JABALPUR SMART CITY LIMITED

MADHYA PRADESH

Office of the Executive Director, JABALPUR SMART CITY LIMITED, Jabalpur (M.P.)

TENDER DOCUMENT

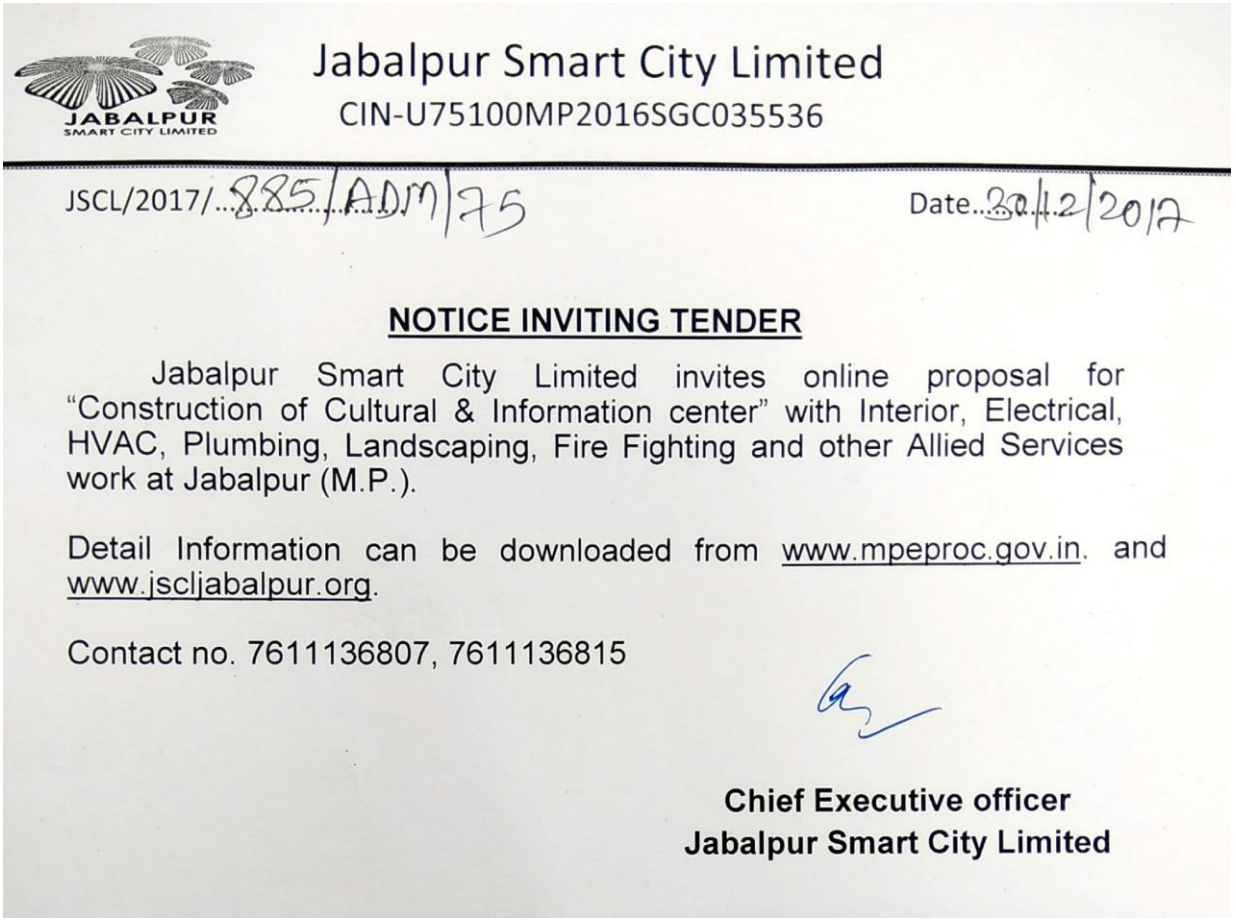
NIT Number and Date	: JSCL/2017/885/ADM/75 Dated 30/12/2017
Agreement Number and Date	: _____
Name of Work	: Construction of Cultural & Information center with Interior, Electrical, HVAC, Plumbing, Fire Fighting and other Allied Services work and Landscaping at Jabalpur (M.P.).
Name of the Contractor	: _____
Probable Amount of Contract,	
(Rs. In Figure)	: ₹ 55,23,00,000.00
(Rs. In Words)	: Rupees Fifty five crore twenty three lakhs only
Contract Amount	
(Rs. In Figure)	:_____
(Rs. In Words)	: _____

Stipulated Period of Completion: 18 ***months i/c rainy season.***

Appendix 2.10

Tender Document

Table of Contents



Jabalpur Smart City Limited
CIN-U75100MP2016SGC035536

JSCL/2017/885/ADM/75 Date 30/12/2017

NOTICE INVITING TENDER

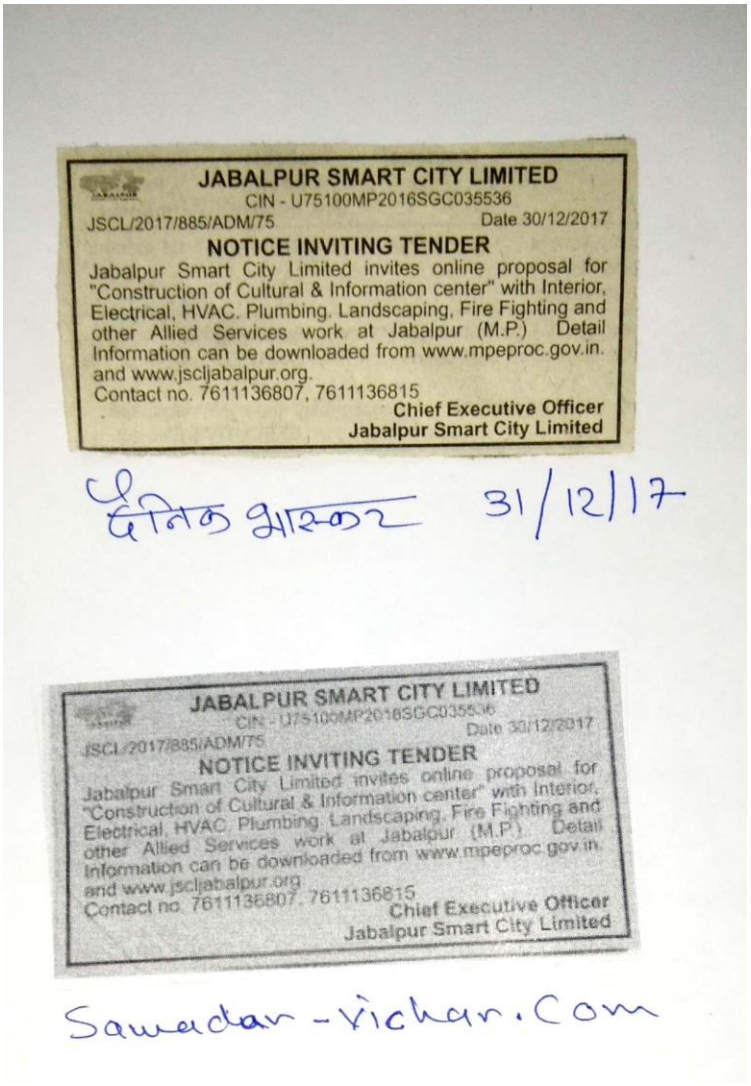
Jabalpur Smart City Limited invites online proposal for "Construction of Cultural & Information center" with Interior, Electrical, HVAC, Plumbing, Landscaping, Fire Fighting and other Allied Services work at Jabalpur (M.P.).

Detail Information can be downloaded from www.mpeproc.gov.in. and www.jscljabalpur.org.

Contact no. 7611136807, 7611136815

Chief Executive officer
Jabalpur Smart City Limited

Tenders reference number	JSCL/2017/885/ADM/75
Date of Pre Bid Meeting	24/01/2018 Time 15.00 Hrs
Last date for purchase the Tender	06/02/2018 Till 17.30 Hrs
Last date of online submission	14/02/2018
Date of opening of online technical bid	15/02/2018
Last date of physical submission	20/02/2018
Date of opening of Financial bid	23/02/2018
Tender document Cost	₹ 50000.00
Earnest Money Deposit	₹ 27,62,000.00



JABALPUR SMART CITY LIMITED
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Chief Executive Officer
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दैनिक भास्कर 31/12/17

JABALPUR SMART CITY LIMITED
CIN - U75100MP2016SGC035536
JSCL/2017/885/ADM/75 Date 30/12/2017

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Chief Executive Officer
Jabalpur Smart City Limited

Samachar-Vichar.Com

Notice Inviting Tenders

JABALPUR SMART CITY LIMITED

Office of The Executive Director, JABALPUR SMART CITY LIMITED, Jabalpur (M.P.)

N.I.T.NO._____/e-tendering Dated13thNov 2017

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

S.no. / Pkg /Code	Name of Work	District (s)	Probable Amount of Contract (Rs.)	Earnest Money Deposit (EMD) (in Rupees)	Cost of Bid Document (in Rupees)	Category of Contractor	Period of completion (in Months)
	Construction of Cultural & Information center with Interior, Electrical, HVAC, Plumbing, Fire Fighting and other Allied Services work and Landscaping at Jabalpur (M.P.	Jabalpur	₹ 55,23,00,000.00	₹ 27,62,000.00	₹ 50000.00	As per required	18 months including Rainy Season

1. All details relating to the Bid Document(s) can be viewed and downloaded free of cost on the website.
2. Bid Document can be purchased after making online payment of portal fees through Credit/Debit/Cash Card/ internet banking.
3. At the time of submission of the bid the eligible bidder shall be required to:
   - I. Pay the cost of Bid Document.
   - II. Earnest Money Deposit (EMD)
   - III. Submit a check list and
   - IV. 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. The Bidder would be required to have valid registration at the time of signing of the Contract.
   - C. Failure to sign the Contract by the Selected Bidder, for whatsoever reason, shall result in forfeiture of the earnest money deposit

5. **Pre-qualification –** Prequalification conditions, wherever applicable, are given in the Bid Data Sheet.
6. **Special Eligibility-** Special Eligibility Conditions, if any, are given in the Bid data sheet.
7. The Bid Document can be purchased only online from **17.30 Hrs on 05-01-2018** to time **1730 Hrs on 06/02/2018.** The key dates may be seen in bid data sheet.
8. The Pre Bid meeting will be held on **24th Jan 2018 at 15:00 Hrs** (03:00 pm) onwards at JSCL Office, Manas Bhawan, Wright Town, Jabalpur.
9. 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

BACKGROUND

The Proposed Cultural & Information center is proposed to stand at par with similar business epicenters globally. The design shell meets the National Building Codes and standards alongside meeting high end efficiency in sustainability and efficiency.

The Center is to house multi- use arenas capable of hosting events of state and national importance, business conventions, cultural events, art and product exhibits, theatre and private functions or ceremonies. A 900 plus seater auditorium with a state of the art audio- visual facility forms a larger part of the Cultural & Information center along with a facility for 500seaters. The complex shall meet its parking requirements of over 100 cars in the basement.

Over all the complex shall serve the dual purpose of a business and cultural hub to the city, and is designed to serve the following:

- Asa state of the art International business and cultural center with Auditorium, coupled with providing a business hotel serving the convention activities.
- The complex shall be designed as a highly efficient and sustainable campus target to achieve GRIHA 5-star certification (highest Star rating). Further the Energy Performance Index targets are 30% better than Energy Conservation Building Code – ECBC of India.
- Cultural and exhibit zones serving as business stand buys to the two major functions.
- As an architectural marvel addition to the city, it is proposed as a brand facility that exhibits the growth of business and revitalizes the local arts both nationally and internationally.
- The project shall demonstrate world class construction technology and support infrastructure, and at the same time gain the opportunity to create local jobs by providing a canvas to enhanced local craftsmanship and artisans.
- The Cultural & Information Center being the epicenter has a high potential to garner tourism, cultural activities, local crafts, artisan employment and corporate business all in one.

The auditorium will be developed equipped with the best of finishes and technology for proper promotion of Business meets and conventions, theatrics, music festivals and other allied fields of business and art.

1. SCOPE OF BID

The detailed description of work, hereinafter referred as 'work' is given as below:

Construction of Cultural & Information center with Interior, Electrical, HVAC, Plumbing, Fire Fighting and other Allied Services work and Landscaping at Jabalpur (M.P.).

2. 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. PROCEDURE FOR PARTICIPATION IN E- TENDERING:

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

4. ONE BID PER BIDDER

4.1 The bidder can be an individual entity or joint venture (if permitted as per Bid Data Sheet). In case the J.V. is permitted, the requirement of joint venture shall be as per the Bid Data Sheet.

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

5. COST OF BIDDING:

The bidder shall bear all costs associated with the preparation and submission of his bid, and no claim whatsoever for the same shall lie on the Government/J.S.C.L regardless of the conduct or outcome of the bidding.

6. SITE VISIT AND EXAMINATION OFWORKS:

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 regardless of the conduct or outcome of the bidding.

B.BID DOCUMENTS

7. 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 the Contract Data with all Annexure, and
    II. Part II Special Condition of Contract.
4. Specifications
5. Drawings
6. Priced bill of quantities
7. Technical and Financial bid
8. Letter of Acceptance
9. Agreement, and
10. Any other document(s), as specified

8. 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. 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 option, give such clarifications as are felt necessary at its discretion.

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 Documents, it shall be done by issuing amendment to the online NIT.

10. AMENDMENT OF BID DOCUMENTS:

10.1 Before the deadline for submission of bids, the Employer may amend or modify the bid document 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. 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. DOCUMENTS COMPRISING THE BID:

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

Part1- This shall be known as online Envelop A and would apply for all bids. Online envelop A shall contain the following as per details given in the bid data sheet:

i) Registration number or proof of application for registration and organizational details in the format given in the bid data sheet.

ii) Payment of the cost of Bid Document.

iii) Earnest Money

iv) An Affidavit Duly Notarized.

Part 2 – This shall be known as Online **Envelope B** and required to be submitted only in work 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. Envelop C shall contain financial offer in the prescribed format enclosed with the Bid Data Sheet.

13. 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 duly certified. In such case, for the purposes of interpretation of the bid, such translation shall govern.

14. 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 documents/ information enclosed with the Technical Proposal should be self-attested and certified by the 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.

15. FINANCIAL BID:

i) i. The bidder shall have to quote rates 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 contract 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) They bidder shall have to put rate inclusive of all duties, royalties, levies and taxes except Goods and Services Tax (GST). The amount of applicable GST will be paid separately to the contractor with each bill at the time of payment. The employer shall not be liable for any duties, taxes (except GST), royalties and levies.

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. PERIOD OF VALIDITY OF BIDS:

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

17. EARNEST MONEY DEPOSIT (EMD)

17.1 The Bidder shall furnish, as part of the Bid, Earnest Money Deposit (EMD), in 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 favors 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. However, form(s) of EMD may be allowed by the employer by mentioning it in the Bid Data Sheet.

17.3 Bid not accompanied by EMD shall be rejected as non-responsive.

17.4 EMD of bidders whose bids are not accepted will be returned within ten 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 or Failure to furnishing the required Performance security by the successful bidder, within the specified period, for whatsoever reason, shall result in forfeiture of the earnest money.

D.SUBMISSION OF BID

18. The bidder is required to submit online bid duly signed digitally, and envelop "A" in physical form also at the place prescribed in the Bid Data Sheet.

E. OPENING AND EVALUATION OF BID

19. PROCEDURE:

19.1 Envelop "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 Envelop 'C' (Financial Bid) 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 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. 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 his bid.

F. AWARD OF CONTRACT

21. AWARD OF CONTRACT:

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

22. PERFORMANCE SECURITY

22.1 Prior to singing 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. 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. No 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 any other action against the bidder.

24. 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 fanatical or other benefit or to avoid an obligation:

c. 'coercive practice' means impairing of 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		
SR.NO.	**PARTICULARS**	**DATA**
1	OFFICE INVITING TENDER	OFFICE OF THE EXECUTIVE DIRECTOR, JABALPUR SMART CITY LIMITED, JABALPUR.
2	NIT NO.	JSCL/2017/885/ADM/75 Dated 30/12/2017
3	DATE OF NIT	30th December, 2017
4	BID DOCUMENT DOWNLOAD AVAILABLE FOR DATE & TIME	The Bid Document can be purchased only online from **1730 Hrs on 05-01-2018** to time**1730 Hrs on 06/02/2018.**
5	WEBSITE LINK	http://www.mpeproc.gov.in
SECTION 1 – NIT		
SR.NO.	**PARTICULARS**	**DATA**
1	PORTAL FEES	AS NOTIFIED IN E-TENDERING WEBSITE
2	COST OF BID DOCUMENT	₹ 50,000.00 (FIFTY THOUSAND ONLY)
	COST OF BID DOCUMENT PAYABLE AT	***As notified in e-tendering website***
	COST OF BID DOCUMENT IN FAVOR OF	***As notified in e-tendering website***
3	AFFIDAVIT FORMAT	ANNEXURE B
4	PRE-QUALIFICATIONS REQUIRED	YES
	IF YES, DETAILS	AS PER ANNEXURE C
5	SPECIAL ELIGIBILITY	YES
	IF YES, DETAILS	***AS PER ANNEXURE D***
6	KEY DATES	ANNEXURE A
SECTION 2 – ITB		
SR.NO.	**PARTICULARS**	**DATA**
1	NAME OF 'WORK'	CONSTRUCTION OF CULTURAL & INFORMATION CENTER WITH INTERIOR, ELECTRICAL, HVAC, PLUMBING, FIRE FIGHTING AND OTHER ALLIED SERVICES WORK AND LANDSCAPING AT JABALPUR (M.P.).
2	SPECIFICATIONS	AS PER ANNEXURE –E
3	PROCEDURE FOR PARTICIPATION IN E-TENDERING	ANNEXURE-F
4	WHETHER JOINT VENTURE IS ALLOWED	YES
	If yes, requirement for joint venture	Annexure - G
5	PRE BID MEETING TO BE HELD	YES
	DATE, TIME & PLACE	**24th Jan 2018 at 15:00 Hrs** (03:00 pm) Venue - JSCL Office, Manas Bhawan, Wright Town,

		Jabalpur
6	ENVELOPMENT A CONTAINING: i. REGISTRATION NUMBER OR PROOF OF APPLICATION FOR REGISTRATION AND ORGANIZATIONAL DETAILS AS PER ANNEXURE H	OFFICE OF THE EXECUTIVE DIRECTOR, JABALPUR SMART CITY LIMITED, JABALPUR (M.P.)
	ii. COST OF BID DOCUMENT	₹ 50,000.00 (FIFTY THOUSAND ONLY)
	iii. EMD	₹ 27,62,000.00 (Twenty Seven Lakhs sixty two thousand Only)
	iv. AN AFFIDAVIT DULY NOTARIZED AS PER ANNEXURE – B SHOULD REACH IN PHYSICAL FORM	
7	ENVELOPE-B TECHNICAL PROPOSAL	ANNEXURE – I AND ANNEXURE –I (FORMAT I-1 TO I-5)
8	ENVELOPE-C FINANCIAL BID	ANNEXURE – J
9	MATERIALS TO BE ISSUED BY THE DEPARTMENT	ANNEXURE-K
10	PERIOD OF VALIDITY OF BID	120 DAYS
11	EARNEST MONEY DEPOSIT	₹ 27,62,000.00 (Twenty Seven Lakhs sixty two thousand Only)
	FORMS OF EARNEST MONEY DEPOSIT	DD/FDR/E-FDR in favor of EXECUTIVE DIRECTOR, JABALPUR SMART CITY LIMITED, JABALPUR (M.P.)
	EMD VALID FOR A PERIOD OF	180 DAYS
	FDR MUST BE DRAWN IN FAVOUR OF	EXECUTIVE DIRECTOR, JABALPUR SMART CITY LIMITED
12	LETTER OF ACCEPTANCE (LOA)	ANNEXURE L
13	Amount Of Performance Security	5% of contract amount
	Additional Performance Security, If Any	as per rules
	Performance Security In The Format	Annexure M
	Performance Security In Favor Of	Executive Director, Jabalpur Smart City Limited
	Performance Security Valid Up To	Valid Contract Period Plus 3 Months

Annexure – A

(See clause 1, 7 of Section 1-NIT)

KEY DATES

S.NO	WORKS STAGE	BIDDERS STAGE	START		EXPIRY		ENVELOPE
			DATE	TIME	DATE	TIME	
1	TENDER PURCHASE	PURCHASE OF TENDER – ONLINE	05/01/2018	17.30 Hrs	06/02/2018	Till 17.30 Hrs	
2	TENDER FILING	BID SUBMISSION – ONLINE	05/01/2018	17.30 Hrs	14/02/2018	Till 17.30 Hrs	
3	MANDATORY SUBMISSION OPEN (ENVELOP-A)		23/02/2018	15.00 Hrs			ENVELOPE A ONLINE OPENING
4	TECHNICAL PROPOSAL OPEN (ENVELOPE-B)		23/02/2018	15.00 Hrs			ENVELOPE B ONLINE OPENING
5	PHYSICAL SUBMISSION REACHING J.S.C.L.		20/02/2018	17.30 Hrs			
5	FINANCIAL BID OPEN (ENVELOPE-C)		23/02/2018	15.00 Hrs			ENVELOPE C

Original term deposit receipt of earnest money deposit, demand draft for the cost of bid document and affidavit shall be submitted by the bidder so as to reach the office as prescribed as per key dates in Bid Data Sheet.

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 anoath 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.

a. That the self – certified information given in the bid document is fully true and authentic.

b. That:

1. Term deposit receipt deposited as earnest money, demand draft for cost of bid document and other relevant documents provided by the Bank are authentic.
2. Information regarding financial qualification and annual turnover is correct.
3. Information regarding various technical qualifications is correct.

c. 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.

Annexure—C

(Sec clause 5 of Section 1-NIT)

PRE- QUALIFICATIONS CRITERIA

The bidder should have:

A. Financial

I. experience of having successfully executed: -

- ***three similar works,*** each costing not less than the ***amount equal to 20%*** of the probable amount of contract during the ***last 3 financial years;*** or
- ***two similar works,*** each costing not less than the ***amount equal to 30%*** of the probable amount of contract during the ***last 3 financial years;*** or
- ***one similar work*** of aggregate cost not less than the amount ***equal to 50%*** of the probable amount of contract in any one financial year during the **last 3 financial years;**

ii. Average annual construction turnover on the construction works not less than ***50%*** of the probable amount of contract, during the last 3 financial years.

iii. Executed similar items of work in any one financial year during the last 3 financial years, which should not be less than the minimum, physical requirement, if any, fixed for the work.

iv. Bid Capacity — Bidder shall be allotted work up to his available Bid Capacity, which shall be worked out as given in format 1-2 of Annexure I.

