB :

xi. Motors:

Manufacturer :
 Motor HP :
 Type :
 Class of Insulation :
 Electrical Characteristics :
 Starting Current (Amps) :
 Full Load Current (Amps) :
 Motor Speed RPM :
 Method of Starting :
 Starter manufacturer : :

12.3. MS PIPE :

a. Make :

- b. Class :
- c. Wall thickness of pipes :

12.4. VALVES : Manufacture I.S.I Marked Pressure Drop

- a. Butterfly Valve :
- b. Balancing valve :
- c. Non return valve make :
- d. Ball valves :
- e. Pot strainer :
- f. Y strainer :
- f. Suction Guides cum Strainers :
- g. 3/2 Way Mixing Valve :

12.5. GRILLES/DIFFUSERS/DAMPERS: Make, Materials and Gauge

- i) Fire dampers :
- ii) Grilles :
- iii) Louvers :
- iv) Diffusers :
- v) Duct Dampers :

12.6. INSULATIONS:

- a. Manufacturer :
- b. Duct Acoustic Lining materials :
- c. Duct insulation material :
- d. Pipe insulation material :
- e. Thermal conductivity :
 - Duct insulation :
 - Pipe insulation :
- f. Density - Pipe insulation. :

Density - Duct Insulation. :

12.7. CONTROL

- a) Return Air Thermostat :
- b) Room Thermostats :
- c) 2 way/3 way valves actuators :

12.8. WATER COLLED SCREW CHILLER:

S. No	Description	TR
1.0	CHILLER :	
	Make	
	Model	
	Manufacturing Place	
	Size(mm) (L x W x H)	
	Operating Weight(Kg.)	
	ARI/Euro Certification	
2.0	COOLER :	
	Chilled water in / out (Deg C)	
	Flow Rate (Usgpm)	
	Fouling Factor (FPS)	
	Water pressure drop (Ft.)	
	Water Velocity (FPS)	
3.0	CONDENSER :	
	Condenser water in / out (Deg F)	
	Flow Rate (Usgpm)	
	Fouling Factor (FPS)	

S. No	Description	TR
	Water pressure drop (Ft.)	
	Water Velocity (FPS)	
4.0	COMPRESSOR :	
	Type	
	No. of Compressor	
	Model No.	
	Refrigerant	
	Refrigeration capacity (TR)	
	Power Consumption KW/TR	
	100 % Load	
	75 % Load	
	50 % Load	
	30 % Load	
	NPLV (KW/TR)	
	Operating Compressor Speed (RPM)	
	Step of Capacity control	
5.0	COMPRESSOR MOTOR :	
	Type	
	Rating (KW)	
	Method of starting	
	Class of Insulation	
	Starter Manufacturer / Manufacturing Place	
	Full load current (Amps)	
	Starting current (Amps)	
	Locked rotor current (Amps.)	
	Type of Vibration Isolators for Compressor and Motor	

12.9.PUMPS :

	PUMP SETS :	CHILLED WATER		CONDENSER WATER
		Primary	Secondary	
a)	Manufacturer			
b)	Type			
c)	Model			
d)	Capacity (USGPM)			
e)	Head (Ft.)			
f)	Efficiency (%)			
g)	Pump RPM:			
h)	B.H.P.			
i)	Motor (HP)			
j)	Motor RPM			
k)	Motor Make (Manufacturer)			
l)	Insulation Class			
m)	Full Load Current (Amps)			
n)	Current Characteristics			
o)	Starting Current (Amps)			
p)	Type of Starter			:
q)	Starter make (manufacturer)			:
r)	Impeller material			
s)	Impeller Diameter (mm.)			:
t)	Suction/Discharge dia (mm.)			:
u)	Type of seals/shaft coupling			:
v)	Vibration Isolation			:
w)	Operation weight (Kg.)			:
x)	Size : Lmm W mm H mm			

Note : Selection of Pumps along with operating curves for parallel operation to be furnished.