B. Physical

Physical qualifications for the work shall be as below

S.No	Physical qualification required	Quantity	Period
1	Basement Work	At least one work of 750 sqm. Basement built-up area in (high) water table areas.	In any one of the last 3 years
2	Concrete work	At least one work of 1500 sqm built-up area, and 1200 cum of controlled RMC work under high water table areas	In any one of the last 3 years
	Comprehensive construction contracts	Including Civil work, Interior finishing, all allied services such as Fire-fighting sprinkler system, HVAC/ MEP, acoustics and Landscaping with excellent workmanship.	

Note:

(a) The bidder will have to provide certificates for above prequalifying conditions from competent authority.

(b) The bidder should attach a PowerPoint presentation of not more than 20 slides exhibiting exemplary work.

Annexure —D

(See clause 6 of Section 1-NIT)

SPECIAL ELIGIBILITY CRITERIA

nil

ANNEXURE- E

(See clause 2 of Section 2 —ITB & clause 10 of GCC)

SPECIFICATIONS

GENERAL NOTES

a) SOR of UADD / MPPWD/ CPWD Department for all works is used for Items and specifications for this project and form a part of this document.

b) Electrical items to be used shall be taken from the list of makes as approved by UADD / MPPWD.

c) Detailed specifications for Non-scheduled items are also included in the document however, in case if any specification is incomplete or missing or not clear or needs further clarifications, the decision of Employer shall be binding in this regard.

d) 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.

Specifications of Non-Scheduled Items:

RETROPLATING

This is a complete process that revitalizes and strengthens old / new concrete floor – to abrasion withimproved impact resistance, sealing, glossy sheen as per manufacturer specification,

Technical details: Retroplate permanently strengthen concrete floors that delivers a highly abrasion resistant, dustproofed surface with increased impact resistance and reflectivity.
Applicable Standards;
1. Abrasion: ASTM C779 - up to 400% increase in abrasion resistance, depending on concrete quality.
2. Hardness: ASTM C805 - 21% increase in impact resistance.
3. Weathering: ASTM G23-81 no adverse effect to ultraviolet light or water sprays.
4. Light Reflectivity: 30% increase in reflectivity.
5. Skidability Static: Coefficient of Friction ASTM 1028 - independent testing has shown that RetroPlate® can exceed OSHA and ADA recommendations for wet and dry hard surfaces.

APPLICATION PROCEDURE OF COLOUR DYE AND RETROPLATE SYSTEM

SUMMARY
1. Step One – Prepare the surface for the application of the stabilizer (Grinding) and repairing if require depend on floor condition.
2. Step Two- Apply color dye
3. Step Three - Apply the Retro plate
4. Step Four- Apply the second coat either spiff or squeegee(OPTIONAL)
5. Step Five- Finish Polishing

- **STEP ONE-PREPARE THE SURFACE FOR THE RETROPLATE;**
  Depending on the floor the diamond grits are used to grind and smoothen the surface and repair wherever require.

- **Step TWO: Apply colour dye:**
  Apply the colour dye with a spray pump and leave it for four to five hours or till it gets dry properly.
  Then wash the surface thoroughly to see the colour is apply properly and if need be, dye will be reapplied however it will not give uniform appearance.
  DO NOT ALLOW ANY TRAFFIC ON THE FLOOR WHILE THIS COAT IS DRYING.

- **STEP THREE: -APPLY THE RETROPLATE**

The product is applied at a rate of 40sqft/liter approximately. It is important that the area to be treated is measured and the product is applied accordingly. After the product has been applied to the floor, it should be scrubbed with an aggressive brush.

The Retro plate must be allowed to dwell on the surface for a minimum of 60 minutes. There is no maximum amount of time that it can stay on the surface. In cold temperatures of less than 50 degrees Fahrenheit, it should be allowed to dwell a minimum of one hour.

After approximately 30 minutes the Retro plate should become more viscous and slippery. This is the result of dehydration and a chemical reaction. An excessive amount of product or low temperature can cause a slower reaction. If the product is not slick in one hour, proceed as if it were. When the Retro plate on the floor becomes a slick, resolubalize the Retro plate by adding more water.

After the product has become slick a second time, remove it from the floor by flushing with water.

OPTIONAL: (THIS STEP IS REQUIRED ONLY FOR OLD CONSTRUCTED AND POROUS FLOOR)

- **STEP FOUR – THE SPIFF OR SQUEEGEE COAT**

Small area (e.g. garages, isles, and such) can be done using a clean web-footed blended finish mop, a clean mop bucket with a down press wringer, and a couple of gallons of the Retro plate. Place the finish mop into the solutions and allow it to become saturated. Remove the mop from the solution and wring it dry.
Large Areas: - Spray the product on the floor making sure that the application is even and consistent. Using an Etoria Wipe and Dry Squeegee, pull the product across the floor. Make sure that no footprints or puddles remain.

DO NOT ALLOW ANY TRAFFIC ON THE FLOOR WHILE THIS COAT IS DRYING.

With either application method, the floor should be dry to the touch in 15 to 20 minutes. When it is dry to the touch, it is safe for traffic. If the floor remains wet for more than 20 minutes, the spiff coat is too heavy. Immediately add water agitate with a brush on a rotary buffer and remove with a wet vac.

- **STEP FIVE-CONTINUE THE POLISHING PROCESS:**

After the Retro plate has cured for a minimum of 8-24 hours the polishing process is ready to continue.

Note: This confirms the requirement of applicable standards for Abrasion ASTM, C779 and Hardening ASTM C805.

SPECIFICATIONS FOR COLOUR DYE/STAIN
solvent based colour dye formulated using extremely fine molecules of colour designed to penetrate and colour any cementious surface, It can be used with polished concrete as well as base colour or touch up for concrete that has received integral colours, dry shake hardener, acid stains or even as overlay to itself as per manufacturer specification,

TERRACOTTA JALLI:

Process of making Terracotta tiles:

Terra cotta is made from natural clay. The raw clay needs to be refined before it is made into terracottatiles. This process involves drying the clay and then screening and filtering it to remove impurities thataffect the consistency, color and other properties of the clay. Depending on the purity of the clay pitfrom which the material is removed, raw clay has foreign matter, minerals, rocks and other items thatneed to be removed during this process. Once it has been refined, terra cotta clay is often pressed intomolds. The clay is firmly pressed into the mold and its been dry for 7-8 days, so that it takes on theshape before firing.
Once the terra cotta has been pressed into the appropriate shape, it needs to be fired in order to cook and harden. Terra cotta falls into the category of low fire clay. This means that you must fire it at a lower temperature than many other clays or it will melt. This can damage the kiln as well as ruin the work. Normally, terra cotta is fired at a temperature between 2,048 and 2,079 degrees Fahrenheit.

Measurement: Tile work is measured in length & breadth corrected to a cm. The quantity shall be worked out in square meter corrected to two decimal places. No reduction shall be made in respect of voids. Voids can be a max of 40% of the total area. Dimension of individual terracotta tile is 150mm x 150mm x 50mm thick.

FLOORING WORKS

General:
CPWD Specifications to be followed in general. However, all flooring shall be laid to the best practice known to the trade. The flooring shall be laidto the level except where slopes are called for on the drawings in which case the slopesshall be uniform and so arranged to drain in to the indicated outlets.Particular care shall be exercised to ensure that all flooring, skirting and dado are perfectly matched for colour and finish.

- KOTA STONE FLOORING

The best quality stone sizes(300x300mm), (500x500mm) (350 mm x width of staircase upto 2m) (Gold /Grey) fromapproved quarry, shall be laid either with rough stone or machine cut andmachine polished as specified in respective items and shall be of specifiedthickness and of approved quality and size, free from cracks and flakes and shallbe uniform in colour, with straight edges. The sides of machine cut and machinepolished stones shall have perfect right and finished. The stones shall be laid onminimum thickness of 25mm thick cement mortar 1:4 (1 cement : 4 coarse sand)mix to match the total thickness of flooring of 50mm thick & joint to be fitted withcement slurry mixed with pigment to match the shade of stone. The finishedstone surface including edge prepared surface thus laid shall then be polished tothe required degree as approved by the Project Manager. Flooring shall be finallymirror polished and protected till the handing over of the building.

- TERRAZO FLOORING IN-SITU (white chips with white cement)

Under Layer

Cement concrete of specified mix shall be used and the specifications givenunder shall apply. The panels shall be of uniform size, not exceeding 2 sqm inarea or 2 m in length for inside situations.
In exposed situations, the length of any side of the panel shall not be more than1.25 metre. Cement slurry @ 2.00 kg per sqm shall be applied before laying ofunder layer over the base cement concrete/RCC base.
Fixing of Strips 4 mm thick glass strips or 2 mm thick PVC strips/aluminium strips/brass strips /stainless steel strips/copper strips unless otherwise specified shall be fixed with their top at proper level to required slope. Strips of stone or marble or of any other material of specified thickness can also be used if specifically required.
Use of glass and metallic strips shall be avoided and areas exposed to sun. The fixing and laying shall be as specified.

Top Layer

Mortar: The mix for terrazzo shall consist of cement with or without pigment, marble powder,marble aggregate (marble chips) and water. The cement and marble powder shall be mixed in the proportion of three parts of cement to one part marble powder by weight.

The marble chips shall be primarily white marble chips in white cement with brass strips lining as specified. It shall be hard, sound, dense and homogenous in texture with crystalline and coarse grains. It shall be uniform in colour and free from stains, cracks, decay and weathering.

Where aggregate of size larger than 10 mm are used, the minimum thickness of topping shall not be less than one and one third times the maximum size of the chips. Where large size chips such as 20 mm or 25 mm are used, they shall be used only with a flat shape and bedded on the flat face to keep the minimum thickness of wearing layer.

Before starting the work, the contractor shall get the sample of marble chips approved from the Engineer-in-Charge. This shall be done in advance by mixing different colour marble chips and panel samples of minimum 1 m x 1 m size shall be prepared and got approved from the Engineer-in- charge before laying of flooring. The cement to be used shall be ordinary grey cement, white cement, cement with admixture of colouring matter of approved quality in the ratio specified in the description of the item in the ratio to get the required shade as ordered by the Engineer-in- Charge. Colouring materials where specified shall be mixed dry thoroughly with the cement and marble powder and then marble chips added and mixed as specified above. The full

quantity of dry mixture of mortar required for a room shall be prepared in a lot in order to ensure a uniform colour.
This mixture shall be stored in a dry place and well covered and protected from moisture. The dry mortar shall be mixed with water in the usual way as and when required. The mixed mortar shall be homogenous and stiff and contain just sufficient water to make it workable.
The terrazzo topping shall be laid while the under layer is still plastic, but has hardened sufficiently to prevent cement from rising to the surface. This is normally achieved between 18 to 24 hours after the under layer has been laid. A cement slurry preferably of the same colour as the topping shall be brushed on the surface immediately before laying is commenced. It shall be laid to a uniform thickness slightly more than that specified in order to get the specified finished thickness after rubbing. The surface of the top layer shall be trowelled over, pressed and brought true to required level by a straight edge and steel floats in such a manner that the maximum amount of marble chips come up and are spread uniformly over the surface.

Curing, Polishing and Finishing: The surface shall be left dry for air-curing for a duration of 12 to 18 hours depending on atmospheric temperature conditions. It shall then be cured by allowing water to stand in pools over it for a period of not less than 4 days.
The grinding and polishing may be commenced not before 2 days from the time of completion of laying for manual grinding and not before 7 days for matching, grinding. For polishing by machines, the surface shall be watered and ground evenly with machine fitted with special rapid cutting grit blocks (carborundum stone) of coarse grade (No. 60) till the marble chips are evenly exposed and the floor is smooth. After the first grinding, the surface shall be thoroughly washed to remove all grinding mud and covered with a grout of cement and colouring matter in same mix and proportion as the topping in order to fill any pin holes that appear. The surface shall be allowed to dry for 24 hours and wet cured for 4 days and then rubbed with machine fitted with fine grit blocks (No. 120). Curing shall be done by ponding of water between panels formed with fine sand. The surface is cleaned and repaired as before and allowed to cure again for 3 to 5 days.
Finally the third grinding shall be done with machine fitted with mere fine grade grit blocks (No. 320) to get even and smooth surface without pin holes. The finished surface should show the marble chips evenly exposed.
Where use of machine for polishing is not feasible or possible, rubbing and polishing shall be done by hand, in the same manner as specified for machine polishing except that carborundum stone of coarse grade (No. 60) shall be used for the 1st rubbing, stone of medium grade (No. 80) for second rubbing and stone of fine grade (No. 120) for final rubbing polishing.
After the final polish either by machine or by hand, oxalic acid shall be dusted over the surface @ 33 gm per square metre sprinkled with water and rubbed hard with a nemdah block (Pad of Woolen rags).
The following day, the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean. Curing shall be done by suitable means such as laying moist sawdust or ponding water.
Precautions flooring in lavatories and bathrooms shall be laid after fixing of water closet and squatting pans and floor traps. Traps shall be plugged, while laying the floors and opened after the floors are cured and cleaned. Any damage done to WC's squatting pans and floor traps during the execution of work shall be made good.
During cold weather, concreting shall not be done when the temperature falls below 4°C. The concrete placed shall be protected against frost by suitable coverings. Concrete damaged by frost shall be removed and work redone. During hot weather, precautions shall be taken to see that the temperature of wet concrete does not exceed 38°C. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in- Charge.

Measurements Length and breadth shall be measured correct to a cm before lying skirting, dado or wallplaster. The area as laid shall be calculated in sqm correct to two decimal places.

The thickness of the under layer shall be measured correct to a cm. The thickness of top layer shall not be less than that specified. No deduction shall be made, nor extra paid for voids not exceeding 0.20 square metres. Deduction for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for laying the floor at different levels in the same room or courtyard. Terrazo (Marble Chips) flooring laid as floor borders, margins and similar bands upto 30 cm width shall be measured under the item of terrazo flooring but extra shall be paid for such work. This extra in the case of staircase treads shall include the cost of forming the nosing also.Extra shall also be paid for laying flooring in narrow bands not exceeding 7.5 cm in width and such bands shall be measured in running metres for this purpose.
Dividing strips of glass/PVC inserted in terrazo to form bays, patterns shall be described stating the materials, its width and thickness and measured in running metres.

Special surface finishes to treads, risers and the ends of concrete steps and the like shall be measured separately and given in square metres and shall include form work, if required.

Rate: The rate shall include the cost of all materials and labour involved in all the operations described above including cleaning of surface of RCC slab or base concrete and application of cement slurry but shall not include the cost of baseconcrete and cost of providing and fixing strips of glass or aluminium or of any other material used for making panels, which shall be paid for separately.

- **MARBLE / GRANITE STONE**

Marble/Stone shall be of best quality, as approved by the Architect and Engineer- in-charge. The stone shall be without any veins, cracks and flaws. The stone shall be even, sound and durable, regular in shape and of uniform colour. The size of the stone shall be as specified in the item or detailed drawing or as approved by the Architect and Engineer-in- charge. The thickness of the stone shall be as specified in the item of work, with the permissible tolerance of +2 mm. The stones shall have machine polished surface. When brought on site, the stone shall be rough, single polished or double polished, depending upon its use and as specified in the item or detailed drawing. The stones for paving shall generally be single polished. All angles and edges of the stone shall be fine chiselled or polished, as specified in the item of work and all the four edges shall be machine cut. All angles and edges of the face of the stone shall be true and plane. The sample of stone shall be got approved by the Engineer-in- charge and Architect, for a particular work. It shall be ensured that the stones to be used in a particular work shall not differ much in shade or tint, from the approved sample.
No white, black or any other colour spots shall be there. Cheetah or tiger skinned stones shall not be allowed under any case.
Marble stone flooring with 18mm thick marble stone (sample of marble shall be approved by Engineer-in-charge) over 20 mm (average) thick base of cement mortar 1:4 (1 cement : 4 coarse sand) laid and jointed with grey cement slurry including rubbing and polishing complete

1. KATNI STONE (Marble)

- Water Absorption -less than 0.1%
- Hardness – 4 Mohr's scale
- Density (Bulk Specific Gravity) – 2857
- Compressive strength – Dry – 1649 kg/m3
- Wet – 2023 kg/m3
- Katni stone used in pattern 50% (size 600x600mm)
- Katni Stone with Handicraft white marble inlay pattern of size 1.5 x 1.5m.
- Lift wall in Katni stone with chamfered edges with 6mm groove lines: highlighter
- Wall in forest brown stone till false ceiling height.
- Katni stone skirting upto 150mm ht. with 6mm U groove in between the stone and remaining painted wall

2. DESERT GOLD (Marble)

- Flooring (20%) size:300x300mm

3. JAISALMER STONE (Marble)

- Water Absorption – 1.67%
- Density – 2530 kg/m3
- Compressive Strength – 58 MPa
- Jaisalmer stone skirting upto 150mm height with 6mm U groove in between
- stone and remaining painted wall,
- Flooring size : 300x300mm , Dado – 1050mmhigh

- BROKEN CHINA MOSAIC FLOORING

Providing and fixing well graded broken pieces of glossy glazed tiles (China mosaic) and grouting all the joints with cement mortar 1:4 mix (1 cement : 4 coarse sand) including cleaning the surface and including providing and mixing waterproofing material (of approved brand and manufacture) in the proportion recommended by the manufacturer. Single colour as well as mixed colour patterns may be required at no extra cost and the broken pieces shall be bedded down in wet mortar so as to create a smooth and even surface with no undulations or bumps. The edges of the broken tiles should be straightened to match the pattern

- STONE FLOORING

1. Dressing

Every stone slab 18-20mm thick shall be cut to the required size and shape and fine chisel dressed in chamfered sizes on the sides to the full depth so that a straight edge laid along the side of the stone shall be in full contact with it. The sides (edges) shall be table rubbed with coarse sand or machine rubbed before paving. All angles and edges of the tiles shall be true, square and free from chipping and the surface shall be true and plane.

2. Preparation of surface and laying

The sub-grade concrete or the RCC slab on which the slabs are to be laid shall be cleaned, wetted & mopped. The bedding for the slabs shall be with 20mm cement mortar 1:4 (1 cement: 4 coarse sand) as given in the description of the item except that the edges of the slabs to be jointed shall be buttered with cement, with admixture of pigment to match the shade of the stone slab.

3. Polishing and finishing

The day after the stone slabs are laid all joints shall be cleaned of the cement grout with a wire brush or trowel to a depth of 5mm and all dust & loose mortar removed and cleaned. Joints shall then be grouted with grey or white cement mixed with or without pigment to match the shade of the stone slabs. The flooring thus laid shall be grounded evenly with machine.

4 Laying

The specified thickness of cement concrete shall be laid in the pattern as approved by the Architects and ISI specifications. The flooring shall be laid to the level except where slopes are called for in the drawings in which case the slope shall be uniform and arranged to drain off in the indicated outlets. Particular care shall be taken to ensure that all flooring / skirting dado do perfectly match for colour / texture/ finish.

1. KHAREDA STONE (sandstone)
   - Hardness – 6-7 Mohr's scale
   - Compressive strength – 365-460 kg/m2
   - Density – 2.32 – 2.42 kg/m3
   - Water absorption – Not more than 1%
   - Khareda sandstone dado upto 600mm height
   - Kiosk wall to have 2700mm high khareda stone with 6mm groove between stone and remaining painted wall
   - Khareda skirting of 300mm height , 900mm high stone with 6mm U groove between stone and remaining painted wall.

2. KADAPPA STONE (Limestone)
   - Hardness : 3-4 Mohr's Scale
   - Density : 2.5-2.7 kg/cm3
   - Compressive strength – 60-170 n/mm3
   - Water Absorption – less than 1%
   - Porosity : Quite Low
   - Black Kadappa stone for flooring

3. QUARTZITE STONE (sandstone converted into quartzite)

   Hardness – 6-7 Mohr's scale
   Compressive strength – 365-460 kg/m3
   Water Absorption – not less than 1%
   Porosity – Low to Very Low
   Weather impact – Resistant

   Quartzite Stone (colour as per selection) with handicraft white marble inlay pattern in 2m diameter area , dado upto 900mm height, with 6mm groove U groove in between the stone and remaining painted wall , Quartzite stone (color as per selection) till 5.5m full height Black Quartzite stone with handicraft coloured marble inlay pattern of size 2x2m remaining floor in quartzite.

Annexure-F

(See clause 3 of section 2-ITB)

PROCEDURE FOR PARTICIPATION IN E-TENDERING

1. REGISTRATION OF BIDDERS ON E-TENDERING SYSTEM:

All the PWD registered bidders are already registered on the new e-procurement portal https://www.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 email 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 CERTIFICATE:

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 Certificate 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 up to 7 working days for issuance of Class III DigitalCertificate; hence the bidders are advised to obtain the Certificate at theearliest. Those bidders who already have valid Class III DigitalCertificate need not obtain another Digital Certificate for the same.The bidders may obtain more information and the Application From required to be submitted for the issuance of Digital Certificate from cca.gov.in

II. Bids can be submitted till bid submission end date. Bidder will require digital signature while bid submission.

The digital certificate issued to the Authorized User of a Partnership firm / Private Limited Company / Public Limited Company and used for online biding 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 authorize 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 BIDDER'S COMPUTER SYSTEM:

In order for a bidder to operate on the e-tendering System, the ComputerSystem of the bidder is required to be set up for Operating System, Internet Connectivity, Utilities, Fonts, etc. The details are available athttps://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 end submit Bid 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.

6. PURCHASE OF BID DOCUMENT

For purchasing of the bid document bidders have to pay Service Charge online ONLY which is Rs. [as per Bid Date Sheet]. Cost of bid document is separately mentioned in the Detailed NIT. The Bid Document shall be available for purchase to concerned eligible bidders immediately after online release of the bids and up to scheduled time and date as set in the key dates. The payment 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.

7 WITHDRAWAL, SUBSTITUTION AND MODIFICATION OF BIDS

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

JOINT VENTURE (J.V.)

J.V. is allowed as per the conditions of contract.