12.10. COOLING TOWER:

- a) Manufacturer :
- b) Type :
- c) Model No. & Dimensions (L x W x H) (mm) :
- d) Overall dimensions (mm) :
- e) Operating Weight (Kg) :
- f) Capacity (TR) :
- g) Water Flow rate (USGPM) :
- h) Wet bulb (design) (oF) :
- i) Fan motor rating (HP) :
- j) Fan speed (RPM) :
- k) Fan diameter (mm) :
- l) Fan capacity (CFM) :
- m) No. of fans :
- n) Outlet velocity (FPM) :
- o) Drift loss (USGPM) :
- p) Evaporative loss (USGPM) :
- q) Total water loss (USGPM) :
- r) Range (oF) :
- s) Approach to design wet bulb (oF) :
- t) Bird Screen :
- u) Eliminator material :
- v) Casing Material :
- w) Basin Material :
- x) Piping Material :

13. SPECIFICATIONS FOR PAINTING WORK

13.1.Cleaning the surface

13.2.Apply a primer coat of Red oxide

13.3.Applying two coats of enamel paint of APPROVED colour code after applying cement primer for plastered surface

13.4.Standard colour code.

a) Pump sets	:	Battleship Grey
b) Motor	:	Siemens Grey
c) Ductable Units	:	As Directed
d) Pot Strainers (Base)	:	Grey
e) Liquid Line	:	Orange
f) Suction Line	:	Green / Blue
g) B. M. Valve / Copper Line	:	Golden paint
h) Gauge Panel	:	Siemens Grey
i) Chilled Water Line		
i. Inlet Line (Hot)	:	Dark Blue
ii. Outlet Line (Cold)	:	Light Blue
j) All supports / Stands	:	Black
k) Condenser Water Piping	:	
i. Hot	:	Dark Green
ii. Cold	:	Light Green
l) Ducting		
i. Concealed	:	Black Rust Proof
ii. Exposed to Grilles		
iii. Insulated / un-insulated duct	:	Black
iv. Exposed	:	Fiesta Blue

All painting works shall form part of the cost of equipment, piping etc. No separate payment shall be applicable.

14. TESTING OF AIRCONDITIONING SYSTEM-

- 14.1. Routine and types tests for various items of equipment shall be performed at the contractor's work and the test certificate furnished. Functional test shall be conducted at site.
- 14.2. The performance test to determine whether OR not the full indent of the specification is met shall be conducted by the contractor. After notification to the Employers that the installation has been completed and the system has run continuously for a period of at-least two weeks, the contractor shall conduct under the direction of the Consultants & in the presence of Employer's representatives perform such test as specified to establish the capacity of various equipment supplied and installed by the contractor.
- 14.3. The contractor shall operate test and adjust the air conditioning system units, fans, motors, all air-conditioning appliances including adjustments of regulators dampers etc.
- 14.4. All test equipment, labour, operating personnel required for this test shall be furnished by the contractor to enable the system to be put in continuous running test for a period of 3 days after all other tests and adjustments have been made.

The contractor shall make arrangement of electrical power and water for testing. The performance test shall be conducted during peak summer and peak monsoon.

15. PROCEDURE

15.1. Design Conditions

The inlet and outlet conditions of the Units will be recorded for 7 days duration on hourly basis. The outside and inside Dry Bulb and Wet Bulb temperatures shall be recorded by the means of a sling psychrometer with mercury thermometers. The relative humidity shall be computed from the psychrometric chart. The inside Dry Bulb temp. and relative humidity shall fall within the specified limits.

15.2. Capacity of the System

The following aspects shall be checked before conducting the performance tests-

- i. The outside conditions shall be as close to the design values as possible. The tests shall be arranged during the peak summer and monsoon.
- ii. The internal loads of various spaces shall be close to the design values as far as possible.
- iii. The system shall be fully loaded and the temperatures stabilised.
- iv. Hourly readings of air-flow shall be recorded by a calibrated flow meter.
- v. Hourly readings of pressure, temperature, electrical current, voltage, KW, KWH and power factor shall be properly recorded.

The capacity of the plant and various other equipments and accessories shall be ascertained as follows-

15.3. Cooling coil of AHUs and Indoor units

The flow of air over the cooling coil will be measured by recording the velocity of air across each filter placed before the cooling coil. The velocity shall be measured by means of end anemometer

Air quantity across the filters = velocity of air across the filters in FPM x net filter area (in sq. ft.).