If J.V. is allowed following conditions and requirements must be fulfilled -

1. Number of partners in a Joint Venture shall not exceed 3 (three). The partners shall comply with the following requirements:
   a. one of the partners shall be nominated as being Lead Partner, and this authorization shall be evidenced by submitting a power of attorney signed by legally authorized signatories of all the partners;
   b. the bid and, in case of a successful bid, the Agreement, shall be signed so as to be legally binding on all partners;
   c. the partner in charge shall be authorized to incur liabilities and receive instructions for and on behalf of any and all partners of the joint venture and the entire execution of the contract, including payment, shall be done exclusively with the partner in charge;
   d. all partners of the joint venture shall be liable jointly and severally for the execution of the contract in accordance with the contract terms, and a statement to this effect shall be included in the authorization mentioned under[c] of above, as well as in the bid and in the Agreement tin case of a successful bid];
   e. The joint venture agreement should indicate precisely the role of all members of IV in respect of planning, design, construction equipment key personnel, work execution, and financing of the project. All members of JV should have active participation in execution during the currency of the contract. This should not be varied/modified subsequently without prior approval of the employer;
   f. The-joint venture agreement should be registered, so as to be legally valid and binding on all partners and
   g. a copy of the joint Venture Agreement entered into by the partners shall be submitted with the bid.
2. The figures for each of the partners of a joint venture shall be added together to determine the Bidder's compliance with the minimum qualifying criteria required for the bid. All the partners collectively must meet the criteria specified in full. Failure to comply with this requirement will result in rejection of the joint venture's bid.
3. The performance security of a joint venture shall be in the name of the partner Lead Partner/joint venture.
4. Attach the power of attorney of the partners authorizing the Bid signatory(ies) On behalf of the joint venture
5. Attach the agreement among all partners of the joint venture [and which is legally binding on all partners], which shows the requirements as indicted in the Instructions to Bidders'.
6. Furnish details of participation proposed in the joint venture as below:

DETAILS OF PARTICIPATION IN THE IOINT VENTURE

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)			

7. The partners of J.V. should satisfy the qualification criteria as below,
   a. The Lead Partner must meet at least 50% requirement of Technical and Financial eligibility criteria required for the bid.
   b. The other partner(s) must meet at least 25% requirement of Technical and financial eligibility criteria required for the bid.
   c. The lead partner and the other partners should together meet 100% of all the eligibility criteria required for the bid.
8. For the meeting the minimum qualification criteria of experience of similar nature work. Every partner can have experience of different works as defined in similar nature works and together should have the experience of all type of works described in similar nature works.

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 be 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	
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:

a) 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.

b) Self-Attested photocopies/scanned copies of all the relevant proof documents should be submitted in the physical bid as well as online bid.

Signature of Bidder with Seal

Date: _____

Annexure —I

See clause 14 of Section 2 -ITB)

Envelope — B

Technical Proposal

Technical Proposal shall comprise the following documents:

S.No.	Particulars	Details to be submitted
1	Experience — Financial & Physical	Annexure - I (Format: I-1)
2	Annual Turnover	Annexure - I (Format: I-2)
3	List of technical personnel for the key positions	Annexure - I (Format: I-3)
4	List of Key equipment's/ machines for quality control labs	Annexure - I (Format: I-4)
5	List of Key equipment's/ machines for construction work	Annexure - I (Format: I-5)

Note:

1. Technical Proposal should be uploaded duly page numbered and indexed.
2. Technical Proposal uploaded otherwise will not be considered.

Annexure - I (Format: I-1)

(See clause 14 of Section 2 -ITB)

FINANCIAL & PHYSICAL EXPERIENCE DETAILS

A. Financial Requirement:

The bidder should have completed either of the below:

i) three similar works, each costing not less than the amount equal to 20% of the probable amount of contract during the last 3 financial years; or

ii) two similar works, each costing not less than the amount equal to 30% of the probable amount of contract during the last 3 financial years; or

iii) one similar work of aggregate cost not less than the amount equal to 50% of the probable amount of contract in 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:

Execution of similar items bf work in any one 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 - I	Year - 2	Year - 3
I	Basement Construction			
2	Concrete work			
S.No	Particulars	Details		

.		Project Name	Quantity Executed	Year of Completion
1	Construction of underground structures in high water table areas			
2	Construction of Auditorium or large span building works			
3	Comprehensive construction contractsincluding Civil work, Interior finishing, all allied services such as Fire-fighting sprinkler system, HVAC and MEP and Landscaping			

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.

Annexure-I (Format: I-2)

(See clause 14 of Section 2 -ITB)

ANNUALTURN OVER

Requirement:

Average annual construction turnover on the construction works not less than 50% of the probable amount of contract during the last 3 financial years;

To be filled in by the contractor:

Financial Year	Payments received for contracts in progress or completed
I	
2	
3	

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=(1.5AX B) - C

Where

A. = Maximum value of civil engineering works executed in any one year during the last five year (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.

Annexure - I (Format: I-3)

(See clause 14 of Section 2-ITB & Clause 6 of GCC)

List of Technical Personnel for the Key Positions

Minimum requirement							**Available with the bidder**						
S.No.	Key Position	Minimum requirement	Qualification	Age	Similar work experience	Total Work Experience	S.No.	Name of Personnel	Key Position	Qualification	Age	Similar work experience	Total Work Experience
1.	**Project Manager**	1	B.E. Civil	below 65 years	10 Years	15 Years							
2.	**Site Engineer**	3	B.E. Civil	below 65 years	5 years	10 years							
3.	**Architect – 1 No**	1	B. Arch	below 65 years	3 years	5 years							
4.	**Quality Assurance Engineer- – 1 No**	1	B.E. Civil *with experience in QA/QC*	below 65 years	5 years	10 years							
5.	**Plant Engineer – 1 No**	1	B.E. Mech/ Diploma in Mech	below 65 years	5 years	10 years							
6.	**Quantity Surveyor**	2	B.E. Civil / Diploma Civil	below 65 years	5 years	10 years							
7.	**Soil & Material Engineer**	1	B.E. Civil / Diploma Civil	below 65 years	5 years	10 years							
	Total	10											

Annexure - I (Format: I-4)

(See clause 14 of Section 2-ITB)

List of Key Equipment's for Quality Control Labs

Minimum requirement			Available with the bidder	
S. No.	Name of Equipment/ Machinery	Quantity	Name of Equipment/ Machinery	Quantity
1.	Balances i) 7 Kg. To 10 Kg. Capacity. Semi-Self Indicating type-Accuracy 10 gm. ii) 500 gm. Capacity, Semi-Self indicating type-Accuracy 1 gm. iii) Pan Balance- 5 Kg. Capacity, Accuracy 10 gm	I set		
2	Ovens-Electrically operated, thermostatically controlled up to 110 G. Sensitivity 1C	I set		
3	Sieves: As per 15 460-1962. i) I.S. Sieves- 450 mm internal dia of sizes 100 mm, 80 mm, 63 mm. 50 mm, 40 mm, 25 mm, 20 nun, 12.5 mm, 10 mm, 6.3 mm. 4.75 mm complete with lid and pan. ii) IS Sieves- 200 mm internal dia. (brass frame)consisting of 2.36 mm, 1.18 mm, 600 microns, 425 microns, 300 microns, 212 microns, 150 microns, 90 microns, 75 microns with lid and pan.	I set		
4	Sieve shaker capable of 200 mm and 300 mm dia sieves, manually operated with timing switch assembly.	I set		
5	Equipment for slump test-Slump Cone, steel plate tamping rod, steel scale scoop	I set		
6	Dial gauges 25 mm travel- 0.01 mm/division. Least count	I set		
7	100 tones compression testing machine, electrical-cum manually operated.	I set		
8	Graduated measuring cylinders 200 ml capacity - 3 Nos.	I set		
9	Enamel trays (for efflorescence test for bricks) 1) 300mm X 250 mm X 40 mm - 2 Nos. ii. Circular plates of 250 mm dia - 4 Nos.	I set		

Annexure - I (Format: I-5)

(See clause 14 of Section 2-ITB)

List of Key Machines for Construction Work

Minimum requirement			**Available with the bidder**	
S. No.	Name of Equipment /Machinery	Quantity	Name of Equipment/ Machinery	Quantity
1	Concrete batching Plant with min capacity 30 cum/hr	1 no		
2	Concrete Mechanical Mixer With Hooper	3 nos		
3	Plate Vibrator	4 nos		
4	Diesel/Electric pin Vibrator	4 nos		
5	Fully well-equipped lab	1 nos		
6	Curing pump of 1.5 hp capacity with set of pipe	3 nos		
7	Steel centering plates/centering pipes	1000 sqm		
8	Auto label instrument	1 nos		

Annexure — J

(See clause 14 of Section 2 -ITB)

FINANCIAL BID

(To Be Contained in Envelope-C)

NAME OF WORK_____

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 / at par based on the Bill of Quantities and item 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 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 Jabalpur Smart City Limited 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 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" or "below" is not given by a bidder, his bid shall be treated as non-responsive.

iv. All duties, royalties, levies and taxes except Goods and Service Tax (GST) are included in the rates (in case of percentage rate bid quoted by the bidder.

Signature of Bidder

Name of Bidder

The above bid is hereby accepted by me on behalf of the Jabalpur Smart City Limiteddated the _____ day of _____ 20_____

Signature of Officer

by whom accepted

Annexure — K

(See clause 15 of Section 2 -ITB)

MATERIALS TO BE ISSUED BY THE DEPARTMENT

NIL

Annexure—L

(See clause 21 of Section 2 -ITB)

LETTER OF ACCEPTANCE (LOA)

No. _____ Dated: _____

To,

M/s._____

(Name and address of the contractor)

Subject: _____

(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 Jabalpur Smart City Limitedat your bided percentage _____ below/ above or at par the Bill of Quantities and item 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) (Rupees _____ in words only). The performance security shall be in the shape of term deposit receipt / bank guarantee of any nationalized / schedule commercial bank valid up to three 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 _____ months including/ excluding rainy season, shall be reckoned from the date 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

Executive Engineer

Annexure — M

(See clause 22 of Section 2 -ITB)

PERFORMANCE SECURITY

FORM OF BANK GUARANTEE

Performance Security/Additional Performance Security

The Executive Director,

Jabalapur Smart City Limited

Jabalpur

WHEREAS:

A. _____ [name and address of contractor] (hereinafter called the "Contractor") and Jablapur Smart City Limited, _____, (hereinafter called the "Employer") have entered into an agreement (hereinafter called the "Agreement") for the Construction of _____ in the state of Madhya Pradesh on online percentage rate (the "percentage rate") basis, subject to and in accordance with the provisions of the Agreement.

B. The Agreement requires the Contractor to furnish a Performance Security for due and faithful performance of its obligations, under and in accordance with the Agreement, during the {Construction Period/ Defects Liability Period and Maintenance Period} (as defined in the Agreement) in a sum of Rs….. cr. (Rupees …….. crore) (the "Guarantee Amount").

C. We, …….. through our branch at ……. (the "Bank") have agreed to furnish this bank guarantee (hereinafter called the "Guarantee") by way of Performance Security.

NOW, THEREFORE, the Bank hereby, unconditionally and irrevocably, guarantees and affirms as follows:

1. The Bank hereby unconditionally and irrevocably guarantees the due and faithful performance of the Contractor's obligations during the {Construction Period/ Defects Liability Period and Maintenance Period} under and in accordance with the Agreement, and agrees and undertakes to pay to the Employer, upon its mere first written demand, and without any demur, reservation, recourse, contest or protest, and without any reference to the Contractor, such sum or sums up to an aggregate sum of the Guarantee Amount as the Employer shall claim, without the Employer being required to prove or to show grounds or reasons for its demand and/or for the sum specified therein.
2. A letter from the Employer, under the hand of an officer not below the rank of Engineer in Charge in the Jabalpur Smart City Limited, that the Contractor has committed default in the due and faithful performance of all or any of its obligations under and in accordance with the Agreement shall be conclusive, final and binding on the Bank. The Bank further agrees that the Employer shall be the sole judge as to whether the Contractor is in default in due and faithful

performance of its obligations during and under the Agreement and its decision that the Contractor is in default shall be final and binding on the Bank, notwithstanding any differences between the Employer and the Contractor, or any dispute between them pending before any court, tribunal, arbitrators or any other employer or body, or by the discharge of the Contractor for any reason whatsoever.

3. In order to give effect to this Guarantee, the Employer shall be entitled to act as if the Bank were the principal debtor and any change in the constitution of the Contractor and/or the Bank, whether by their absorption with any other body or corporation or otherwise, shall not in any way or manner affect the liability or obligation of the Bank under this Guarantee.
4. It shall not be necessary, and the Bank hereby waives any necessity, for the Employer to proceed against the Contractor before presenting to the Bank its demand under this Guarantee.
5. The Employer shall have the liberty, without affecting in any manner the liability of the Bank under this Guarantee, to vary at any time, the terms and conditions of the Agreement or to extend the time or period for the compliance with, fulfillment and/ or performance of all or any of the obligations of the Contractor contained in the Agreement or to postpone for any time, and from time to time, any of the rights and powers exercisable by the Employer against the Contractor, and either to enforce or forbear from enforcing any of the terms and conditions contained in the Agreement and/or the securities available to the Employer, and the Bank shall not be released from its liability and obligation under these presents by any exercise by the Employer of the liberty with reference to the matters aforesaid or by reason of time being given to the Contractor or any other forbearance, indulgence, act or omission on the part of the Employer or of any other matter or thing whatsoever which under any law relating to sureties and guarantors would but for this provision have the effect of releasing the Bank from its liability and obligation under this Guarantee and the Bank hereby waives all of its rights under any such law.
6. This Guarantee is in addition to and not in substitution of any other guarantee or security now or which may hereafter be held by the Employer in respect of or relating to the Agreement or for the fulfillment, compliance and/or performance of all or any of the obligations of the Contractor under the Agreement.
7. Notwithstanding anything contained hereinbefore, the liability of the Bank under this Guarantee is restricted to the Guarantee Amount and thisGuarantee will remain in force for the period specified in paragraph 8 below and unless a demand or claim in writing is made by the Employer on the Bank under this Guarantee all rights of the Employer under this Guarantee shall be forfeited and the Bank shall be relieved from its liabilities hereunder.
8. The Guarantee shall cease to be in force and effect on ****$. Unless a demand or claim under this Guarantee is made in writing before expiry of the Guarantee, the Bank shall be discharged from its liabilities hereunder.
9. The Bank undertakes not to revoke this Guarantee during its currency, except with the previous express consent of the Employer in writing, and declares and warrants that it has the power to issue this Guarantee and the undersigned has full powers to do so on behalf of the Bank.
10. Any notice by way of request, demand or otherwise hereunder may be sent by post addressed to the Bank at its above referred branch, which shall be deemed to have been duly authorised to receive such notice and to effect payment thereof forthwith, and if sent by post it shall be deemed to have been given at the time when it ought to have been delivered in due course of post and in proving such notice, when given by post, it shall be sufficient to prove that the envelope containing the notice was posted and a certificate signed by an officer of the Employer that the envelope was so posted shall be conclusive.

11. This Guarantee shall come into force with immediate effect and shall remain in force and effect for up to the date specified in paragraph 8 above or until it is released earlier by the Employer pursuant to the provisions of the Agreement.
12. This guarantee shall also be operatable at our…… …….. Branch at Jablapur, from whom, confirmation regarding the issue of this guarantee or extension / renewal thereof shall be made available on demand. In the contingency of this guarantee being invoked and payment thereunder claimed, the said branch shall accept such invocation letter and make payment of amounts so demanded under the said invocation.

Signed and sealed this ……. day of ……., 20…… at …….

SIGNED, SEALED AND DELIVERED

For and on behalf of the Bank by:

(Signature)

(Name)

(Designation)

(Code Number)

(Address)

NOTES:

(i) The bank guarantee should contain the name, designation and code number of the officer(s) signing the guarantee.
(ii) The address, telephone number and other details of the head office of the Bank as well as of issuing branch should be mentioned on the covering letter of issuing branch.

SECTION 3

Conditions of Contract

Part - I General Conditions of Contract [GCC]

Table of Clauses of GCC

A. General

1. 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:

13. **Completion:** means completion of the work as certified bytheEngineer-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 of 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. Water Resources Department, Public Works Department, Public Health Engineering Department Rural Engineering Service and any other organization which adopts this document.

1.13. **Drawings:** means drawings including calculations and other information provided or approved by the Engineer-in-Charge.

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.

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 far 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, 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.

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.

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 construed 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. INTERPRETATIONS AND DOCUMENTS

2.1 Interpretations

In the contract, except where the context requires otherwise:

a. words indicating one gender include all genders;

b. Wards 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:

1. NIT with all amendments.
2. Instructions to Bidders (ITB, Bid Data Sheet with all Annexure's)
3. Conditions of Contract:
   i. Part I General Conditions of Contract and the Contract Data; with all Annexures
   ii. Part II Special Conditions of Contract.
4. Specifications
5. Drawings
6 Bill of Quantities
7. Technical and Financial Bid
8. Agreement, and
9. Any other document(s), as specified.

3. Language and Law

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

4. 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 immediately notified to Engineer-in-Charge.

5. Subcontracting

Subcontracting shall be permitted for contracts of value more than amount specified in the Contract Data with following conditions.

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 Contractors 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 G0MP.

6. Personnel

61 The Contractor shall employ for the construction work and routine maintenance the technical personnel as provided in the Annexure I-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 three days and has no further connection with the Works in the Contract.

7. Force Majeure

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

Which is beyond a Party's control,

Which such Party could not reasonably have provided against before entering into the Contract

Which, having arisen, such Party could not reasonably have avoided or overcome, and

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:

i. War, hostilities (whether war be declared or not), invasion, act of foreign enemies,

ii. Rebellion, terrorism, sabotage by persons other than the contractor's Personnel, revolution, insurrection, military or usurped power, or civil war,

iii. Riot, commotion, disorder, strike or lockout by persons other than the Contractor's Personnel,

iv. 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

v. 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 contact after holding mutual discussions.

8. 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, drawing, designs, other documents and/or information submitted by the contractor shall be the responsibility of the Contractor alone, notwithstanding the fact that the design/ drawings or other documents have been approved by the department.

9. Liability for Accidents to Person

The contractor shall be deemed to have indemnified and saved harmless the Corporation 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. 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. 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. 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 shall decide the matter within 45 days.

12.4 Appeal against the order of the Competent Authority can be preferred 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 preferred 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. **Programme**

13.1 Within the time stated in the Contract Data, the Contractor shall submit to the Engineer for approval a Programme 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 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 Programme.

13.3 An update of the Programme shall be a programme 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 Programme at intervals no longer than the period stated in the Contract Data. If the Contractor does not submit an updated Programme 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 Programme has been submitted.

13.5 The Engineer's approval of the Programme shall not alter the Contractor'sobligations.

14. 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.

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. 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 time lines mentioned in the Contract Data the Engineer-in-charge shall retain from the bills of the Contractor amount equal to the liquidated damages leviable 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. Contractor's quoted percentage

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

C. Quality Control

17. Tests

17.1 The Contractor shall be responsible for:

a. Carrying out the tests prescribed in specifications, and

b. 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 equipment's 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.

17.4 Ten percent of the mandatory test prescribed under the specification shall be got carried out through laboratories accredited by national Accreditation Board of laboratories (NABL) By the Engineer-in-charge and the cost of such testing shall be deducted from the payments due to contractor .

18. Correction of Defects noticed during the Defect Liability Period

18.1 The Defect Liability Period of work in the contract shall be as per the Contract Data.

18.2 The Contractor shall promptly rectify all defects pointed out by the Engineer well before the end of the Defect Liability Period. The Defect Liability 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 to the satisfaction of the Engineer, within the time specified by the Engineer, the Engineer will assess the cost of haying 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.

D. COST CONTROL

19. 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 adjusted in the proportion that the altered, additional or substituted work bears to the original contract work and the certificate of the Engineer-in-charge shall be conclusive as to such proportion.

20. Extra items

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

21. Payments for Variations and / or Extra Quantities

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 the irrespective 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 the department, the rate shall be arrived at by applying the quoted tender percentage on the SOR rate.

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 the percentage quoted by the contractor.

e. If the 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. 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. 'No Interest Payable

No interest shall be payable to the Contractor on any payment due or awarded by any authority.

24. 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. Tax -

25.1 The rates quoted by the contractor shall be deemed to be inclusive of all duties, levies and taxes except Goods and Services Tax (GST). The amount of applicable GST will be paid separately to contractor with each bill at the time of payment.

25.2 The liability, if any, on account of query fee, duties, and taxes (except GST) royalties and levies in respect of material consumed or services rendered on public works shall be borne 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. 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. 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

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 falls to comply with the notice to correct a particular defect within a reasonable period of time;

d) the Contractor does not maintain avalid 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 chargé 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. 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. 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. 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 The security deposit may be replaced by equivalent amount of bank guarantee or fixed deposit receipt assigned to the Employer, with validity up to 3 (three) months beyond the completion of Defect Liability Period/ extended Delectability Period.

30.3 The Security Deposit shall be refunded on completion of' Defect Liability Period.

31. Price Adjustment

31.1 Applicability

1. Price adjustment shall be applicable only if provided for in the Contract Data.
2. 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.
3. 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.
4. In the Force Majeure event the price escalation clause shall apply.

31.2 Procedure

1. Contract price shall be adjusted for increase or decrease in rates and price of labour, materials, fuels and lubricants in accordance with following principles and procedures and as per formula given in the contract data.
2. The price adjustable shall be determined during each quarter from the formula given in the contract data.
3. 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.
4. Weightages 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 fail 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. 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 deducing 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. 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 materials 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.

3.4 The Secured Advance paid shall be recovered as stated in the Contract Data.

34. 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 GCC.

E. Finishing the Contract

35. 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. 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. Currencies

All payments will be made in Indian Rupees.

38. 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. Compliance with Labour Regulations

39.1 During continuance of the Contract, the Contractor and his SubContractors 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 their under, 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. Audit and Technical Examination

Government/ JSCL 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 sun is found 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 Government/ JSCL 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 Government/ JSCL to the Contractor.

41. on seeking clarifications from bidders

a. JSCL, in its sole discretion and without incurring any obligation or liability, reserve the right to:

I. to consult with any Bidder in order to receive clarification or further information or documents as considered necessary by the JSCL;

II. retain and/or consider part of the tender any information and/or evidence submitted to JSCL by, on behalf of, and/ or in relation to any Bidder; and

III. Independently verify, disqualify, reject and/ or accept any and all submissions or other information and/or evidence submitted by or on behalf of any Bidder.

b. JSCL reserves the right to verify all statements, information and documents submitted by the Bidder in response to the Tender document. Failure of JSCL to undertake such verification shall not relieve the Bidder of its obligations or liabilities hereunder to submit true and correct information; nor will it affect any rights of JSCL.

c. Notwithstanding anything stated elsewhere in these documents, JSCL shall have the right to seek updated information from the Bidders to ensure their continued eligibility. Bidders shall provide evidence of their continued eligibility in a manner that is satisfactory to JSCL. A Bidder may be disqualified if it is determined by JSCL, at any stage of the tender Process, that the Bidder will be unable to fulfil the requirements of the Project or the Bidder fails to continue to satisfy the eligibility criteria. Supplementary information or documentation may be sought from Bidders at any time and must be provided within a reasonable timeframe as stipulated by JSCL.

42. Death or Permanent Invalidity of Contractor

If the Contractor is an individual or a proprietary concern, partnership concern, dies during the currency 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.

43. 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.

[End of GCC]

Contract Data

Clause reference	Particulars	Data
1.14	Employer	JABALPUR SMART CITY LIMITED
1.15	Engineer	Executive Engineer, JSCL
1.16	Engineer in Charge	Executive Engineer, JSCL
1.12	Stipulated period of completion	18 Months
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, email.	JABALPUR SMART CITY LIMITED, Manas Bhawan, Wright Town, Jabalpur
5	Subcontracting permitted for the Contract Value	More than Rs 100 Lakhs
6	Technical Personnel to be provided the contractor—requirement, &	As per Annexure - I (Format I-3)
	Penalty, if required Technical Personnel not employed	Rs thirty thousand per month for each Graduate Engineer and Rs eighteen thousand per month for each Diploma Engineer
10	Specifications	As per Annexure E
	Drawings	As per Annexure N
12	Competent Authority for deciding dispute under Dispute Resolution System	CEO, JSCL
	Appellate Authority for deciding dispute under Dispute Resolution System	Executive Director, JSCL
13	Period for submission of updated construction program	(a) Every 3 months or (b) at the end of every milestone, whichever is less
	Amount to be withheld for hot submitting construction program in prescribed period	a maximum of Rs. 50,000/- per month of delay
14	Competent Authority for granting Time Extension.	Executive Director, JSCL
15	Milestones laid down for the contract	Yes No
	If Yes, details of Milestones	As per Annexure - O
	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	a maximum of Rs. 50,000/- per month of delay

	Laboratory	
18	Defect Liability Period	3years (Three Year) to 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" 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: (a) deploydepartmental labour and material or (b) engage a contractor by issuing a work order at contract rate/SOR rate or (c)sanction supplementary work in an existing agreement to a contractor for zonal works or similar other work or (d) invite open tender or (e) combination of above
21	Competent Authority for determining the rate	As per book of financial power (updated)
27	Any other condition for breach of contract	Yes as below: If the contractor fails to achieve 50% financial progress in any milestone and /or fails to achieve 75% financial progress in two consecutive mile stones
28	Penalty	Penalty Shall include (a) Security deposit as per clause 30 of General 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	**Three months beyond** the completion of Defect Liability Period (Maintenance Guarantee Period) and Additional Performance guarantee valid up to stipulated time of completion plus three months
30	Security Deposit to be deducted from each running bill	At the rate of **5%** of Gross Amount of Running Bill

	Maximum limit of deduction of Security Deposit	Up to 5% of Final Contract Amount.
31	Price Adjustment formula and procedure to calculate	As per Annexure R and as below: (a) The price Adjustment shall apply only in respect of **Cement, Steel, Bitumen** and **POL** components.
32	32:1 Mobilization and Construction Machinery Advance Applicable	No Mobilization and Construction Machinery Advance payable .
	32.2 If yes, Unconditional Bank Guarantee	Not Applicable
	32.3 If yes, Rate of interest chargeable on advances	Not Applicable
	32.4 If yes, Type & Amount of Advance payment that can be paid	Not Applicable
	32.5 If yes, Recovery of advance payment	Not Applicable
33	33.1 secured Advance Applicable	Not Applicable
	33.2 if yes, Unconditional Bank Guarantee	Not Applicable
	33.2 if yes, Amount of Secured Advance :	Not Applicable
	33.3 if yes, Conditions for secured advance.	Not Applicable
	33.4 if yes, Recovery of Secured advance	Not Applicable
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
36	Competent Authority	CEO, JSCL
39	Salient features of some of the majorlabour laws that are applicable	As per Annexure - W
41	Competent Authority	Executive Engineer, JSCL

ANNEXURE—N

(See clause 10 of Section 3— GCC)

Drawings (Attached)

List of drawings

(a) SITE PLAN

(b) FLOOR PLAN LVL -1200

(c) FLOOR PLAN LVL +1300

(d) ELEVATIONS 1

(e) ELEVATIONS 2

(f) SECTIONS

(g) STRUCTURE: FOUNDATION PLAN

(h) PLINTH BEAM PLAN

(i) ROOF FRAMING PLAN

(j) ELECTRIC LAYOUT PLAN LVL -1200

(k) ELECTRIC LAYOUT PLAN LVL +1300

(l) SITE PLUMBING LAYOUT

(m) GREEN ROOF DETAIL

ANNEXURE—O

(See clause 15 of Section 3 -GCC)

Details of Milestones

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

ANNEXURE—P

(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 Superintending Engineer shall be final and binding upon both the parties.

Annexure – Q

(See clause 17 of Section 3 GCC)

List of Equipment for Quality Control Lab

As per Annexure I-4

ANNEXURE - R

(See clause 31 of Section 3 -GCC)

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	18%
2.	Steel -P_s	13%
3.	Bitumen –P_b	0%
4.	POL P_f	5%

* Weightages of various components of the work shall be as determined by the competent Technical authority.

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.

C_0= 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)

C_1= The all India average wholesale price Index for grey cement for the month under consideration as published by Ministry 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 $0.85 \times P_s \times /100 \times R \times (S_1-S_o)/S_o$

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

S_o = 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)

S_i= 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 bitumen component

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

V_b= $0.85xP_b/100xRx(B_I-B_0/B_o$

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

B_0= 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 = $0.85x\ P_f/100xRx(F_i—F_o)/F_o$

V_f= Increase or decrease in the cost of work during the month under consideration due to changes in rates for fuel and lubricant.

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 douse, the price of High Speed Diesel has been chosen to represent fuel and lubricants group.

Annexure - S

(See clause 32 of Section 3-GCC)

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 thereunder 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: _____

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

Annexure - T

(See clause 33 of Section 3 -GCC)

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 executive 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 authority 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 (thereceipt 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 be 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 were 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 utilize 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 repayable 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.

Annexure - U

(See clause 35 of Section 3 -GCC)

Physical Completion Certificate

Name of Work:

.....

.....

.....

Agreement No .....Date .....

Amount of Contract Rs .....

Name of Agency .....

Used MB No. .....

Last measurement recorded

a. Page No. & MB No. _____

b. 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

.....

.....

Annexure-V

(See clause 35 of Section 3-GCC)

Final Completion Certificate

Name of Work:

.....

.....

.....

Agreement no ..... Date .....

Name of Agency: .....

Used MB No. .....

Last measurement recorded

a: Page No. & MB No. _____

b. Date _____

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

Agreemented 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

.....

.....

Annexure - W

(See clause 39 of Section 3 -GCC)

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, Traveling 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 prescribedminimum (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.

SECTION 3

Conditions of Contract

Part — II Special Conditions of Contract [SCC]

Nil

LIST OF APPROVED MAKES OF MATERIALS

NOTE: CONTRACTORS SHALL QUOTE FOR THE 1ST MENTIONED SUPPLIER/MAKE FOR TENDERING, UNLESS APPROVED BY THE CLIENT/CONSULTANT

S.No.	ITEM	BRAND
1	Reinforcement	TATA, SAIL, JSW
2	Grey Cement (43 grade OPC)	Ambuja, ACC, Ultratech,
3	Structural Steel	SAIL/ TISCO
4	RMC	ACC, Ultratech, RMC India
5	M.S. Pipe, Tubes, Bar, Flats, Angle, Tee Sections	SAIL/ TISCO
6	Concrete admixture	Fosroc/ Cico.
7	Structural Sealant	Wacker, Dow Corning, GE
8	Polysulphide Sealant	Pidilite, Chemetall-Rai
9	Bitumen Impregnated Board	Shalitex or approved equivalent
10	Polyethylene back up rod	Supreme
11	PVC water stops	Fixopan/ Sintex
12	White Cement	Birla, J.K
13	Water Proofing Compound	CICO/ Pidilite/ Laticrete
14	UPVC Doors & Windows	Veka, Rehau,
15	Paints / (Putty)	Asian Paints, ICI Dulux, Nerolac / (Birla, Jk)
16	Water proof cement paint	Snowcem India Ltd.
17	Fire Retardant paint	Viper
18	Wax Polish	Mansion
19	Epoxy	Forsroc/ Laticrete/ Cico.

20	Glass	Pilkington, Saint Gobian, Asahi, Modi Guard
21	Toughened Glass	Pilkington, Saint Gobain, Asahi, GSC, Hindustan Safety Glass
22	Mirror	Modi Guard
23	Waterproof ply	Century, Green,
24	Commercial ply	Century, Green,
25	Veneer	Century, Green,
26	Laminate	Century, Green, Merino
27	Cement Bonded Board	BISON', Everest
28	Grid False ceiling	Armstrong
29	EPDM	Fire Stone
30	Hessian Based Felt	BITUMAT
31	Eucalyptus Timber for Door Frames	Navair, Shakti
32	Flush Door Shutter	Century, Green, Duro
33	Door Hardware	Assa abloy, Hafele, Hettich, Godrej, ,
34	Chequered Precast Cement Concrete Tiles	NITCO/ Nimco
35	Tiles	Nitco, Kajaria,
36	PVC strips	Fixopan
37	Geotextile Fabric	Netlon/ Ca Polyteck Pvt. Ltd.
38	Steel Fire Door	Assa Abloy, Navair, Met/ Promat
39	Non Metallic Fire Door	Navair/ Promat
40	Particle Board	Century, Merino,
41	MDF	NUWUD MDF grade I as per IS 12406/ Green Panelmax/ Bajaj Ecotec/ Duratuff
42	Screws, Nails etc.	Nettlefold
43	Pre-Laminated Board	Merino/ Green

44	Welding rod	ADVANI
45	Fire Door Hardware	Briton
46	Night Latche	Assa Abloy, Hafele, Godrej
47	Cupboard/ Wardrobe/ Drawer Lock	Assa Abloy, Hafele, Godrej
48	Hardner or acid resistant Coating	Fosroc/ Roffe
49	Acid resistant tiles	Granamite, Spartex
50	Tin oxide polishing	Surie Polex
51	Smooth Glazed ceramic tiles	NITCO/ Kajaria/
52	XPS	Supreme, Insuboard, BASF
53	LIFT & ESCALATORS	Schindler, Thyssen Krupp, Otis, Kone

PLUMBING WORKS

TECHNICAL CONDITIONS

SECTION – I SCOPE OF WORK

1.1 Work under this contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely furnish all the Plumbing and other specialized services as described hereinafter and as specified in the Schedule of Quantities and/or shown on the Plumbing Drawings.

1.2 Without restricting to the generality of the foregoing Sanitary installations shall include the following:

a) Sanitary Fixtures & CP Fittings (Providing & Fixing)

b) Soil, Waste, Rain Water and Vent Pipes.

c) Water Supply System (Cold Water & Hot Water supply system)

d) Sewerage, Storm Water Drainage System and Rain water harvesting system around the Building

END OF THE SECTION – I

SECTION – II SPECIAL CONDITIONS OF CONTRACT

1. GENERAL INSTRUCTIONS

1.1 All works specified in the tender have to be executed in accordance with:

a. The latest DSR & guidelines of CPWD specifications as maximum wherever possible.

b. The rules and regulations ofLocal Authority Having Jurisdiction, and as per the statutory regulations applicable.

c. Applicable norms laid down by the relevant sections of latest editions of National Building Code (NBC) and all relevant codes of Bureau of Indian Standards (B.I.S.) shall be followed as applicable.

d. The codes of the Uniform Plumbing Code of India and relevant British Standards shall be used as a general guide for good engineering practice, design and workmanship norms.

1.2 All materials used in the works shall have Bureau of Indian Standards valid certification stamped, marked or cast on the material in an acceptable and approved manner, as specified hereinafter.

1.3 It is the contractor's responsibility to ensure the competence of design to meet the above requirements.

a. Drawings issued with the tenders are schematic and indicate the concept. Contractor shall make his shop drawings on basis of Architectural and Interior design drawings issued by the Engineer-in-Charge. Work will be executed only as per approved shop drawings.

1.5 Quantities in the tender document are approximate worked out on the tender drawing issued.

1.6 Contractors are invited to highlight any aspects of the contract document that may need revision or reconsideration before the work is started. He must furnish details of any variations in the specifications or the quantities that may be necessary for him to comply with the Code and statutory requirements. These may be identified and approval of the Project managers taken before the start of the work.

1.7 Contractors shall furnish detailed Shop drawings, hydraulic and other design calculations for approval.

1.8 Work under this contract shall be carried out strictly in accordance with Specifications attached with the tender.

1.9 Items not covered under these Specifications due to any ambiguity or misprints, or additional works, the work shall be carried out as per Specifications of the latest Central Public Works Department with latest amendments as applicable in the contract.

1.10 The work shall be carried out strictly as specified in Schedule of Quantities and Technical Specifications. In case of any ambiguity, the details of particular item as given in Schedule of Quantities shall supersede the details in Specifications.

2. LICENSE AND PERMITS

2.1 Contractor must hold a valid Plumbing license issued by the Municipal Authority or other competent authority under whose jurisdiction the work falls.

2.2 Contractor must keep constant liaison with all relevant authorities and shall be responsible for obtaining all approvals relating to water supply, sewerage, storm-water drainage system including rainwater harvesting complete.

2.3 Contractor shall obtain No Objection Certificate before commencement of work, from the local authorities all related to his work as required for the building.

2.4 Contractor shall obtain, from the local authorities all related completion certificates with respect to his work as required for occupation of the building.

2.5 No additional charges other than official payment shall be payable to the contractor on getting NOC / completion certificate/Inspection fees. Unless it is obtained, the final payment of the contractor shall not be released.

3. METRIC CONVERSION

3.1 All dimensions and sizes of materials and equipment given in the tender document are commercial metric sizes.

3.2 Any weights, or sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

4. **REFERENCE POINTS**

4.1 Contractor shall provide permanent Bench Marks, Flag Tops and other reference points for the proper execution of work and these shall be preserved till the end of the work.

4.2 All such reference points shall be in relation to the levels and locations given in the Architectural and Plumbing drawings.

5. **DRAWINGS ISSUED TO CONTRACTOR**

5.1 Service drawings are diagrammatic but shall be followed as closely as actual construction permits. Any deviations made shall be in conformity with the Architectural and other services drawings.

5.2 Architectural drawings shall take precedence over Plumbing or other services drawings as to all dimensions.

5.3 Contractor shall verify all dimensions at site and bring to the notice of the Architects, all discrepancies or deviations noticed. Architects decision shall be final.

5.4 Large size details and manufacturers dimensions for materials to be incorporated shall take precedence over small-scale drawings.

5.5 All drawings supplied with the tender shall be returned in good conditions along with the tender.

5.6 All drawings/sketches issued by the Architects/Consultant for the works are the property of the Architects/Consultant and shall not be lent, reproduced or used on any works other than intended without the written permission of the Architects/Consultant.

5.7 The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site.

All corrections, 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 initialed by the Engineer-In-Charge /Owner.

6. **SHOP DRAWINGS**

6.1 The Contractor shall submit to the Consultant two copies of Shop Drawings for Plumbing works as an Advance Copy to the Engineer-in-Charge for approval before start of work. Subsequent to the approval of the shop drawings, the Contractor shall submit seven copies of Shop Drawings for execution to the Engineer-in-Charge. The Contractor shall also submit four copies of the Technical Specifications and Catalogues for all items, including pump curves, single line diagrams etc. as relevant.

a. All Sanitary Engineering drawings issued to the Contractor shall be studied by them. Contractor shall also obtain the necessary architectural, structural and other services drawings, based on which they shall prepare their shop drawings as per site conditions.

b. Shop drawings shall incorporate the following:

(a) All proposed Structural supports/hanging/laying and jointing details for all types of pipes as required.

(b) Typical details for Toilets & Fixtures required.

(a) Plumbing layout plans as required and for any changes in the layout of Plumbing/ Architectural Drawings.

(b) Equipment & piping layout for Mechanical and Electrical equipments as required, SLDs, mounting details of circuit breakers, location of panels, installation of terminals and faucets etc. w.r.t. finishes, surrounding levels & locations.

(c) Manufacturer's and Contractor's fabrication drawings

6.4 The Contractor can only commence the work after the approval of above documents by Project Manager/ Consultant.

6.5 Contractors shall ensure that the Shop drawings are approved by the Engineer-In-Charge / Owner / Consultant prior to any execution.

7. COMPLETION DRAWINGS & DOCUMENTS

7.1 On completion of work contractor shall submit one complete set of original tracings and two prints of "As Built" drawings for the Engineer-In-Charge. These drawings shall have the following information.

(a) Run of all pipes with diameters and length on all floors and vertical stacks.

(b) Ground and Invert levels of all Plumbing services pipes.

(c) Location of all valves.

(d) Location of all Mechanical equipment with layout and piping connection.

7.2 Contractor shall provide four sets of Test Certificate, Routine Type Test certificates for Motors, Dynamic balancing certificate for Impellers, Calibration certificate for instrument catalogues, Operation and Maintenance Manuals, performance data and list of spare parts supplied together with the name and address of the Manufacturers for all Mechanical and Electrical equipments provided by him in the form of a Book or Manual.

7.3 All "Warranty / Guarantee" cards / certificates in original issued by the manufacturers shall be handed over to the Engineer-In-charge also in the form of a comprehensive record book / documents.

8. MATERIALS (SUPPLIED BY THE CONTRACTOR)

8.1 All materials used in the works shall conform to the tender specifications.

8.2 As far as possible all materials shall be bearing I.S. certification marks as per approval of the Engineer-In-Charge.

8.3 All materials shall bear the necessary certification marks, conforming to the Tender Specifications / BOQ / Drawings requirements.

8.4 Unless otherwise specified and expressly approved in writing by the Engineer-In-Charge, materials of makes and specifications mentioned with tender shall be used.

9. INSPECTION AND TESTING OF MATERIALS

9.1 All materials before being allowed to be brought into the store will be preliminary / visually inspected at the entry gate of the project site before the security personnel. All materials shall be inspected by the Engineer-In-charge / Owner before receiving. This inspection will be conducted with the help of the quality approval format as prepared by the Clients.

9.2 Contractor shall be required, if requested, to produce manufacturers Test Certificate for the particular batch of materials supplied to him. The tests carried out shall be as per the relevant Indian Standards.

9.3 For examination and testing of materials and works at the site Contractor shall provide all Testing and Gauging Equipment necessary but not limited to the followings:-

18 Theodolite
19 Dumpy level
20 Steel tapes
21 Weighing machine
22 Plumb bobs, Spirit levels, Hammers
23 Micrometers
24 Thermometers, Stoves
25 Hydraulic test machine
26 Smoke test machine

9.4 All such equipment shall be tested for calibration at any approved laboratory, and the test and calibration certificate shall be submitted to the Engineer-In-Charge / Owner.

9.5 All Testing Equipment shall be preferably located in special room meant for the purpose.

10. **MATERIALS SUPPLIED BY THE OWNER**

10.1 The Contractor shall verify that all materials supplied by the Owner conform to the specifications of the relevant item in the tender. Any discrepancy found shall be brought to the notice of the Engineer-In-Charge.

10.2 After receipt of materials, it shall be the responsibility of the Contractor for any damage found and he shall be liable to pay the actual cost of the material as per market rate at that time.

11. **RECOVERY OF COST FOR MATERIALS ISSUED TO CONTRACTORS FREE OF COST**

If any materials issued to the Contractor, free of cost, are damaged or pilfered, the cost of the same shall be recovered from the Contractor on the basis of actual cost to the Owner which shall include all freight and transportation, excise duty, sales tax, octroi, import duty etc. or the actual cost given by the Owner shall be final and binding on the Contractor.

12. **CONTRACTORS RATES**

12.1 Rates quoted in this tender shall be inclusive of cost of materials, labor, supervision, erection, tools, plant, scaffolding, service connections, transport to site, taxes, octroi and levies, breakage, wastage, sales tax on works contract and all such expenses as may be necessary and required to completely do all the items of work and put them in a working condition.

12.2 Rates quoted are for all heights and depths required for this work.

12.3 All rates quoted must be for complete items inclusive of all such accessories, Fixtures and fixing arrangements, nuts, bolts, hangers as are a standard part of the particular item except where specially mentioned otherwise.

12.4 All rates quoted are inclusive of cutting holes and chases in walls and floors and making good the same with cement mortar/concrete of appropriate mix and strength as directed by Engineer-In-Charge. Contractor shall provide holes, sleeves and recesses in the concrete and masonry work as the work proceeds.

12.5 Rates quoted shall be inclusive of cost incurred in testing, commissioning of works and materials.

12.6 The items not covered in BOQ shall be paid extra after getting the approval from Engineer-In-Charge / Owner. The rate analysis considering Cost Price, Labor, 10% (Ten percent) along with supporting documents / bills etc., shall be submitted to Engineer-In-Charge / Owner for approval.

13. **MOCK UP AND TRIAL ASSEMBLY**

The installation of Sanitary Fixtures and fittings shall be as per the shop drawings approved by Architect / Consultant.

The Contractor shall have to assemble at least one set of each type of Sanitary Fixtures and Fittings in order to determine precisely the required supply and disposal connections. Relevant instructions from manufacturers shall be followed as applicable. This trial assembly shall be developed to determine the location of puncture holes, holding devices etc, which will be required for final installation of all Sanitary fixtures and fittings. The above assembly shall be subject to final approval by the Architect / interior designers.

The Fixtures in the trial assembly can be reused for final installation without any additional payments for fixing or dismantling of the fixtures.

14. **EXECUTION OF WORK**

14.1 The work shall be carried out in conformity with the Plumbing drawings and within the requirements of Architectural, HVAC, Electrical, Structural / GreenBuilding consultant and other specialized services drawings.

14.2 The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction programme.

14.3. On award of the work, Contractor shall submit a programme of construction in the form of a Pert Chart or Bar Chart for approval of the Engineer-In-Charge / Owner. All dates and time schedule agreed upon should be strictly adhered to, within the stipulated time of completion/commissioning along with the specified phasing, if any.

14.4 Contractor shall be responsible for co-ordination with other agencies working on the project relating to their scope of work and shall take approval from the Engineer-In-Charge / Owner wherever required.

14.5 **Cutting & Making Good**

No structural member shall be chased or cut without the written permission of the Engineer-In-Charge.

15. **TESTING**

15.1 Piping and drainage works shall be tested as specified under the relevant clauses of the specifications.

15.2 Tests shall be performed in the presence of the Engineer-In-Charge / Consultant.

15.3 All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.

15.4 Contractor shall perform all such tests as may be necessary and required by the local authorities to meet Municipal or other by-laws in force.

15.5 Contractor shall provide all labour, equipment and materials for the performance of the tests.

15.6 Contractor shall afford all the expenses for the offsite testing of material and equipments.

15.7 All appliances, fixtures and fittings shall be tested before and after installation. Water seals of all appliances shall be tested. The Contractor shall block the ends of waste and ventilation pipes and shall conduct air test.

16. SITE CLEARANCE AND CLEANUP

16.1 The Contractor shall, from time to time clear away all debris and excess materials accumulated at the site.

16.2 After the Fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints stains, stickers and other foreign matter of discoloration leaving the same in a ready to use condition.