The wet bulb temperature of air entering the coil and that leaving the coil shall be measured. The enthalpy of entering and leaving air shall be noted from the psychrometric chart, corresponding to the wet bulb temp. recorded.

SAY,

he - Enthalpy of Entering Air in Btu /lb

H1 - Enthalpy of Leaving Air in Btu / lb.

Ve - Specific Volume of Entering Air (CFT. / lb. of air)

V1 - Specific volume of Leaving Air (CFT. / lb. of air)

Average specific volume = $(ve + v1) / 2 = v$ (CFT/lb of air)

cap. Of cooling coil = $(CFM \times 60) / v \times (He -H1) /1200$

$(CFM \times \{He -H1\} \times 4.5 / 12000)$

15.4. System capacity

The capacity of the AHU / Indoor unit will be the capacity of system.

15.5. Power consumption by Compressor

The following readings shall be recorded-

- i] Suction gas pressure
- ii] Discharge gas pressure
- iii] Suction gas temperature.
- iv] Discharge gas temperature.
- v] Readings of Ammeter, voltmeter and power factor meter.

Same pressure gauge shall be used for different pressure measurements and the same thermometers shall be used for different temperature measurements. The capacity of the compressor shall be computed from the performance chart supplied by the manufacturer.

IKW / Ton of compressor-

= $(\text{Power in put in KW}) / \text{Compressor Capacity in Tons.}$

15.6. Air Balancing

After the desired inside conditions are achieved, the quantity of air thru' every outlet shall be measured. Air quantity in CFM = Air velocity at the outlet in FPM x effective area of the outlet in Ft².

The pressure levels of each area will be measured and recorded with respective adjoining areas. On load actual CFM of each cell will be recorded.

15.7. Motor

For all electrical motors the current, voltage and power will be recorded.

15.8. TESTING OF VARIOUS LOADING CONDITIONS

The performance test shall be conducted for various loads such as 100%, 75%, and 50% of the

capacity of the coil, if feasible

15.9. FUNCTIONAL TESTES

15.10. Safety Devices and controls

- [i] Interlocks for compressor motor with that of condenser fan shall be checked.
- [ii] High pressure – stat shall be checked by varying the settings of the cutout.
- [iii] Low-pressure stat – shall be tested by closing the pilot solenoid valve.
- [iv] Oil failure switch shall be tested by varying the settings.

15.11. Capacity Controls

The capacity control arrangements shall be tested by varying the load on the system. Any other procedure recommended by the manufactures may be adopted with the prior permission of the Employers and consultants.

15.12. TEST READINGS

15.12.1 The following readings shall be recorded hourly during the tests and capacity of the system shall be computed.

[I] COMPRESSOR

- Suction pressure - Kg/Cm2 (PSI)
- Suction Temperature - °C (°F)
- Discharge pressure - Kg/Cm2 (PSI)
- Condensing Temperature - °C (°F)
- Oil Pressure - Kg/Cm2 (PSI)
- Compressor Speed - RPM
- Motor
 - a) Rated Capacity - HP
 - b) Rated Volts - Volts
 - c) Rated Current - Amps
 - d) Starting Current - Amps

Power Consumption for

100%

75%

50% loads

Motor current in amps

Voltage

Starting Current

15.13. SUPPLY AIR GRILLES

1]	Area of Grill	–	M ² (FT ²)
2]	Velocity	–	M/Hr. (FPM)
3]	Air Flow Rate	–	M3 (FPM)
4]	Temperature DB	–	°C (°F)
5]	Temperature WB	–	°C (°F)

15.14. FRESH AIR /EXHAUST AIR LOUVERS

1]	Total Area	–	M ² (FT ²)
2]	Effective Area	–	M ² (FT ²)
3]	Velocity of Air	–	M/Hr. (FPM)
4]	Quantity of Air	–	M3/Hr. (CFM)