16.3 On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done at Contractors risk and cost.

17. FINAL INSTALLATION

The Contractor shall install all Sanitary fixtures and fittings in their final position in accordance with the approved trial assemblies and as shown on the Drawings. The installation shall be complete with all supply and waste connections. The connection between building and piping system and the sanitary fixtures shall be through proper unions and flanges to facilitate removal / replacement of Sanitary Fixtures without disturbing the built in piping system. All unions and flanges shall match in appearance with other exposed fittings.

Fixtures shall be mounted rigid, plumb and true to alignment. The outlet of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting and the receiving pipes before making the joint. It shall be ensured that the receiving pipes are clear of obstruction. When Fixtures are being mounted, attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other appliances.

18. PROTECTION AGAINST DAMAGE

The Contractor shall take every precaution to protect all Sanitary fixtures against damage, misuse, cracking, staining, breakage and pilferage by providing proper wrapping and locking arrangement till the completion of the installation and handling over. At the time of handling over, the Contractor shall clean, disinfect and polish all the fixtures and fittings. Any Fixtures found damped, cracked, clipped, strained or scratched shall be removed and new fixtures and fittings free from defects shall be installed at his own cost to complete the work.

19. GUARANTEE / WARRANTY

19.1 The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.

19.2 The form of warranty shall be as approved by the Engineer-in-charge.

19.3 The warranty shall be valid for a period of one year from the date of commissioning and handing over.

19.4 The warranty shall expressly include replacement of all defective or under capacity equipment. Engineer-in-charge may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.

19.5 The warranty shall include replacement of any equipment found to have capacity lesser than the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Engineer-in-charge.

19.6 The contractor shall include in his rates the operation of all mechanical equipment for a period of one month from the date of commissioning. No separate payment will be made on this account.

END OF THE SECTION - II

TECHNICAL SPECIFICATIONS

SECTION - I SANITARY FIXTURES

1. SCOPE OF WORK

1.1 Work under this section shall consist of furnishing all Material and labour as necessary and required to completely install all Sanitary Fixtures, brass and chromium plated fittings and accessories as required by the drawings and specified hereinafter or given in the Schedule of Quantities.

1.2 Without restricting to the generally of the foregoing the Sanitary Fixtures shall include all Sanitary Fixtures, C.P. fittings and Accessories etc. necessary and required for the Building.

1.3 Whether specifically mentioned or not all Fixtures and appliances shall be provided with all fixing devices, nuts, bolts, screws, hangers as required.

2. GENERAL REQUIREMENTS

2.1 All Fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Schedule of Quantities, Specifications and Drawings.

2.2 All Fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Architectural/ Interior designer's requirements. Wherever necessary the fittings shall be centered to dimensions and pattern desired.

2.3 Fixing screws shall be half round head Chromium Plated brass with C.P. washers wherever required as per directions of Engineer-in-Charge / Owner.

2.4 All Fittings and Fixtures shall be fixed in a neat workmanlike manner true to Levels and Heights shown on the drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all Inlet and Outlet Pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling or terrace shall be made good at Contractors cost.

a. When directed, Contractor shall install Fixtures and accessories in a mock-up room for the approval of the Engineer-in-Charge/Owner. Sample room Fixtures may be reused on the works if undamaged, but no additional payment for fixing or dismantling shall be admissible.

3. EUROPEAN W.C.

Water closets shall be of white vitreous chain conforming to IS 2556 (Part-1) and 2556 (Part-2), as specified and shall be of 'Wash down type". The closets shall be either of the two patterns (Pattern I & Pattern II) and sizes as specified. The closets shall be of one piece construction. Each water closet shall have not less than two holes having a minimum diameter of 6.5 mm for fixing to floor and shall have an integral flushing rim of suitable type.

It shall also have an inlet or supply horn for connecting the flushing pipe of dimensions. The flushing rim may be boxed or open type. In the case of box rims adequate number of holes, on each side together with a slot opposite the inlet shall be provided. The flushing rim and inlet shall be of the self draining type. The water closet shall have a weep hole at the flushing inlet. Each water closet shall have an integral trap with either 'S' or 'P' outlet with a least 50mm water seal. For P trap, the slope of the outlet shall be 14 deg. Below the horizontal.

Where required the water closet shall have an antisiphonage 50mm dia vent horn on the outlet side of the trap with dimension conforming to those on either right or left hand or centre as specified set at an angle of 45 deg and invert of vent hole not below the central line of the outlet. The inside surface of water closets and traps shall be uniform and smooth in order to enable an efficient flush.

The serrated part of the outlet shall not be glazed externally. The water closet, when sealed at the bottom of the trap in line with the back plate, shall be capable of holding not less than 15 litres of water between the normal water level and the highest possible water level of the water closet as installed.

4. **FLUSHING CISTERN**

The cistern shall be fixed on C.I. cantilever brackets which shall be firmly embedded in the wall in cement concrete (1:2:4) block 100 x75 x 150 mm. Connection between cistern and closet shall be made by means of 40 mm dia flush bend with rubber of G.I. inlet connection as specified.

CP Brass stop cock shall be provided for cistern having a capacity of more than 5 litre.
The main & distribution flush pipe shall be fixed to the wall by means of standard pattern holder bat clamp.

Painting
The brackets shall be painted, if specified, with two or more coats of paint of approved shade and quality.

Measurements
Cistern, including all fittings, shall be measured in numbers.

5. URINALS

Bowl Type Urinals:

Urinal basins shall be of flat back or corner wall type lipped infront. These shall be of white vitreous china conforming to IS 2556-(Part 6.). The urinals shall of one piece construction. Each urinal shall be provided with not less than two fixing holes of minimum dia 6.5 mm on each side.

Each urinal shall have an integral flushing rim of suitable type and inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self draining type. It shall have a weep hole at the flushing inlet of the
urinals.

At the bottom of the urinal an outlet horn for connecting to an outlet pipe shall be provided. The exterior of the outlet horn shall not be glazed and the surface shall be provided with grooves at right angles to the axis of the outlet to facilitate fixing to the outlet pipe. The inside surface of the urinal shall be uniform and smooth throughout to ensure efficient flushing. The bottom of pan shall have sufficient slope from the front towards the outlet such that there is efficient draining.

Half Stall Urinals:

They shall be of white vitreous China conforming to IS 2556 (Part 6). They shall be of one piece construction with or without an integral flushing box rim and provided with slots or alternative fixing arrangement at the flat back end.

They shall be provided with ridges where integral flushing rim is not provided in the sides of the interior of the bowl, to divert the water toward the front line of the urinal where integral flushing box rim is specified, water spreaders provided shall conform to IS 2556 Part-6. These shall be vitreous China of one piece construction with integral flush inlet. The tolerance of ± 4 per cent may be allowed on the

dimensions specified.

Urinal Partition Slabs

Urinal Partition slabs shall be provided, as specified in the item of work.

Squatting plate urinal

The plates shall be of white vitreous china conforming to IS 2556 (Part-1) and IS 2556 (Part-6) with internal flushing rim with front or side inlet. Squatting Plate shall be of one piece construction. Each urinal shall have integral longitudinal flushing pipe of suitable type which may be connected to flush pipe. These shall be 100 mm dia white glazed vitreious china channel with stop and outlet piece in front.

Installation of urinals

Urinal installation shall consist of a lipped urinal (Single or range), an automatic flushing cistern, G.I. flush and waste pipe.

Waste pipe shall be of 32 mm nominal bore G.I. pipe and shall be paid separately.

Urinals shall be fixed in position by using wooden plugs and screws. It shall be at a height of 65 cm from the standing level to the top of the lip of the urinal, unless otherwise directed by the Engineer-in-Charge. The size of wooden plugs shall be 50 mm x 50 mm at base tapering to 38 mm x 38 mm at top and of length 5.0 cms. These shall be fixed in the wall in cement mortar 1:3 (1cement: 3 fine sand). After the plug fixed in the wall, the mortar shall be cured till it is set.

6. Wash Basins

Wash basins shall be of white vitreous china conforming to IS 2556 (Part-1) nd IS 2556 (Part-4). Wash basins either of flat back or angle back as specified shall be of one piece construction, including a combined overflow. All internal angles shall be designed so as to facilitate cleaning. Each basin shall have a rim or all sides, except sides in contact with the walls and shall have a skirting at the back. Basins shall be provided with single or double tap holes as specified.

The tap holes shall be 28 mm square or 30 mm round or 25 mm round for pop up hole. A suitable tap hole button shall be supplied if one tap hole is not required in installation. Each basin shall have circular waste hole to which the interior of basin shall drain. The waste hole shall be either rebated or beveled internally with dia meter of 65 mm at top. Each basin shall be provided with a non-ferrous 32 mm waste fitting.

Stud slots to receive the brackets on the underside of the wash basin shall be suitable for a bracket with stud not exceeding 13 mm dia meter, 5 mm high and 305 mm from the back of basin to the centre of the stud. The stud slots shall be of depth sufficient to take 5 mm stud. Every basin shall have an integral soap holder recess or recesses, which shall fully drain into the bowl. A slot type of overflow having an area of not less than 5 sq.cm shall be provided and shall be so designed as to facilitate cleaning of the overflow.

Where oval shape or round shape wash basins are required to be fixed these shall be fixed preferably in RCC platform with local available stone topping either fully sunk in stone top or top flush with the stone topping as directed by Engineer-in-Charge.

The wash basins shall be one of the following patterns and sizes as specified
(a) Flat back: 660 x 460 mm (Surgeon's Basin)
630 x 450 mm
550 x 400 mm

450 x 300 mm
(b) Angle back : 600 x 480 mm
400 x 400 mm

White glazed pedestals for wash basins, where specified shall be provided. The quality of the glazing of the pedestal shall be exactly the same as that of the basin along with which it is to be installed. It shall be completely recessed at the back to accommodate supply and waste pipes and fittings. It shall be capable of supporting the basin rigidly and adequately and shall be so designed as to make the height from the floor to top of the rim of basin 75 to 80 cm. All the waste fittings shall be brass chromium plated, or as specified.

5. SINKS

Laboratory sinks and kitchen sinks shall be of white glazed fire clay conforming to IS 771 (Part-2) with upto date amendments. The kitchen sink shall be of one piece construction with or without rim but without overflow. Stainless steel kitchen sink shall be of sizes as specified and shall be conforming to IS: 13983.

The installation shall consist of assembly of sink C.I. brackets, union and G.I. or P.V.C. waste pipe.

The sink shall be supported on C.I. cantilever brackets, embedded in cement concrete (1:2:4) block of size 100 x 75x 150 mm. Brackets shall be fixed in position before the dado work is done. The C.P. brass or P.V.C. union shall be connected to 40 mm nominal bore G.I. or PVC waste pipe which shall be suitably bend towards the wall and shall discharge into a floor trap. C.P. brass trap and union and waste shall be paid separately. The height of front edge of sink from the floor level shall be 80 cm.

The sinks shall be measured in numbers.

6. SHOWER SET

6.1 The shower rose shall be of chromium plated brass of specified diameter. It shall have uniform perforations. The inlet size shall be 15 mm or 20 mm as required.

7. ACCESSORIES

Other accessories which shall be catered for, are as under:-

(a) Back up pump of rigid and flexible pipes of varying lengths of similar rating/specifications

(b) Curved sections of rigid pipes

(c) Swivel joints and rotary distributors

(d) Pin and gate valves to prevent back flow in pipe lines

(e) Switch valves to direct the flow into another pipe line

(f) Connection devices to fill forms from the bottom up

(g) Splints, rollers, and other devices for protection of conduit over rock concrete Reinforcing steel
and form and to provide lifting and lashing points in the pipe line.

(h) Transitions for connecting different sizes of pipe sections

(i) Air vents for downward pumping.

(j) Clean out equipment.

8. URINAL PARTITIONS

8.1 Urinal partitions shall be white glazed vitreous china or 25mm thick marble of size specified in the Schedule of Quantities.

8.2 Porcelain partitions shall be fixed at proper heights with C.P. brass bolts, anchor fasteners and M.S. clips as recommended by the manufacturer and directed by Engineer-in-Charge / Owner.

9. EWC PAN CONNECTOR

The EWC pan connector shall be Flexible, soft and shall be made of single body construction with integral fins. The pan connector must be supplied with factory fitted spring loaded seal guard.

While fixing of the pan connector with the Soil pipe, the pipe must be reasonably clean and smooth on the inner surface; in case the soil piping is in C.I. then supplier supplied bush / adaptor shall be used. The connector socket is pushed fully home onto the pan spigot, thereafter the WC is placed in position gently pushing the fitment to ensure that the connector end fits into the Spigot of the pipe. The pan connector must be pushed in such a easy as to ensure that the seals and fins turn inward to ensure proper sealing.

10. MEASUREMENT

10.1 Rates for fixing of Sanitary Fixtures Accessories, urinal partitions shall include all items and operations stated in the respective specifications and Schedule of Quantities and nothing extra is payable.

10.2 Rates for all items under specifications above shall be inclusive of cutting holes and chases and making good the same, C.P. screws, nuts, bolts and any fixing arrangements required and recommended by Manufacturers, Testing and Commissioning.

10.3 Payment shall be made as per approved BOQ quantity and Rates.

END OF SECTION – I

SECTION - II SOIL, WASTE & VENT PIPES

1. SCOPE OF WORK

1.1 Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes as required by the drawings, specified hereinafter and given in the Schedule of Quantities.

1.2 Without restricting to the generally of the foregoing, the soil, waste, vent and rainwater pipes system shall include the followings:

(i) Vertical and horizontal Soil, Waste and Vent Pipes, Rainwater Pipes and Fittings, Joints Clamps and connections to Fixtures.

(ii) Connection of pipes to Gully Traps & Manholes etc.

2. GENERAL REQUIREMENTS

2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-in-Charge / Owner.

2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

2.3 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

2.4 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

2.5 Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

2.6 All works shall be executed as directed by Engineer-in-Charge / Owner.

3. CAST IRON PIPES & FITTINGS (IS:3989)

3.1 Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories shall conform to IS 3989.

3.2 The fittings shall conform to the same I.S. specifications to which the pipe itself conforms in which they are connected.

3.3 The pipes shall have spigot and socket ends, with head on spigot end in case of sand cast iron pipes and without head on spigot end in case iron (Spun) pipes. The pipes and fittings shall be true to shapes, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. They shall be sound and shall be free from cracks, taps, pinholes and other imperfections and shall be neatly dressed and carefully fettled. All pipes and fittings shall ring clearly when struck with a light hand hammer.

3.4 The ends of pipes and fittings shall be reasonably square to their axis. The sand cast iron pipes shall be 1.5/1.8/2.0 metre in length including socket ends, cast iron (Spun) pipes shall be 1.5/1.75/2.0/2.5/3.0 metre in length excluding socket ends, unless shorter lengths are either specified or required at junctions etc. The pipe and fittings shall be supplied without ears, unless specified or directed otherwise.

3.5 All pipes and fittings shall be coated internally and externally with the same material at the factory, the fitting being preheated prior to total immersion in a bath containing a uniformly heated composition having a tar or other suitable base. The coating material shall have good adherence and shall not scale off.

36 In all instances where the coating material has tar or similar base it shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 77 degree centigrade but not so brittle at a temperature of 0 degree centigrade as to chip off when scribed lightly with a pen knife.

3.7 The standard weights and thicknesses of pipes and their tolerances shall be as mentioned below.

3.8 STANDARD WEIGHTS AND THICKNESS OF C.I. PIPES 3989

Nominal dia (mm)	Thickness (mm)	Overall Weight in Kg. for an effective length in metres of				
		3.000	2.500	2.000	1.800	1.500
50	3.5	13.40	11.3	9.2	8.4	7.1
75	3.5	20.0	16.8	13.8	12.5	10.6
100	4.0	30.0	25.5	21.0	18.8	16.0
150	5.0	56.0	47.0	38.5	34.9	29.5

3.9 **Lead Joints**

3.9.1 Pig Lead-Pig lead should be of uniform quality, clean and free from foreign materials. It shall be of uniform softness and capable of being easily caulked or driven. It shall conform to IS: 782 for caulking lead in all respects.

3.9.2 The quantity of lead and spun yarn required for different sizes of C.I. pipes are as below:

Diameter	Lead per joint	Depth of Lead Joint	Yarn per joint
Mm	Kg	mm	Kg
80	1.8	45	0.10
100	2.2	45	0.18
125	2.6	45	0.2
150	3.4	50	0.22
200	5.0	50	0.3
250	6.1	50	0.35
300	7.2	55	0.48
350	8.4	55	0.60
400	9.5	55	0.75
450	14	55	0.95
500	15	60	1
600	19	60	1.2
700	22	60	1.35
750	25	60	1.45
800	31.5	65	1.53
900	35	65	1.88
1000	41	65	2.05

3.9.3. Lead shall be heated in a melting pot kept in easy reach of the joint to be poured so that the molten metal will not be chilled in being carried from the melting pot to the joint and shall be brought to a proper temperature so that when stirred it will show a rapid change of colour.

3.9.4 Before pouring, all scum shall be removed. Each joint shall be made with one continuous pour filling of the entire joint space with solid lead. Spongy or imperfectly filled joints shall be burnt out and repoured.

3.9.5 The joint runner shall fit snugly against the face of the socket and the outside of the pipe shall be dammed with clay to form a pouring lip to provide for filling the joint flush with the face and to the top of the socket.

3.9.6 The common form of joint is made by first caulking in spun yarn, then filling the remainder of the joint space by running in molten lead, taking care that no dross enters the joint, and then thoroughly caulking the lead. The lead need not extend into the joint further than the back of the groove formed in the socket.

3.9.7 The spun yarn is used to centre the spigot in the socket, to prevent the flow of molten lead into the bore of the pipe, to reduce the amount of lead required to complete the joint to make the joint watertight, Spun yarn may become infected with bacteria, which may contaminate the water and, therefore, shall be effectively disinfected before use.

3.9.8 Caulking may be done with pneumatic tools or with a hand hammer weighing not less than 2 kg. When working with lead wool, it is very important to use caulking tools of appropriate thickness to fill the joint space, and to thoroughly consolidate the material from the pack to the front of the socket. Lead run joints shall be preferably finished 3 mm behind the socket face.

3.10 Detection of Cracks in Pipes :

3.10.1 The pipe and fittings shall be inspected for defects and be rung with a light hammer preferably while suspended to detect cracks. Smearing the outside with chalk dust helps the location of cracks. If doubt persists further confirmation may be obtained by pouring a little kerosene on the inside of the pipe at the suspected spot; if a crack is present the kerosene seeps through and shows on the outer surface.

3.10.2 If a pipe is mishandled either accidentally or due to carelessness during unloading or lowering it should be thoroughly inspected before laying and should be rejected if found unsuitable.

3.11 **Drip seal Jointing**

CI pipes shall be jointed with synthetic sealing compounds (drip seal compound) of approved make.

The sealant shall be manufactured in two separate compounds of different colors “Black” and “White”, and used for jointing of C.I. in place of lead joints, as per approval of the engineer-in-Charge / Owner. The sealant compound shall be of approved make and manufacturer.

The compound shall have high bonding strength and shall be non-toxic. The specified density shall be 1.95 grams / c.c. or as per approved manufacturer specifications.

The two separate compounds shall be mixed homogeneously from the supplied packets. In cold conditions both unmixed packets are to be heated in Sun or heated to room temperature (25^0 C) to make them more workable for mixing. The pipe joint is cleaned to make it free from dust, grease, oil, cement splashes and all other foreign matters and contaminants. The joint shall be made dry. Hemp yarn shall be provided in pipe joint as back filler. The mixed compound is to be forced into the lap of pipe joint with Caulking tool, MS Flat piece or by Hand.

Proper pressing of compound is necessary to avoid air entrapment. The joint is not to be disturbed till the compound is hardened.

The mixed compound shall not be kept without use for more than 30 to 40 minutes. The expiry date of the material shall also be checked before use and in case of expiry of material, the lot shall be rejected.

The compound shall be allowed to cure at room temperature with a setting time of 4 to 6 hours.

Consumption of mixed compound shall be as per the following table:

Diameter of pipe (mm)	Consumption per joint (grams)
50	130 to 150
80	150 to 170
100	200 to 250
150	250 to 300

To ensure proper quantity of compound used in to the joint, three samples shall be made and the quantum of compound per joint shall be approved by the Engineer-in-Charge / Owner. The actual consumption should be within ± 5% of the approved samples.

5. UPVC PIPES (I.S. 4985)

5.1 4/6/10 kg/cm2 Class selection shall be as per Bill of Quantities.

All fittings for uPVC pipes up to 200 mm O.D. size shall be injections moulded as per manufacturer, confirming to IS: 4985 and as specified in bill of quantities.

5.2 For Fittings of sizes which are not injection moulded but fabricated (Locally/ Imported) sample of the same shall be submitted for approval.

6. CILA PIPES & FITTINGS

The spun iron pipes shall conform to IS 1536. The spun iron pipes shall be of cast iron cast centrifugally and vary in diameters from 80 mm to 1050 mm. These shall be of class LA, class A and class B, as specified. Pipes shall be tested hydrostatically at the pressure as specified in the following table. Tolerances on specified dimensions shall be as prescribed in Appendix A.

Specials: The specials shall conform to IS 1538. The hydraulic test pressure of each class shall be as follows.

Hydrostatic Test pressure for centrifugally cast socket & spigot pipes in MPa		
Hydrostatic Test pressure for work in MPa		
Class	Upto DN 600	DN 700 & above
LA	3.5	1.5
A	3.5	2.0
B	3.5	2.5

Hydrostatic Test pressure for centrifugally cast pipes with screwed on flanges in MPa		
Class	Upto DN 600	DN 700 & above
B	2.5	1.6

Hydrostatic Test pressure for fittings in MPa (N/mm^2) (metre head)		
Nominal – Diameter	Fitting without branches or with branches not greater than half the principal diameter	Fitting with branches greater than half the principal Diameter
Upto and including 300mm	2.5 (25)	2.5 (25)
Over 300mm and upto and including 600mm	2.0 (20)	2.0 (20)
Over 600mm and upto and including 1500mm	1.5 (15)	1.0 (10)

8. TRAPS

8.1 Sand cast iron Floor trap or Nahani trap shall be 'P' or 'S' type with minimum 50 mm seal. However, if the Plumbing is in two pipes system and with a gully trap at the ground level the minimum water seal shall be 35 mm. The traps shall be of self cleansing design and shall have exit of same size as that of waste pipe. These shall confirm to IS: 1729

8.2 **Urinal Traps**

Urinal traps shall be either uPVC or Cast Iron deep seal traps or as given in bill of quantities with or without Vent and set in cement concrete block specified in Para above without extra charge.

8.3 **C.P./Stainless Steel Gratings**

Floor and Urinal Traps shall be provided with 100-150 mm square or round C.P/Stainless steel grating, with rim of approved design and shape. Minimum thickness shall be 4-5 mm or as specified in the Schedule of Quantities.