Approved Make List for HVAC					
S.no.	Item	Make			
1.0	Machines/Equipment :				
1.1	Water-Cooled Screw Packaged Chiller	Cristopia	Daikin (McQuay)	Carrier	Trane / York / Kiloskar / Hitachi
1.2	Chilled Water Handling Unit with Coil	Edgetech	Zeco	Citizen	Bluestar / Nutech
1.3	Centrifugal Fans for AHUs	Kruger	Comefri	Nicotra	
1.4	Chilled Water Fan Coil Unit	Edgetech	Zeco	Citizen	Nutech / Sincko / Midea
1.5	Cooling Tower	Bell	Advance	Mihir	
2.0	Chilled Water / Condenser Water Pumps :				
2.1	End Suction Pumps	Wilo	Armstrong	Grundfoss	Kirloskar / Bell & Gossett
2.2	Variable Speed Pumping System	Wilo	Armstrong	Grundfoss	Kirloskar / Bell & Gossett
3.0	Ventilations Fan :				
3.1	Axial Flow Fans	Maico (Dynair)	Kruger	Nicotra	Fantech (Airovent)
3.2	Centrifugal Fans (SISW,DIDW)	Maico (Dynair)	Kruger	Nicotra	Fantech (Airovent)
3.3	Fan Section	Maico (Dynair)	Kruger	Nicotra	Edgetech / Zeco / Citizen / Bluestar
4.0	Pipes:				
4.1	MS upto 150 mm dia	TATA	Jindal-Hissar	Surya Prakash	
4.2	MS 200 dia to 350 dia	TATA	Jindal Ghaziabad	Mukut	Shashi
4.3	Copper Pipes (Hard/Soft)	Mandev	Totaline	Rajco	
5.0	Sheets:				
5.1	G.I. Sheets, Rolls	TATA	Jindal	Nippon Denso	SAIL / National
5.2	Factory Fabricated Duct Work	Zeco	Rollastar	Alfa	Techno Aircon /
6.0	Grilles, Diffuser, Collar, Duct Damper, Louvers , Gravity Louvers, Jet Nozzles	Caryaire	Cosmos	Systemair	Dyna Craft / Air Flow
7.0	Fire Damper	Caryaire	Cosmos	Systemair	Conaire / V-george
8.0	Expansion Tank, centrifugal Air separator	KD Agencies	Anergy	Armstrong	Sevcon
9.0	Valves:				
9.1	GM valve upto 65mm dia	Leader	Zoloto		
9.2	Butterfly Valve	Advance	Kitz	Audco	Honeywell / Danfoss / Intervalve Keystone
9.3	Balancing Valve Manual	Advance	Honey Well	Danfoss	Flowcon
9.4	Non-return Valve	Advance	Honey Well	Danfoss	

9.5	Ball Valve & Ball Valve with Strainer (SS Ball)	Emerald	Rapid Control		
9.6	Pot Strainer, Y-Strainer, Suction Guide (Strainer)	Emerald	Sant	Armstrong	
10.0	Water Flow Switch	Danfoss	Honeywell	Johnson	Belimo
11.0	Electronic Control Valve				
11.1	Two Way Flow Valve WITH Rotary Actuators (Motorised Control Valve)	Belimo	Honeywell	Danfoss	Johnson / Siemens
11.2	Motorised Valves For FCU	Belimo	Honeywell	Danfoss	Johnson / Siemens
11.3	Motorised Butterfly Valve	Advance	Belimo	Honeywell	Audco
12.0	Thermostat For FCU	Belimo	Honeywell	Danfoss	Johnson / Siemens
13.0	BTU Meter	Honeywell	Forbes Marshall	Sontex (Belimo)	Siemens
14.0	Water Flow Switch	Johnson	Honeywell	Danfoss	Siemens
15.0	Mercury Thermometer, Pressure Gauge with Isolating Valve	H Guru	Fiebig		
16.0	Auto air Vent	Anergy	Danfoss	Honey Well	
17.0	Vibration Isolators	Resistoflex	Kanwal	Dunlop	
18.0	Flexible Connections	Kanwal	Resistoflex		
19.0	Insulation :				
19.1	Glass wool	UP Twiga	Owen	Corning	Kimmco
19.2	Closed Cell Nitrile Rubber	Armacell	K-Flex	A-Flex	Thermoflex / Supreme
19.3	Expanded Polystyrene (TF Quality)	Beard Sell	Styrene Packings		
20.0	V belts, Pulleys	Dunlop	Fenner		
21.0	Electric Motors (EFF-1 / IE-2)	ABB	Crompton	Kirloskar	Siemens / Havells
22.0	Rigid PVC Drain Pipe	Astral	Finolex	Supreme	Prince
23.0	Anchor Fastener	Hilti	Fischer		
24.0	Anti-vibration mounting	Resistoflex	Kanwal	Dunlop	Welcom Engg
25.0	Paint Primer	Asian	Berger	Nerolac	
NOTE :					
All The materials to be ISI marked.					
The materials shall be only of the approved makes as specified in this .					
The Contractor shall submit samples of all the makes as specified in this list and the Consultant / AKVN shall have the power to select any of them.					
Consultant/ AKVN decision in this regard shall be binding on the Contractor.					
In case any material is not available for any one or all of these approved makes the Consultant/ AKVN shall select and approve alternative make(s).					