9. CLEANOUT PLUGS

Contractor shall provide brass cleanout plugs as required. Cleanout plugs shall be threaded and provided with key holes for opening. Cleanout plugs shall be fixed to the pipe by a male threaded adaptor.

10. WASTE PIPE FROM WASH BASINS AND SINKS

The waste fittings shall be of nickel chromium plated brass, with thickness of plating not less than service grade 2 of IS 4827 which is capable of receiving polish and will not easily scale off. The fitting shall conform in all respect to IS 2963 and shall be sound, free from laps, blow holes and

fittings and other manufacturing defects. External and internal surfaces shall be clean and smooth. They shall be neatly dressed and be truly machined so that the nut smoothly moves on the body.

Waste fitting for wash basins shall be of nominal size of 32mm. Waste fittings for sinks shall be of nominal size 50mm.

11. CEMENT CONCRETE

Cast Iron Soil and Waste pipes under floors in sunken slabs and in wall chases (When cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm size) 75 mm in bed and alround. When pipes are running well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars of required height and size at intervals as directed by Engineer-in-Charge/Owner.

12. PAINTING

12.1 Wherever CI pipes are used, it shall be painted with two or more coats of synthetic enamel paint to give an even shade. All surfaces shall be thoroughly cleaned before painting.

12.2 Paint shall be of approved quality and shade, pipes shall be painted in accordance with approved pipe color code.

12.3 Waste pipes in chase shall be painted with two coats of Bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with two or more coats of Synthetic enamel paint.

12.4 C.I. pipes below ground and covered in cement concrete shall not be painted.

13. CUTTING AND MAKING GOOD

Pipes shall be fixed and tested as buildings proceeds. Contractor shall provide all necessary holes cutouts and chases in structural members as building work proceeds. Wherever holes are cut or left originally, they shall be made good with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement: 2 coarse sand) and the surface restored as in original condition.

14. INSPECTION & TESTING

14.1 Inspections of pipes:

The pipe and fittings shall be inspected for defects and be rung with a light hammer, preferably while suspended, to detect cracks. Smearing the outside with chalk dust helps the location of cracks.

If doubt persists further confirmation may be obtained by purring a little kerosene of the inside of the pipe at the suspected spot. If a crack is present the kerosene seeps through and shows on the outer surface any pipe found unsuitable after inspection before laying shall be rejected.

15 Testing of Pipes:

15.1 Pipes shall be subjected to the mechanical test during manufacture after every four hour of production.

15.2 The Pipes may be subjected to reheat treatment to ensure that Brinell hardness does not exceed the specified value and the specified mechanical properties are satisfied.

15.3 The ring test shall be conducted for pipes for sizes up to and including 300 mm.
For above 300 mm sizes bar test are to be conducted.

15.4 Pipe shall be tested hydrostatically at the pressure specified in the following table

Hydrostatic Test pressure for centrifugally cast socket & spigot pipes in MPa		
	Hydrostatic Test pressure for work in MPa	
Class	Up to DN 600 (including)	DN 700 & above
LA	3.5	1.5
A	3.5	2.0
B	3.5	2.5

15.5 Tolerance on Barrel diameter and socket dimensions suitable for (Lead Joints) are given in table below

Tolerance for caulking space

Dimensions	**Nominal diameter (DN)**	**Tolerances in mm**
(a) External diameter of barrel (DE)	All diameters	±1/2 f = ± (4.5+0.0015DN)
(b) Internal diameter of socket (DI)	All diameters	±1/3 f= ± (3±0.001 DN)
(c) Depth of socket (P)	(1) Up to and including 600 mm	±5
	(2) Over DN 600mm and up to and including 1000mm	±10

15.6 Length of pipes:

15.6.1 Length of pipes does not include the length of the socket of the pipe.

15.6.2 Length - Effective length of pipe, as shown on the drawings.

Note - For flanged pipes the effective length is equal to the overall length and is noted L. For socketed pipes the effective length is equal to the overall length minus the spigot insertion depth.

15.7 Tolerance on length:

The tolerance on length of pipes shall be as under:

Type of casting Tolerance in mm
(a) Socket and spigot pipes ± 100
(b) Flange pipes ± 10

15.8 On the total number of socket and spigot pipes to be supplied in each diameter, the Manufacturer may supply up to l0 percent in lengths shorter than the specified length as mentioned under:-

Specified Length	Decrease in Length
Up to 4 m	0.5, 1 m
Over 4 m	0.5, 1, 1.5, 2m

a) Tolerance on pipe wall thickness "e" and flange thickness "b" in mm shall be as follows: -

Wall thickness - (1+0.05 e)
Flange thickness ± (2+0.05 b)

15.9 Specials (Fittings):

15.9.1 The specials shall conform to IS 1538:1993. Tolerances on external diameter of the barrel, internal diameter and the depth of the socket (for lead joints) shall be as prescribed below:-

Dimensions	Nature of Joint	Nominal diameter (DN)	Tolerances in mm
External diameter of spigot (DE)	Lead Joints	All diameters	± ½f or ±(4.5+0.0015DN)
Internal diameter of socket (DI)	Lead Joints	All diameters	± 1/3f or ± (3 + 0.001 DN)
Depth of socket (P)	Lead Joints	Upto and including 600mm	± 5
		Over 600mm upto and including 1000mm	±10
		Over 1000mm upto and including 1500mm	±15

Where DN is the nominal diameter of the fittings in millimeters and f is the caulking space of the joint in millimeters and is equal to (9.00 + 0.003 DN).

15.9.2 <u>Testing of fittings :</u>

15.9.2.1 Fittings are subjected to mechanical test viz tensile test & Brinell Hardness tests at the time manufacture.

15.9.2.2 Fittings are subjected to Hydrostatic test by keeping under pressure for 15 seconds, they are struck with a 700g hammer. Fitting shall withstand the test pressure without showing any leakage, sweating or other defect of any kind.

15.9.2.3 Hydrostatic test pressure for the fittings shall be as under:-

Hydrostatic Test pressure for fittings in MPa (kgf/mm^2)

Nominal Diameter	Fitting without branches or with branches not greater than half the principal diameter	Fitting with branches greater than half the principal Diameter
Up to and including 300mm	2.5 (25)	2.5 (25)
Over 300mm and up to and including 600mm	2.0 (20)	2.0 (20)
Over 600mm and up to and including 1500mm	1.5 (15)	1.0 (10)

15.9.2.4 Mass (weight) of the various types of fittings as under:-

15.9.2.4.1 Double socket cast iron 90º bend:-

Diameter (mm)	**Weight (approx) kg**	
	Heavy	**Medium**
80	18	-
100	24	23
125	33	31
150	43	41
200	67	63
250	98	91
300	135	125
350	181	167
400	234	215
450	290	265
500	370	338
600	546	496
700	770	697
750	899	812
800	1047	944
900	1389	1247
1000	1780	1597

15.9.2.5 Double socket cast iron 45º bend:-

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
80	18	-
100	24	23
125	32	30
150	41	39
200	62	58
250	89	83
300	121	113
350	159	148
400	202	188
450	248	229
500	310	287
600	448	412
700	619	568
750	716	655
800	827	756
900	1077	980

15.9.2.6 Double socket cast iron 22.5º bend:-

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
80	16	-
100	21	20
125	27	26
150	35	34
200	53	51
250	75	72
300	100	95
350	130	123

400	164	155
450	197	186
500	246	232
600	351	329
700	478	446
750	551	517
800	632	588
900	813	754
1000	1024	948

15.9.2.7 Double socket cast iron 11.25º bend

Diameter (mm)	**Weight (approx) kg**	
	Heavy	**Medium**
80	15	14
100	19	18
125	25	24
150	32	31
200	48	46
250	67	65
300	89	86
350	115	110
400	144	138
450	172	164
500	215	205
600	302	287
700	408	386
750	469	443
800	534	501
900	682	641
1000	852	800

15.9.2.8 All socketed tees:-

Diameter (mm)	**Weight (approx) kg**	
	Heavy	**Medium**

80x80	23	22
100x80	28	27
100x100	30	29
125x80	36	34
125x100	38	36
125x125	41	39
150x80	45	43
150x100	47	45
150x125	50	47
150x150	53	50
200x80	67	63
200x100	69	65
200x125	71	67
200x150	74	70
200x200	81	77
250x80	94	88
250x100	96	90
250x125	99	93
250x150	102	96
250x200	108	102
250x250	116	109
300x80	128	119
300x100	129	120
300x125	132	123
300x150	134	125
300x200	142	133
300x250	150	140
300x300	159	149
350x200	182	169
350x250	190	177
350x300	199	186
350x350	209	195
400x200	229	212
400x250	237	220
400x300	246	228

400x350	256	238	
400x400	268	250	
450x250	295	274	
450x300	304	283	
450x350	314	293	
450x400	324	303	
450x450	337	315	
500x250	356	327	
500x300	365	336	
500x350	375	346	
500x400	386	356	
500x450	398	368	
500x500	413	382	
600x300	521	476	
600x350	531	486	
600x400	543	498	
600x450	556	510	
600x500	569	523	
600x600	602	554	
700x350	729	668	
700x400	742		680
700x450	756		693
700x500	769		706
700x600	795		733
700x700	832		768
750x400	855		781
750x450	869		795
750x500	884		809
750x600	911		836
750x700	942		867
750x750	965		889
800x400	982		896
800x450	996		909
800x500	1010		923
800x600	1040		953

800x700	1072		984
800x750	1089		1000
800x800	1114		1024
900x450	1288		1170
900x500	1302		1184
900x600	1337		1217
900x700	1371		1251
900x750	1388		1267
900x800	1405		1285
900x900	1453		1331
1000x500	1648		1493
1000x600	1681		1525
1000x700	1723		1565
1000x750	1741		1582
1000x800	1759		1601
1000x900	1797		1639
1000x1000	1852		1693

15.9.2.9 All socketed cast iron crosses:-

Diameter (mm)	**Weight (approx) kg**	
	Heavy	**Medium**
80	30	29
100	39	37
125	52	50
150	67	64
200	102	97
250	145	137
300	197	186

15.9.2.10 Socket and spigot cast iron tapers (Reducer):-

Diameter (mm)	**Weight (approx) kg**	
	Heavy	**Medium**
100x80	16	15
125x80	21	20
125x100	23	21

150x80	27	25
150x100	28	26
150x125	31	29
200x100	40	37
200x125	42	39
200x150	45	42
250x125	56	53
250x150	59	55
250x200	66	61
300x150	80	74
300x200	88	81
300x250	97	88
350x200	104	96
350x250	113	104
350x300	123	112
400x250	143	131
400x300	154	141
400x350	166	151
450x350	185	169
450x400	199	181
500x350	211	194
500x400	225	206
500x450	240	219
600x400	300	275
600x450	316	289
600x500	333	304
700x500	398	365
700x600	437	399
750x600	492	449
750x700	539	490

15.9.2.11 Double socket cast iron tapers (Reducer):-

Diameter (mm)	**Weight (approx) kg**	
	Heavy	**Medium**
100x80	18	15

125x80		27	20	
125x100		30	21	
150x80		31	25	
150x100		34	26	
150x125		38	28	
200x100		43	37	
200x125		47	39	
200x150		51	42	
250x125		58	53	
250x150		62	55	
250x200		72	61	
300x150		75	74	
300x200		84	81	
	300x250	95	88	
	350x200	117	96	
	350x250	131	104	
	350x300	146	112	
	400x250	149	131	
	400x300	164	141	
	400x350	181	151	
	450x350	195	169	
	450x400	213	181	
	500x350	222	194	
	500x400	241	206	
	500x450	256	219	
	600x400	310	275	
	600x450	310	289	
	600x500	332	304	
	700x500	388	365	
	700x600	437	399	
	750x600	470	449	
	750x700	522	490	

15.9.2.12 Cast iron collars:-

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
80	14	13
100	17	16
125	22	21
150	28	27
200	40	38
250	55	52
300	71	68
350	90	86
400	110	103
450	133	127
500	159	151
600	216	205
700	283	269
750	320	304
800	360	341
900	448	424
1000	547	518

15.9.2.13 Cast iron socket caps:-

Diameter (mm)	Weight (approx) kg
	Heavy
80	7
100	9
125	12
150	15
200	24
250	34
300	46
350	61
400	77
450	97
500	118
600	171

700	235
750	272
800	314
900	405
1000	514

15.9.2.14 Cast iron plugs:-

Diameter (mm)	**Weight (approx) kg**	
	Heavy	**Medium**
80	3	2
100	4	3
125	6	5
150	9	8
200	14	13
250	22	20
300	30	28
350	41	38
400	54	51
450	69	65
500	86	81
600	127	120
700	180	171
750	211	201
800	246	235
900	321	307
1000	411	394

16. MEASUREMENTS

The net length of pipes as laid or fixed, shall be measured in the running metres correct to a cm. specials shall be excluded and enumerated and paid for separately. The portion of the pipe within the collar at the joints shall not be included in the length of pipe work.

Excavation, refilling, shoring and timbering in trenches masonry or concrete pillars and thrust blocks, wherever required, shall be measured and paid for separately, under relevant items of work.

Lead caulked joins shall be measured and paid for separately.

17 **General**

a. Rates shall include the cast of material and labour involved in all the operation describe in the item.

18.0 **Excavation for soil pipes**: No extra payment shall be admissible with respect to excavation, refilling and disposal of surplus earth for Cast Iron Soil and Waste Pipes.

b) Payment shall be made as per approved BOQ quantity and Rates.

END OF SECTION – II

1. SCOPE OF WORK

1.1 Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the Schedule of Quantities.

1.2 Without restricting to the generality of the foregoing, the water supply system shall include the following:-

- All water lines to different parts of building and making connection from source etc.
  - Pipe protection and painting.
  - Providing Hot water supply lines and insulation of hot water pipe lines.
  - Control valves, masonry chambers and other appurtenances.
  - Connections to all toilets, kitchen equipments, storage tanks and appliances.
  - Excavation and refilling of pipe trenches, wherever required.
  - Trenches for taking pipe lines for these services.

2. GENERAL REQUIREMENTS

2.1 All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-Charge / Owner.

2.2 Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

2.3 Short or Long bends shall be used on all main pipe lines as far as possible. Use of Elbows shall be restricted for short connections. As far as possible all Bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 65mm dia.

2.4 Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

2.5 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

2.6 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

5. UPVC PIPES (I.S. 4985)

5.1 APPLICABLE CODES

The laying of Un-plasticized PVC pipes and fittings / specials shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of Un-plasticized PVC pipes shall be part of this Specification.

I.S. NUMBER	TITLE
IS 4985: 2000	Specification for un-plasticized PVC pipes for potable water supply.

IS 7634(PT-3): 2003	Code of practice for plastics pipes selection, Handling, Storage and installation for potable water Supply.
IS 7834(PT I to VIII): 1987	Specification for injection moulded PVC socket fittings with solvent cement joints for water supply.
IS 14182:1994	Solvent cement for use with un-plasticized polyvinyl Chloride Plastic pipes and fittings.

5.2 Jointing of uPVC Pipes

5.2.1 PVC pipes to be jointed with solvent cement conforming to IS:14182 . Solvent cement is quick drying, therefore it shall be applied as quickly and carefully as possibly and in consistence with good workmanship. For larger sizes, it is advisable for two workers to work simultaneously on the pipe and socket.

5.2.2 Dip the applicator brush in the solvent cement and apply a liberal coat of cement to the end of the pipe up to the insertion depth.

5.2.3 Apply a uniform thin coat of cement inside the socket, working axially from the inside of the socket to the outside. Do not apply any cement on the shoulders of the socket (socket-to-pipe transition area). Care should be taken not to apply excess cement inside the socket. Excess cement in the socket will be pushed further into the pipe during assembly and cause the pipe to soften and weaken at that point. Hot and dry climates generally require slightly thicker coatings of solvent cement.

5.2.4 In climates with large differences between day and night temperatures, it is advisable to make joints early in the morning or in the evening when it is cooler. Thus, the joints are prevented from being pulled apart if the pipes contract.

5.2.5 For pipe installation solvent glued spigot is inserted in the socket up to the shoulder and then after a quarter (90º) turn is given to evenly distribute the cement over the treated surface.

5.2.6 Within 20 second after the last application of solvent cement, insert the pipe in to socket in a single steady and every controlled but forceful action. Press it in fully until it bottoms. No. hammer blows should be used. If there is any sign of drying of the cement coat before insertion; the surface should be re-coated, avoiding application of excess cement in the socket. Once the insertion is complete, hold in place for 1 min without shifting the pipe in the socket.

d) Immediately after assembly, wipe the excess solvent cement from the pipe at the end of the socket. A properly made joint will have a uniform bead around its entire perimeter. Any gaps in this bead may be indicative of an improper joint due to insufficient cement or the use of a lighter-bodied cement than the one recommended.

5.3 Measurement

5.3.1 The net length of pipes as laid or installed shall be measured in running meters correct to a cm. Specials shall be excluded and enumerated and paid separately under the relevant item. The portion of pipe at the joints (inside the joint) shall not be included in the length of the pipe work. Excavation, refilling, masonry and concrete work (as required) shall be measured and paid for separately under relevant item of work.

4. CPVC PIPES AND FITTINGS

CPVC pipes & fittings used in hot & cold potable water distribution system shall conform to requirement of IS 15778. The material from which the pipe is produced shall consist of chlorinated polyvinyl chlorides. The polymer from which the pipe compounds are to be manufactured shall have chlorine content not less than 66.5%. The internal and external surfaces of the pipe shall be smooth, clean and free from grooving and other defects. The pipes shall not have any detrimental effect on the composition of the water flowing though it. Diameter and wall thickness of CPVC pipes.

S.No.	Nominal size	Nominal Outside Diameter	Mean Outside Diameter		Outside Diameter at any point		Wall thickness					
							Class 1, SDR 11			Class 3, SDR 17		
			Min	Max	Min	Max	Avg.Max	Min	Max	Avg.	Min	Max
1	2	3	4	5	6	7	8	9	10	11	12	13
(i)	15	15.9	15.8	16.0	15.8	16.0	2.2	1.7	2.2	-	-	-
(ii)	20	22.2	22.1	22.3	22.0	22.4	2.5	2.0	2.5	-	-	-
(iii)	25	28.6	28.5	28.7	28.4	28.8	3.1	2.6	3.1	-	-	-
(iv)	32	34.9	34.8	35.0	34.7	35.1	3.7	3.2	3.7	-	-	-
(v)	40	41.3	41.2	41.4	41.1	41.5	4.3	3.8	4.3	-	-	-
(vi)	50	54.0	53.9	54.1	53.7	54.3	5.5	4.9	5.5	-	-	-

S.No.	Nominal size	Nominal Outside Diameter	Mean Outside Diameter		Outside Diameter at any point		Wall thickness					
							Class 1, SDR 11			Class 3, SDR 17		
			Min	Max	Min	Max	Avg.Max	Min	Max	Avg.	Min	Max
1	2	3	4	5	6	7	8	9	10	11	12	13
(i)	15	15.9	15.8	16.0	15.8	16.0	2.2	1.7	2.2	-	-	-
(ii)	20	22.2	22.1	22.3	22.0	22.4	2.5	2.0	2.5	-	-	-
(iii)	25	28.6	28.5	28.7	28.4	28.8	3.1	2.6	3.1	-	-	-
(iv)	32	34.9	34.8	35.0	34.7	35.1	3.7	3.2	3.7	-	-	-
(v)	40	41.3	41.2	41.4	41.1	41.5	4.3	3.8	4.3	-	-	-
(vi)	50	54.0	53.9	54.1	53.7	54.3	5.5	4.9	5.5	-	-	-

Notes:-

1. For CPVC pipes SDR is calculated by dividing the average outer diameter of the pipe in mm by the minimum wall thickness in mm. If the wall thickness calculated by this formula is less than 1.52 mm, it shall be increased to 1.52 mm. The SDR values shall be rounded to the nearest 0.5.

Fittings

The fittings shall be as follows:

(a) Plain CPVC solvent cement fittings from size 15mm to 160mm.

(b) Brass threaded fittings

(c) Valve from size 15mm to 160mm

(d) Brass Threaded Fittings: All types of one end brass threaded male/female adaptors in various fittings like coupler, socket, elbow, tee are available for transition to other plastic/metal piping and for fixing of CP fittings, Ball, Gate valves in CPVC are available in all dimensions. All fittings shall carry the following information:

e) Manufacturer's name/trade mark.

f) Size of fitting

Piping Installation Support and Spacing

Concealed Piping: Pipes can be concealed in chases. The pipes and fitting are to be pressure tested prior to concealing the chases. To maintain alignment of CP fittings while joining, all alignment of fittings and pipe shall be done correctly. DO NOT USE NAILS FOR HOLDING OF PIPES IN THE CHASES.

External Installations: For pipes fixed in the shafts, ducts etc. there should be sufficient space of work on the pipes. Pipes sleeves shall be fixed at a place the pipe is passing through a wall or floor so as to allow freedom for expansion and contraction. Clamping of the pipe is done to support it while allowing the freedom for movement.

All pipes exposed to sunlight shall be painted with a water based acrylic paint emulsion to enhance UV protection. Pipes in trenching shall be laid in accordance to the Good Plumbing practices followed for Metal piping.

Recommended Support Spacing (Distance between Pipe Clamps Horizontal Support)

Pipe Size	Horizontal Support (In meters)			
	Temperature			
	23^0C	38^0C	60^0C	82^0C
16 mm (1/2")	1.22	1.22	1.07	0.92
20 mm (3/4")	1.53	1.37	1.22	0.92
25 mm (1/0")	1.68	1.3	1.37	0.92
32 mm (1 ¼")	1.83	1.68	1.53	1.22
40 mm (1 ½")	1.98	1.83	1.68	1.22
50 mm (2")	2.29	2.14	1.98	1.22

Expansion Loop: CPVC systems, like all piping materials, expand and contract with changes in temperatures. CPVC pipes shall expand 7.5 cm per 30 m length for a 400C temperature change.

Expansion does not vary with pipe size. thermal expansion can be generally be accommodated a changes in direction. on a long straight run, an offset or loop based on the following chart is required.

Nominal Pipe Size	Length of Run (Meter), Loop length in cms.				
	6 metre	12 metre	18 metre	24 metre	30 metre
15mm	43	56	69	79	86
20mm	48	66	81	91	104
25mm	53	74	91	104	117
32mm	58	81	102	117	130
40mm	63	89	109	127	142
50mm	71	102	124	145	63

Testing

All water supply systems shall be tested to hydrostatic pressure test. The pressure tests are similar to the test pressure used for other plastic/metal pipes. System may be tested in sections and such section shall be entirely checked on completion of connection to the overhead tank or pumping system or mains.

Measurements

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm for the finished work, which shall include CPVC pipe and fittings including plain and Brass threaded fittings and jointing solvent cement.

5. G.I. PIPES & FITTINGS

Internal works

For internal work the galvanized iron pipes and fittings shall run on the surface of the walls on ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5cm clear of the wall. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts or recess etc. provided there in sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage and where so required joints are not buried. Where directed by the Engineer-in-Charge, as M.S. tube sleeve shall be fixed at a place the pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion and contraction and other movements. In case the pipe is embedded in walls or floors it should be painted with anticorrosive bitumastic paints of approved quality. The pipe shall be not come in contact with lime mortar or lime concrete as the pipes is affected by lime. Under the floors the pipes shall be laid in layer of sand filling as done under concrete floors. All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern holder bat clamps of required shape and size so as to fit tightly or the pipes when tightened with screwed bolts, these clamps shall be embedded in brick work in cement mortar 1:3 (1 cement : 3 coarse sand), and shall be spaced at regular intervals in straight lengths as shown in Table 21.13.

For G.I. pipes 15 mm diameter, the holes in the walls and floors shall be made by drilling with chisel or jumper and not by dismantling the brick work or concrete. However, for bigger dimension pipes holes shall be carefully made of the smallest size as directed by the Engineer-in-Charge. After fixing the pipes the holes shall be made good with cement mortar 1:3 (1 cement: 3 coarse sand) and properly finished to match the adjacent surface.

Dia. Of Pipe (mm)	Horizontal length M	Vertical length M
15	2	2.5
20	2.5	3
25	2.5	3
32	2.5	3
40	3	3.5
50	3	3.5
65	3.5	5
80	3.5	5

Unions will be provided to facilitate connections additions and alterations as well as for maintenance and for change of pipes. The locations where unions are to be provided will be decided with prior written approval of the Engineer-in- Charge.

Laying and jointing of G.I. Pipes (external work)

For External work the galvanized iron pipes and fittings shall run Trenches.

The galvanized iron pipes and fitting shall be laid in trenches. The widths and depths of the trenches for different diameters of the pipes shall be as per the following table.

Dia of pipe (mm)	Width of trench (cm)	Depth of trench (cm)
15 to 50	30	60
65 to 100	45	75

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications or earth work in trenches. When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

Cutting and Threading

Where the pipes have to be cut or rethreaded, the ends shall be carefully filed out so that no obstruction to bore is offered. The end of the pipes shall then be carefully threaded conforming to the requirements of IS 554 with pipe dies and taps in such a manner as will not result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening screw threads which have become bend or damaged and shall not be used for turning of the threads so as to make them slack, as the later procedure may not result in a water tight joint. The screw threads of pipes and fitting shall be protected from damage until they are fitted.

Jointing

The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over. Teflon Tape should be used on threads instead of 'Dhaaga/Safeda'. The end shall then be screwed in the socket, Tee etc. with the pipe wrench. Care shall be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

Painting

The pipes shall be painted with two coats of anticorrosive bitumastic paint of approved quality.

Testing of Joints

The pipes and fittings after they are laid and jointed shall be tested to hydraulic pressure of 6 Kg/ sq. cm (60 meter). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw off taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least half an hour. Pipes or fitting which are found leaking shall be replaced and joints found leaking shall be redone, without extra payment.

Trench Filling

The pipes shall be laid on a layer of 7.5 cm sand and filled upto 15 cm above the pipes.

The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be disposed off as directed.

Measurements

The lengths shall be measured in running metre correct to a cm for the finished work, which shall include G.I. pipes and G.I. fittings such as bends, tees, elbows reducers, crosses, plugs, sockets, nipple and nuts but exclude brass or gun metal taps (cocks), valves, unions, lead connection pipes and shower rose. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance quality and finish. In case of fittings of an equal bore the pipe shall be described as including all cuttings and wastage. In case of fittings of unequal bore the largest bore shall be measured. G.I. unions shall be paid for separately in external work as well as in internal work.

Digging and refilling of trenches shall either be measured separately as specified in the appropriates clauses of excavation and earth work or clubbed with main item.

14. **BALL VALVES**

The ball valve shall be of Brass or Gunmetal as specified conforming to IS 1703.The ball valve shall be of following two classes:-

High Pressure: High pressure float valves are indicated by the abbreviation 'HP' and are designed for use on mains having pressure of 0.175 MPa or above.

Low Pressure: Low Pressure float valves are indicated by the abbreviation 'LP' and are designed for use on mains having a pressure upto 0.175 MPa.

The ball valves shall be of following nominal sizes 15mm, 20mm, 25mm, 32 mm, 40 mm and 50mm. The nominal size shall correspond with the nominal bore of the inlet shanks. Polyethylene floats shall conform to IS 9762.

Ball Valves have body material as Forged Brass Chrome plated with Spindle Brass Nickel Plating & Lever handle Steel Chrome plated with green plastic cover. The valve is suitable for water maximum working pressure up to 25 bar (PN 25). The valve is operated by turning. The rotation from open to close is a quarter turn (90^{o}) which closes in a clock-wise direction.

15. **BUTTERFLY VALVES**

15.1 Butterfly valves are used to regulate stop the flow especially in large size conduits. They are sometimes cheaper than sluice valves for larger sizes and occupy less space.

15.2 Butterfly valves with no sliding parts have the advantages of ease of operation, compact size, reduced chamber or valves house and improved closing and retarding characteristics.

15.3 These would involve slightly higher head loss than sluice valves and also are not suitable for continuous throttling. The sealing is sometime not as effective as for sluice valves especially at high pressures.

15.4 They also offer a fairly high resistance to flow even in fully open state because the thickness of the disc obstruct the flow even when it is rotated to fully open position. Butterfly valves as well as sluice valves are not suited for operation in partly open position as the gates and seatings would erode rapidly. Both types require high torques to open them against high pressure, they often have geared hand wheels or power driven actuator.

15.5 Butterfly Valves with loose sealing ring are sometimes not effective, especially at higher pressures. Butterfly valves with fixed liner can overcome this shortcoming, further the butterfly valves with fixed liner needs no frequent maintenance for replacement of sealing ring as in the case of butterfly valves with loose sealing ring.

15.6 Valve shall be placed on a support of concrete so that non shear stress is in the flanges. In case of axial thrust due to closure of a valves against pressure the valve shall be anchored in the support in a suitable manner to transfer the thrust into the floor slab of the chamber.

16. ***SLUICE VALVES***

The sluice valves are used in a pipe line for controlling or stopping flow of water. These shall be of specified size and class and shall be of inside nonraising screw type up to 300mm size and raising or non-raising screw type above 300mm with either double flange or double socket ends and cap or hand wheel.

The body, domes covers, wedge gate spindle, nut, valve seat and stuffing box shall be of good quality. The bodies, spindles and other parts shall be truly machined with surface smoothly finished. The area of the water way of the fittings shall be not less than the area equal to the nominal bore of the pipe details of component are given in the table below.

S.No.	Component	Preferred Material	Grade or Designation	Alternative Material	Grade or Designation
i)	Body, bonnet, dome, stool cover, wedge, stuffing box, gland, thrust plate and cap.	Grey cast iron	FG 200	Spheroidal or Nodular iron cast steel	260-300/12 or 500/2
ii)	Hand wheel	Grey cast iron	FG 200	Mild steel cast steel Nodular iron	F 410 WA 230-450W 400/12
iii)	Stem	Stainless steel	12Cr 13 04Cr 18Ni 10 04Cr 17 Ni 12 MO 2	High Tensile Brass Stainless steel	HT 2 FHTB 2 20Cr13
iv)	Wedge nut, shoe, channel	Leaded tin bronze	LTB-2	High Tensile Brass Phosphor bronze	HTB 2 FHTB -2
v)	Body seat ring, wedge facing ring and bushes	Leaded tin bronze	LTB-2	Alloy steel	Gr. 1 Gr. 4 Gr. 10 04Cr 18Ni 10
vi)	Bolts	Carbon steel	Class 4.6	Stainless steel	
vii)	Nuts	Carbon steel	Class 4.0	Stainless steel	
vii)	Gasket	Rubber	Type B	Neoprene Rubber	
ix)	Gland packing	Jute and hemp		Rubber	Type –B
x)	Gear	Spheroidal graphite iron	Gr. 500/7	Alloy steel	40 Ni 2Cr M20 28 Gr B
xi)	Gear housing	Grey cast iron	FG 200	Cast steel S.G. iron	230-450 W 400/12
xii)	Pinion & pinion shaft	Wrought carbon steel	C55 Mn 75	Alloy steel Stainless steel	40 ni 12Cr 1 MO 28 04Cr18 Ni10

17. AIR RELEASE VALVES

(j) Air release valves shall be single acting type air valves with cast iron body and bronze/gunmetal internal parts and plastic float.

(k) Each air release valve shall be provided with a cast iron isolating sluice valve of specification given above.

20. INSULATION

The insulation for hot water pipes shall be done as specified in Bill of Quantities and accordingly following guidelines shall be followed:

20.1 **For Internal Pipes (Chased / Exposed)**

Hot water pipes fixed in chase shall be insulated by wrapping 6 mm/9 mm thick thermal insulation tubings & jointed as per manufacturer's specifications complete as per requirement and finishing it with 6 mm rough cement plaster 1:3 mixed with Rapid Hardening Cement for the chased pipes or specified protection for the exposed pipes as per the bill of quantities.

20.2 **For External Piping**

External hot water line laid in trenches, exposed in shafts, on terrace and along ceiling level shall be insulated with either thermal tubings of specified thickness or fibre glass wool blankets/mats, as specified in Bill of Quantities. After the insulation, all the pipes shall be protected with either 12mm thick smooth finished cement plaster (two layers of 6 mm thick of mix 1:2 Portland cement and fine sand) orthey shall be cladded with 24 SWG aluminum sheet as specified in Bill of Quantities.

20.3 The specifications of the material shall be generally as follows, unless specified:

- Elastomeric Flexible Material -- Thermal Insulation tubings of 6/9/12mm thickness with density of 60-90 Kg/m3.
- Fibre glass wool -- Blankets/mats of 50 mm thickness in the density of 24 kg/m^3

20.4 Generally, following procedure shall be adopted for external insulation:

- Cleaning the pipe surface to be insulated to make it free from dust &oil.
- Applying a layer of zinc chromate/anti-rust Japanese primer.
- Fixing fibre glass wool blankets or mats/Elastomeric Flexible Tubings as specified.
- Covering it alround with 24 gauge wire netting with proper butt joint and tightly wrapped.
- Applying two layers of 6 mm thick each cement plaster in the ratio of 1:2 (1 cement: 2 fine sand).
- Applying weatherproofing coating of Insulkote OR of approved material over the cement plaster.
- For certain places, where exposed insulation is not to be plastered as specified in item (v) and (vi), then aluminum foil sheet of 24 gauge with 50 mm overlapping, fixed with self tapping recessed screwed shall be provided.

22. VALVE CHAMBERS

22.1 Contractor shall construct chambers for all full way valves, butterfly valves and other type of valves as specified in the Bill of Quantities. These shall be made, in brick masonry in cement mortar 1:4 (1 cement: 4 coarse sand) on cement concrete foundations 150mm thick 1:5:10 mix (1 cement: 5 coarse sand: 10 graded stone aggregate 40mm nominal size) 12 mm thick cement plaster 1:3(1 cement : 3 coarse sand) inside finished with a floating coat of neat cement with 8mm thick M.S surface box with hinged cover and locking arrangement, 150 mm thick reinforcement cement concrete top slab of 1:2:4 (1 cement : 2 coarse sand: 4 graded stone aggregate 20mm nominal size), as specified and shown in drawings, including excavation, back filling rammed complete or as specified in Bill of Quantities.

22.2 Valve chambers shall be constructed as specified in BOQ but generally shall be of following sizes:

	Length (mm)	Width (mm)	Depth (mm)
For pipes dia. Up to 80 mm	600	600	1000
For pipes dia. 80 mm and above	750	750	1000

23. TESTING

23.1 All pipes, fittings and valves shall be tested by hydrostatic pressure of min. 1.5 times, the working pressure and subject to minimum of 7 kg/cm^2 in any case and with the consent of Engineer-in-Charge / Owner.

Pressure shall be maintained for a period of at least two hours without appreciable drop in the pressure after fixing at site. ($\pm$10 %). A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Engineer.

23.2 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 during the defects liability period without any extra cost.

23.3 After completion 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.

24. MEASUREMENT

24.1 Pipes

Pipes shall be measured per linear meter (to the nearest cm) and shall be inclusive of all fittings e.g. couplings, tees, bends, elbows, unions, deduction for valves shall be made, cutting holes chases and making good the same and all items mentioned in the specifications and Schedule of Quantities.

- Gunmetal and cast iron valves shall be measured by numbers.
- Single flanges shall be measured by numbers (per single flange) and shall include bolts, nuts, washers and 3mm thick rubber gasket complete.

- Pair of flanges shall be measured by number of pairs and shall include bolts, nuts, washers, and 3 mm thick rubber gaskets complete.

24.2 **Insulation**

Insulation for hot water pipes shall be measured per linear metre (to the nearest cm) along the centre line of pipe and shall be measured over all fittings and flanges. No separate or additional payment shall be made for insulation of Bends, Tees, Flanges or Other Fittings and Valves. The rate shall include all items specified in the Schedule of Quantities and given in the specifications.

Aluminum cladding/Plaster over the insulated pipes shall be measured in metres or as specified for the area of the finished surface. The rate shall be inclusive of all items given in the Schedule of Quantities.

24.3 **Painting**

Painting for Pipes and over insulation shall be measured per linear metre over finished surface and shall include all valves and fittings for which no deduction shall be made.

c) Payment shall be made as per approved BOQ quantity and Rates, but not exceeds to total L.S. Contract value awarded to the Contractor.

25. DISINFECTION

25.1 After completion of the work Contractor shall flush clean the entire system with the city's filtered water after connection has been made.

25.2 After the first flushing, commercial bleaching powder is to be added to achieve a dosage of 2 to 3 mg/l of water in the system added and flushed. This operation should be performed twice to ensure that the system is fully disinfected and usable.

26. PRE COMMISSIONING

26.1 Ensure that all pipes are free from debris and obstructions.

26.2 Check all valves and fire hydrant for effective opening and closing action. Defects should be rectified or valves replaced.

26.3 Ensure that all Connections to Branches has been made.

26.4 Ensure that mains have been connected to the respective pumps, underground and overhead tanks.

26.5 Water supply should be available at main Underground tank.

26.6 All main line Valves should be closed.

27. COMMISSIONING

27.1 Fill Underground tank with water. Add 1kg fresh bleaching powder after making a solution to be added near inlet.

27.2 Start Water Supply Pump and allow water to fill main Underground tank. Water will first fill the fire tank and then overflow to the Raw Water tanks.

27.3 After filling Overhead Reservoir drain the same to its one forth capacity through tank scour valve. (This is to ensure removal of all mud, debris etc. from the tank).

27.4 Fill Overhead tank to full.

27.5 Release water in the main lines by opening Valves in each circuit. Drain out water in the system through scour valves or fire hydrant in lower regions. Ensure clean water is now coming out of the system.

27.6 Open valves for individual clusters. Observe for leakages or malfunctions, check pressure & flow at end of line by opening Hydrants etc. Remove and rectify defects noticed.

27.7 Check all outlet points for proper operation by opening each valve and allowing water to flow for a few minutes. Also check for effective closure of valve.

27.8 The entire water supply system should be disinfected with bleaching powder and system flush cleaned.

27.9 Send four samples of water drawn from four extreme locations for testing for bacteriological test in sterilized bottles obtained from the concerned laboratory. (Laboratory personal may collect the samples themselves).

28. ***RESPONSIBILITY***

Responsibility for various activities in pre-commissioning and commissioning procedures will rest with the Contractor.

END OF SECTION – III

SECTION - IV SEWERAGE / DRAINAGE SYSTEM

1. SCOPE OF WORK

1.1 Work under this section shall consist of furnishing all Labour, Materials, Equipments and Appliances necessary and required to completely finish Sewerage/Drainage system as required by the drawings and specified hereinafter or given in the Schedule of Quantities.

1.2 Without restricting to the generality of the foregoing, the sewerage system shall include:

- Installation of all sewer lines / effluent lines
- Installation of all storm water drainage lines
- Construction of all catch basins, chambers, manholes & other related civil works
- Rain water harvesting system

2. GENERAL REQUIREMENTS

2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of the Engineer-in-Charge / Owner.

2.2 Drainage lines shall be laid to the required gradients and profiles.

2.3 All drainage work shall be done in accordance with the local Municipal bye laws.

2.4 Location of all manholes, catch basins etc., shall be got confirmed by the Contractor from the Engineer-in-Charge / Owner before the actual execution of work at site.

2.5 All works shall be executed as directed by Engineer-in-Charge / Owner.

3. ALIGNMENT AND GRADE

The sewer pipes shall be laid to alignment and gradient shown on the drawings but subject to such modifications as shall be ordered by the Engineer-in-Charge / Owner from time to time to meet the requirements of the works. No deviations from the lines, depths of cutting or gradients of sewers shown on the plans and sections shall be permitted except by the express direction in writing of the Engineer-in-Charge / Owner.

4. SALT GLAZED STONEWARE PIPES

All pipes with spigot and socket ends and fittings shall conform to class SP1 of IS 651.
These shall be sound, free form visible defects such as fire cracks or hair cracks. The glaze of the pipes shall be free from crazing. The pipes shall give a sharp clear tone when struck with a light hammer. There shall be no broken blisters.

The length of pipes shall be 60, 75, 90 cm exclusive of the internal depth of the socket. The pipes shall be handled with sufficient care to avoid damage to them.

Laying and Jointing Stone Ware Pipes:

For all sewers and drains, glazed stoneware pipes shall be used as far as possible in preference to other types of pipes. These are suitable, particularly where acid effluents or acid sub-soil conditions are likely to be encountered.

Trenches: Specifications described in IS code 4127:1983 shall be followed.

The trench shall be so dug that the pipe can be laid to the required alignment and at the required depth. When the pipe line is under a roadway, a minimum cover of 90 cm is recommended for adoption, but it may be modified to suit local conditions. The trench shall be excavated only so far in advance of pipe laying as specified by the Engineer-in-Charge. The trench shall be so shored and drained that the workmen may work therein safely and efficiently. The discharge of the trench dewatering pumps shall be conveyed either to drainage channels or to natural drains.

The excavation shall be carried out with manual labour or with suitable mechanical equipments as approved by the Engineer-in-Charge. Unless otherwise specified by the Engineer-in-Charge, the width at bottom of trenches for different diameters of pipes laid at different depths shall be as given below:-

c) For all diameters, up to an average depth of 120 cm, width of trench in cm = diameter of pipe + 30 cm.

d) For all diameters for depths above 120 cm, width of trench in cm = diameter of pipe + 40 cm.

e) Notwithstanding (a) and (b) the total width of trench shall not be less than 75 cm for depths exceeding 90 cm.

Laying : Where the pipes are laid on soft soil with maximum water table lying at invert level of the pipe, the pipes shall be bedded in cement concrete with thickness and mix as specified, projecting on each side of the pipe to the specified width of the trench. The pipes with their crown level at 1.20 m depth and less from ground shall be covered with 15 cm thick. Concrete above the crown of the pipe and sloped off to meet the outer edges of the concrete, to give a minimum thickness of 15 cm all-around the pipe. Pipes laid at a depth greater than 1.20 m at crown and maximum water table level rising above the invert level of pipe, shall be concreted at the sides up to the level of the centre of the pipe and sloped off from the edges to meet the pipe tangentially. The pipe shall be carefully laid to the alignments, levels and gradients shown on the plans and sections. Great care shall be taken to prevent sand etc. from entering the pipes. The pipes between two manholes shall be laid truly in a straight line without vertical or horizontal undulation. The pipes shall be laid with socket ends facing upstream. The body of the pipe shall for its entire length rest on an even bed of concrete and places shall be excavated in the concrete to receive the socket of the pipe. Where pipes are not bedded on concrete, the trench floor shall be left slightly high and carefully bottomed up as pipe laying proceeds, so that the pipe barrels rest on firm and undisturbed ground. If the excavation has been carried too low, the desired levels shall be made up with concrete 1:5:10 (1cement: 5 fine sand: 10 graded stone aggregate 40mm nominal size) for which no extra payment shall be made.

If the floor of the trench consists of rock or very hard ground that cannot easily be excavated to smooth surface the pipe shall be laid on a leveling course of concrete as desired. When S.W. pipes are used for storm water drainage, no concreting will normally be necessary. The cement mortar for jointing will be 1:3 (1cement: 3fine sand). Testing of joints will also not be done.

Jointing: Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be slipped home well into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly home so as to fill not more than 1/4th of the total depth of the socket.

The remainder of the socket shall be filled with stiff mixture of cement mortar in the proportion of 1:1 (1cement: 1 fine sand). When the socket is filled, a fillet shall be formed round the joint with a trowel forming an angle of 45 degree with the barrel of the pipe.

After a day's work any extraneous material shall be removed from the inside of the pipe. The joints shall be cured for at last seven days.

Testing of Joints: Stoneware pipes used for sewers shall be subjected to a test pressure of 2.5m head of water at the highest point of the section under test. Before commencing test, the pipeline shall be filled with water and maintained full for 24 hours under head of 0.6m of water. The test shall be carried out by suitably plugging the lower end of the drain and the ends of the connection if any and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head, or the top may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitable for observation. The tolerance of two liters per centimeter of diameter per kilometer may be allowed during a period of 10 minutes. If any leakage is visible, the defective part of the work shall be cut out and made good. A slight amount of sweating which is uniform may be overlooked, but excessive sweating from a particular pipe of joint shall be watched for and taken as indicating a defect to be made good. Any joint found leaking of sweating, shall be rectified or embedded into 15 cm
layer of cement concrete (1:2:4) 30 cm in length and the section retested.

5. *GULLY TRAPS*

Gully traps shall conform to IS 651. These shall be sound, free from visible defects such as fire cracks, or hair cracks. The glaze of the traps shall be free from crazing. They shall give a sharp clear tone when struck with light hammer.

There shall be no broken blisters.

Each gully trap shall have one C.I. grating of square size corresponding to the dimensions of inlet of gully trap. It will also have a water tight C.I. cover with frame inside dimensions 300 x 300 mm the cover weighing not less than 4.50 Kg and the frame not less than 2.70 Kg. The grating, cover and frame shall be of sound and good casting and shall have truly square machines seating faces.

Fixing S.W. Gully Trap

Excavation: The excavation for gully traps shall be done true to dimensions and levels as indicated on plans or as directed by the Engineer-in-Charge.

Fixing: The gully traps shall be fixed on cement concrete foundation 65 cm square and not less than 10 cm thick. The mix for the concrete will be 1:5:10 (1 cement : 5 fine sand: 10 graded stone aggregate 40 mm nominal size). The jointing of gully outlet to the branch drain shall be done similar to jointing of S.W. pipes described above.