ANNEXURE – E7

MISCELLANEOUS WORK

For all SOR items refer MPPWD SOR 2014 with effective from 1 August 2014 / NBC/ CPWD with all amendment up to date.

Technical Specification of Boom Barrier

Boom Barrier of approved make and design suitable for heavy use with following specifications:-

- 6m barrier aluminum bar L = 6000 mm di. 100 x 40mm with fixed support.
- With VDC motor, control unit in box, double built-in LED flashing lights.
- Double spring to counter balance movement and make it more fluent.
- Anti-UV rays epoxy powder coating.
- Robust gears and levers for reliable functioning over time.
- Energy saving mode.
- Universal box.
- Manual lock release by key in case of power failure.
- Pair of Photocells with anodized aluminum vertical mountings.
- Three Station Push Button.
- Power Supply: 230 V ~ / 50 - 60 Hz.
- Protection Rating: IP 54.
- Motor Consumption: 1.3 A.
- Absorbed power: 300 W.
- Working Cycle: 80%.

Technical Specification of Photovoltaic Panel

Photovoltaic Panel of approved make with following specifications:-

- Solar PV Modules:-

TP250 LBZ, 72 Cell, Polycrystalline Type With Tolerance- 0 To +2.5 % And 1.2 Mtr Cable, Length , Equipped With Bypass Diodes & Ip, 65 Junction Box, Configured With RFID Tags, IEC Certified and as per selection of Consultant and Engineer-in-charge.

- Solar Inverters:-

Grid Interactive Solar Inverter (1 x 30KW, 415V AC, 50Hz, MPPT) Transformer less with DC to AC ratio 1.1

- Earthing Kit:-

EARTHING, SUPER EARTHING KIT - 1G635 Along With Accessories (Maintenance Free Earthing) Lightning Arrestor with 2 Structure Clamp.

- Installation Kit:-

Cables & accessories & DCAC distribution board.

Approved Make List of Miscellaneous Work				
S.no.	Item	Make		
1	Median Marker	3M	Avery Dennisson	
2	Square Base Cone	Darkeye	Alcolite	Texla
3	Spring Post	Darkeye	Alcolite	Texla
4	Reflective Road Studs	3M	Avery Dennisson	
5	Solar Powered Road Studs	3M	Avery Dennisson	
6	Plastic Chain	Darkeye	Alcolite	Texla
7	Speed Bumps (Plastic)	Darkeye	Alcolite	Texla
8	CONVEX MIRROR-80 cm	Darkeye	Alcolite	Texla
9	Retro- reflectorised Traffic signs	3M	Avery Dennisson	
10	Direction and Place Identification signs	3M	Avery Dennisson	
11	Road Marking with Hot Applied Thermoplastic Compound	Kataline	Automark	Berger
12	Boom Barrier	FAAC	Gandhi	
13	Photovoltaic Panel	TATA	Divakar PV Solutions	
NOTE :				
All The materials to be ISI marked.				
The materials shall be only of the approved makes as specified in this .				
The Contractor shall submit samples of all the makes as specified in this list and the Consultant / AKVN shall have the				
Consultant/ AKVN decision in this regard shall be binding on the Contractor.				
In case any material is not available for any one or all of these approved makes the Consultant/ AKVN shall select				