Brick Masonry Chamber : After fixing and testing gully and branch drain, a brick masonry chamber 300 x 300mm (inside) in brick work of specified class in cement mortar 1:4 (1 cement : 4 fine sand) shall be built with a half brick thick brick work round the gully trap from the top of the bed concrete up to ground level. The space between the chamber wall and the trap shall be filled in the with cement concrete M5 graded stone aggregate 40mm nominal size). The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside with cement mortar 1:3 (1

cement : 3 coarse sand), finished with a floating coat of neat cement. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating.

C.I. cover with frame 300 x 300 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete M15 graded stone aggregate 20mm nominal size) and rendered smooth. The finished top of cover shall be left about 4 cm above the adjoining ground level so as to excluded the surface water from entering the gully trap.

6. *REINFORCED CEMENT CONCRETE PIPES*

The pipes shall be with or without reinforcement as required and shall be of class not lesser than NP2. These shall conform to IS 458 and shall be capable of withstanding a test pressure of 0.07 MPa (7m head). The reinforced cement concrete pipes shall be manufactured by centrifugal (or spun) process while un-reinforced cement concrete pipes by spun or pressure process. All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws.

The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

Concrete used for the manufacture of un-reinforced and reinforced concrete pipes and collars shall not be leaner than M15 graded stone aggregate). The maximum size of aggregate should not exceed one third of the thickness of the pipe or 20 mm whichever is smaller for pipes above 250 mm internal diameter. But for pipes of internal diameter 80 to 250 mm, the maximum size of aggregate should be 10mm. The reinforcement in the reinforced concrete pipes shall extend throughout the length of the pipe. The circumferential and longitudinal reinforcements shall be adequate to withstand the specified hydrostatic pressure and further bending stresses due to the weight of water when running full across a span equal to the length of pipe plus three times its own weight.

The dimensional requirement of concrete pipes are given in Table 22.3 & 22.4.

Nominal Internal Diameter of Pipe	Barrel Wall Thickness of pipe	Collar Dimensions			Reinforcements in Collar		
		Minimum Caulking space	Minimum Thickness	Minimum Length	Longitudinal, Mild steel or Hard Drawn Steel		Spiral Hard Drawn Steel
mm	mm	mm	mm	mm	Minimum	Weight Kg/Collar	Kg/Collar
1	2	3	4	5	6	7	8
80	25	13	25	150	6	0.08	0.07
100	25	13	25	150	6	0.08	0.08
150	25	13	25	150	6	0.08	0.10
200	25	13	25	150	6	0.08	0.12
225	25	13	25	150	6	0.08	0.14
250	25	13	25	150	6	0.08	0.16
300	30	16	30	150	8	0.11	0.22
350	32	16	32	150	8	0.11	0.25
400	32	16	32	150	8	0.11	0.27
450	35	19	35	200	8	0.15	0.40
500	35	19	35	200	8	0.15	0.60
600	45	19	40	200	8	0.15	0.70
700	50	19	40	200	8	0.23	1.05

Nominal Internal Diameter of Pipe	Barrel Wall Thickness of pipe	Collar Dimensions			Reinforcements in Collar		
		Minimum Caulking space	Minimum Thickness	Minimum Length	Longitudinal, Mild steel or Hard Drawn Steel		Spiral Hard Drawn Steel
mm	mm	mm	mm	mm	Minimum	Weight Kg/Collar	Kg/Collar
800	50	19	45	200	8	0.23	1.85
900	55	19	50	200	8	0.23	2.05
1000	60	19	55	200	8	0.33	2.25
1100	65	19	60	200	8	0.33	3.09
1200	70	19	65	200	8	0.33	4.11
1400	75	19	75	200	12	0.50	5.08
1600	80	19	80	200	12 or 8+8	0.67	6.55
1800	90	19	90	200	12 or 8+8	0.67	9.00
2000	100	19	100	200	12+12	1.00	12.15
2200	110	19	110	200	12+12	1.00	13.30

Note:

1. If the mild steel is used for spiral reinforcement, the weight specified under col. 7 shall be increased by a factor 140/25.

2. Soft grade mild steel wire may be used as reinforcement for collars of pipes of nominal internal diameter up to 250 mm only, by increasing the weight by a factor 140/84. Where only soft grade mild steel wire is used for making collar cages, the weight of reinforcement shall be total weight or col. 6 and 7 multiplied by 140/84. This is allowed as a process requirement.

3. Internal diameter of collar to suit the actual diameter of pipe with minimum caulking space as given in col. 2

Note :

1. The effective length of barrel shall be 2 m upto 250 mm nominal diameter pipes and 2.5, 3.0, 3.5 or 4.0 m for pipes above 250 mm.

2. Collar dimensions, will be same as specified for class NP2 pipes.

The minimum clear cover for reinforcement in pipes and collars shall be as given in

Sl.No.	Precast concrete pipe/collar	Minimum clear cover, mm
(i)	Barrel wall thickness	
(a)	Up to and including 75 mm	8
(b)	Over 75 mm	15
(ii)	At spigot steps	5
(iii)	At end of longitudinal	5

Laying and Jointing Cement Concrete Pipes and Specials

Trenches: Specification given in IS code 783:1959 shall be followed.

Where the pipes are to be bedded directly on soil, the bend shall be suitably rounded to fit the lower part of the pipe, the cost for this operation being included in the rate for laying the pipe itself.

Loading, transporting and unloading of concrete pipes shall be done with care. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain pulley block is recommended. All pipe sections and connections shall be inspected carefully before being laid. Broken or defective pipes or connections shall not be used. Pipes shall be lowered into the trenches carefully. Mechanical appliances may be used. Pipes shall be laid true to line
and grade as specified. Laying of pipes shall proceed upgrade of a slope.

If the pipes have spigot and socket joints, the socket ends shall face upstream. In the case of pipes with joints to be made with loose collars, the collars shall be slipped on before the next pipe is laid. Adequate and proper expansion joints shall be provided where directed.

In case where foundation conditions are unusual such as in the proximity of trees or holes, under existing or proposed tracks manholes etc. the pipes shall be encased all-around in 15 cm thick cement concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) or compacted sand or gravel.

In cases where the natural foundation is inadequate the pipes shall be laid either in concrete cradle supported on proper foundations or on any other suitably designed structure. If a concrete cradle bedding is used the depth of concrete below the bottom of the pipe shall be at least 1/4th of the internal dia of the pipes subject to the min. of 10 cm and a maximum of 30cm. The concrete shall extend up the sides of the pipe at least to a distance of 1/4th of the outside diameter of pipes 300 mm and above in dia. The pipe shall be laid in this concrete bedding before the concrete has set.

Pipes laid in trenches in earth shall be bedded evenly and firmly and as far up the haunches of the pipe as to safely transmit the load expected from the backfill through the pipe of the bed. This shall be done either by excavating the bottom of the trench to fit the curve of the pipe or by compacting the earth under & around the curve of the pipe to form an even bed. Necessary provision shall be made for joints wherever required.

When the pipe is laid in a trench in rock hard clay, shale or other hard material the space below the pipe shall be excavated, replaced with an equalizing bed of concrete, sand or compacted earth. In no place shall pipe be laid directly on such hard material.

When the pipes are laid completely above the ground the foundation shall be made even and sufficiently compacted to support the pipe line without any material settlement. Alternatively the pipe line shall be supported on rigid foundations at intervals. Suitable arrangements shall be made to retain the pipe line in the proper alignment, such as by shaping the top of the supports to fit the lower part of the pipe.

The distance between the supports shall in no case exceed the length of the pipe. The pipe shall be supported as far as possible close to the joints. In no case shall the joints come in the centre of the span.

Suitably designed anchor blocks at change of direction and grades for pressure lines shall be provided where required.

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Jointing : Joints are generally of rigid type. Where specified flexible type joints may also be provided where required.

Rigid Spigot and Socket Joint : The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. The opening of the joint shall be filled with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) which shall be rammed with caulking tool. After a day's work any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured.

Rigid Collar Joint : The two adjoining pipes shall be butted against each other and adjusted in correct position. The collar shall then be slipped over the joint, covering equally both the pipes. The annular space shall be filled with stiff mixture of cement mortar 1:2 (1 cement : 2 fine sand) which shall be rammed with caulking tool. After a day's work any extraneous materials shall be removed from the inside of the pipe and the newly made joint shall be cured.

Semi Flexible Spigot and Socket Joint: The joint is composed of specially shaped spigot and socket ends on the concrete pipes. A rubber ring shall be placed on the spigot which shall be forced into the socket of the pipe previously laid. This compresses the rubber ring as it rolls into the annular space formed between the two surfaces of the spigot and the socket, stiff mixture of cement mortar 1:2 (1 cement : 2 fine sand) shall then be filled into the remaining annular space and rammed with a caulking tool. After day's work any extraneous materials shall be removed from the inside of the pipe and the newly made joint shall be cured.

Semi Flexible Collar Joint : This is made up of a loose collar which covers two specially shaped pipe ends. Each end shall be fitted with a rubber ring which when compressed between the spigot and the collar, seal the joint. Stiff mixture of cement mortar 1:2 (1 cement : 2 fine sand), shall then be filled into the remaining annular space and rammed with a caulking tool. After day's work, any extraneous materials shall be removed from the inside of the pipe and the newly made joint shall be cured.

In all pressure pipe lines the recess at the end of the pipe line shall be filled with jute braiding dipped in hot bitumen or other suitable approved compound. Pipes shall be so jointed that the bitumen ring of one pipe shall set into the recess of the next pipe. The ring shall be thoroughly compressed by jacking or by any other suitable method.

The number of pipes that shall be jacked together at a time shall depend on the diameter of the pipes and the bearing capacity of the soil, for small pipes up to 25 cm diameter, six pipes can be jacked together at a time.

The quantity of jute and bitumen in the ring shall be just sufficient to fill the recess in the pipe when pressed hard by jacking or by any other suitable method. Before and during jacking care shall be taken to see that there is no offset at the joint.

7. HDPE PIPES

7.1 HDPE pipes used for external sewerage / drainage purpose shall conform to IS:14333 & to the grade as specified in the bill of quantities.

7.2 All the HDPE pipes shall be jointed with Butt welding method complete as per manufacturer's specifications including testing of joints etc.

8. **TESTING**

a) All lengths of the sewer and drain shall be fully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from manhole. All pipes shall be subjected to a test pressure of at least 1.5 meter head of water. The test pressure shall, however, not exceed 1.5 meter head at any point. The pipes shall be plugged preferably with standard design rubber plugs on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the

required head. The tolerance figure of two liters per centimeter of dia per kilometer may be allowed during a period of ten minutes. Subsidence of the test water may be due to one or more of the following causes:

a) Absorption by pipes and joints
b) Sweating of pipe or joints
c) Leakage at joints or from defective pipes

b) Trapped Air

Allowance shall be made for (i) by adding water until absorption has ceased after which the test proper should commence. Any leakage will be visible and the defective part of the work should be cut out and made good. A slight amount of sweating which is uniform may be overlooked, but excessive sweating from a particular pipe or joint shall be watched for and taken as indicating a defect to be made good.

c) Sewer and Drain Pipelines shall be tested for straightness by:

d) Inserting a smooth ball 12mm less than the internal diameter of the pipe. In the absence of obstructions such as yarn or mortar projecting at the joints the ball should roll down the invent of the pipe and emerge at the lower end.

e) Means of a mirror at one end and a lamp at the other end. If the pipe line is straight the full circle of light will be seen otherwise obstruction of deviation will be apparent.

f) The Contractor shall give a smoke test to the drains and sewer at his own expense and charges, if directed by the Engineer-in-Charge / Owner.

g) A test register shall be maintained which shall be signed and dated by Contractor, Engineer-in-Charge / Owner and representative of Architects/ Consultants.

10. CEMENT CONCRETE AND MASONRY WORKS FOR MANHOLES AND CHAMBERS ETC.

10.1 Materials

■ **Water**

Acidity , Alkalinity and percentage of Solids shall be in accordance with IS: 3025. The Ph value shall generally be not less than 6. In general potable water is considered satisfactory for use.

Sea water shall not be used.

Testing shall be done individually for different source points before the start of the work and there after once in every three months.

■ **Aggregate for Concrete**

It shall be strong, durable and free from adherent coatings, sea shell, organic impurities, disintegrated pieces.

If dirty, shall be washed with water before actual use. Flaky and elongated piece shall be avoided. It shall confirm to IS: 383 and IS: 2386.

■ **Sand**

It shall be hard, durable, chemically inert, clean and free from adherent coatings, organic matter etc. and shall not contain any appreciable amount of clay bald harmful impurities and shall confirm IS: 23l or pellets an86. It shall not contain more than 8 % of silt as per the field test.

Grading for masonry, plaster and concrete shall be as per IS: 2116, IS: 1542, IS: 383 respectively, Sea sand shall not be used.

Testing for bulkage to be done and allowance be made at the time of use.

■ **Cement**

The cement used for all the constructional purposes shall be Portland pozzolana cement confirming to I.S. 1489 OR rapid hardening, Portland cement conforming to I.S. 269.

Different types of Cement shall not be mixed together, shall be stacked and stored separately. Cement Bags shall be stacked in a manner to facilitate their removal and use in the order in which they are received.

The site where it is stored shall be dry, leak proof and as far as possible moisture proof.

Necessary precautions to be taken to avoid dampness through floor and walls. Stacking shall not be more than 10 bags high.

■ **Mild Steel Reinforcement**

The mild steel for the reinforcement bars shall be in the form of round/ twisted/deformed bars conforming to all requirements of I.S. 432 (Grade I).

■ **Bricks**

Brick shall have uniform color, thoroughly burnt, smooth rectangular faces, with parallel slab, sharp and right angled edges, but not over-burnt.

When struck should give clear ringing sound.

The maximum permissible area of perceptible deposit of efflorescence shall be 50% of the surface area of the Bricks. The affected bricks should not be more than 80% of the lot. There shall be no powdering or flaking of the surface.

The average water absorption shall not exceed 22% by weight after 24 hours immersion in water.

The average minimum compressive strength for bricks of class designation 75 shall not be less than 75 kg / cm2.

■ **Other Materials**

Other materials not fully specified in these specifications and which may be required in the work shall conform to the latest I.S. All such materials shall be approved by the Engineer-in-Charge / Owner before use.

10.2 Cement Concrete (Plain or Reinforced)

b) Cement concrete pipes bedding, cradles, foundations and RCC slabs for all works shall be mixed by a Mechanical mixer where quantities of the concrete poured at one time permit. Hand mixing on properly constructed platforms may be allowed for small quantities by the Engineer-in-Charge / Owner. Rate for cement concrete shall be inclusive of all shuttering and centering at all depth and heights.

c) Concrete work shall be of such thickness and mix as given in the Schedule of Quantities.

d) All concrete work shall be cured for a period of at least 7 days. Such work shall be kept moist by means of gunny Bags at all times. All pipe trenches and foundations shall be kept dry during the curing period.

10.3 Masonry Work

Masonry work for manholes, chambers, brick masonry pipe trench and such other works as required shall be constructed from 1st class bricks as specified in the Schedule of Quantities in cement mortar 1:4 mix (1 cement: 4 coarse sand). All joints shall be properly raked to receive plaster.

10.4 Cement Concrete for Pipe Support

☞ Wherever specified or shown on the drawings, all pipes shall be supported in concrete bed all round or in haunches. The thickness and mix of the concrete shall be given in the Schedule of Quantities. Type of the bedding is as described as follows:

☞ Unless otherwise directed by the Engineer-in-Charge / Owner cement concrete for bed, all round or in haunches shall be laid as follows:-

Description	Upto 3 M depth
Pipes in open ground (No sub soil water)	All round (1:5:10)
Pipes (all) in sub soil water condition	All round (1:3:6)
Pipes under the building or at road crossing or under public places	All round (1:2:4)

(1=1 =1 cement, 2-3-5 coarse sand, 4-6-10) stone aggregate 20 / 40mm nominal size)

☞ R.C.C. pipes or C.I. pipes ,may be supported on brick masonry or precast R.C.C or Cast insitu cradles. Cradles shall be as shown on the drawings.

☞ Pipes in loose soil or above ground shall be supported on brick or RCC anchor blocks as shown on the drawings.

11. MANHOLES AND CHAMBERS

11.1 Applicable codes

The cast iron cover and frames/precast concrete cover and frames shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of cast iron cover and frames/precast concrete cover and frames fittings & specials shall be part of this Specification.

IS: 1726	Cast iron covers and frames Specification
IS:12592	Pre-cast concrete covers and frames Specification

11.2 SEWER APPURTENANCES

General Sewer Appurtenances are Manholes, Inverted Siphons, Storm Water Inlets, Sewer Ventilators. Manholes are the most essential items in any sewerage system.

11.3. Manholes:-

Manholes is the essential ancillary structure in any sewerage system. They shall be provided for inspection, testing, cleaning, repairing and removal of obstruction from sewer line.

11.4 Manholes is built at every change of alignment, gradient or diameter, at the head of all sewer and branches and at every junction of two or more sewers, on sewer, which is to be cleaned manually or which cannot be entered for cleaning or inspection.

11.5 Covers and frame shall conform to IS: 1726 for cast iron and IS: 12592 for precast concrete covers and shall be of the following grades and types.

Grades	Grade Designation	Type/shape of cover	Load (kN)	Diameter of Block (mm)
1	2	3	4	5
Light Duty	LD-2.5	Rectangular, Square, circular	25	300
Medium Duty	MD-10	Rectangular, circular and square (for pre-cast concrete manhole covers)	100	300
Heavy Duty	HD-20	Circular-square, Rectangular, (Scrapper manhole)	200	300
Extra Heavy Duty	EHD-35	Circular, Square, Rectangular,(Scrapper Manhole)	350	300

11.6 Spacing of Manholes : -

Pipe dia (mm)	Max. Spacing (mt)
Upto 900	30
900 to 1500	90-150
1500 to 2000	150-200
Above 2000	300

11.7 At every change of alignment, gradient or diameter of a drain, there shall be a manhole or inspection chamber. Bends and junctions in the drains shall be grouped together in manhole as far as possible.

11.8 Manholes of different types and sizes as specified shall be constructed in the sewer line at such places and to such levels and dimensions as shown in the drawings or as directed by the Engineer-in-Charge. The size specified shall indicate the inside dimensions between brick faces of the manholes.

11.9 Where the diameter of the drain is increased, the crown of the pipe shall be fixed at the same level and necessary slope given in the invert of the manhole chamber. In exceptional cases and where unavoidable, the crown of the branch sewer may be fixed at lower level but in such cases the peak flow level of the two sewers shall be kept the same.

11.10 Sewers of unequal sectional area shall not be jointed at the same invert in a manhole. The invert of the smaller sewer at its junction with main shall be at least 2/3 the diameter of the main above the invert of the main. The branch sewers shall deliver sewage in the manhole in the direction of main flow and the junction must be made with care so that flow in main is not impeded.

11.11 No drain from house fittings, e.g. gully trap or soil pipe, etc to manhole shall normally exceed a length of 6 m unless it is unavoidable.

11.12 Manholes 90 x 80 cm are generally constructed within compound for house drainage only and near the buildings for house drainage. Manholes 1.2 m X 90 cm are generally constructed for main drainage work for depths less than 1.5m.

11.13 Manhole 1.4 m x 90 cm is of the arched type and is generally constructed for main drainage works where depth is 1.50 m or more. The width of manholes shall be increased more than 90cm on

bends or junctions or pipes with diameter greater than 450 mm and that the benching width on either side of the channel is minimum 20 cm.

11.14 Manholes 1.5m internal diameter are generally constructed for main drainage works where depth is 2.45 m or more as an alternative to manholes of arch type. The diameter shall be increased suitably, for pipes with diameter greater than 450mm in the same manner as in the case of rectangular manholes.

11.15 Before deciding size of manholes, Local Municipal Bye Laws shall be consulted. When manholes are constructed on foot path, these shall be provided with cover of medium duty casting and when built within the width of the road under vehicular traffic, these shall be provided with cover of heavy duty casting.

11.16 Types of manholes- Following is the general classification of manholes-

11.17 Straight-through manholes-The simplest type of manhole is that built on a straight run of sewer with no side junctions. Where there is a change in the size of sewer, the soffit or crown level of the two sewers should be the same, except where special conditions require otherwise.

11.18 Junction Manholes- A manhole should be built at every junction of two or more sewers, and the curved portions of the inverts of tributary sewers should be formed within the manhole.

11.19 To achieve this with the best economy of space, the chamber may be built of a shape other than rectangular. The soffit of the smaller sewer at a junction should be not lower than that of the larger sewer, in order to avoid the surcharging of the former when the letter is running full, and the hydraulic design usually assumes such a condition.

11.20 The gradient of the smaller sewer may be increased from the previous manhole sufficiently to reduce the difference of invert level at the point of junction to a convenient amount.

11.21 Side Entrance Manholes: In large sewer or where it is difficult to obtain direct vertical access to the sewer from ground level, owing to existing services, gas, water etc. the access shaft should be constructed in the nearest convenient position off the line of sewer and connected to the manhole chamber by a lateral passage.

11.22 In the tunneled sewer the shaft and the lateral access heading may be used as a working shaft, the tunnel being broken out from the end of the heading, or alternatively the shaft and heading may be used as a working shaft, the tunnel being broken out from the end of the heading, or alternatively the shaft and heading maybe constructed after the main tunnel is completed, provision having been made for breaking in from the access heading to build the chamber.

11.23 The floor of the side-entrance passage, which should fall at about 1 in 30 towards the sewer, should enter the chamber not lower than the soffit level of the sewer. In large sewer here the floor of the side entrance passage is above the soffit either steps or a ladder (which should be protected either by a removable handrail or by safety chains) should be provided to reach the benching.

14.3.5. <u>Drop Manholes-</u>

The term drop manhole is used to indicate the manhole on sewer line which is constructed to provide a connection between the high level branch sewer to extent of about 500 mm to 600 mm above the main sewer to low level man sewer with a minimum amount of disturbance.

The construction of drop manhole avoids unnecessary steep gradient of branch sewer and it thus reduces the quantity of earthwork.

When a sewer connects with another sewer, where the difference in level between water lines (peak flow levels) of main line and the invert level of branch line is more than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or

impractical to arrange the connection with in 600 mm a drop connection shall be provided for which manholes maybe built incorporating a vertical or nearly vertical drop pipe from the higher sewer to the lower one.

This pipes maybe either outside the shaft and enclosed in concrete or supported on brackets inside the shaft, which should be suitably enlarged. If the drop pipe is outside the shaft, a continuation of the sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with a half blank flange.

If the drop pipe is inside the shaft, it should be in cast iron and it would be advantageous to provide adequate means for rodding and water cushion of 150 mm depth should also be provided. The diameter of the backdrop should be at-least as large as that of the incoming pipe

The drop pipe should terminate at its lower end with a plain or duck-foot bend turned so as to discharge its flow at 45 degree or less to the direction of the flow in the main sewer and the pipe, unless of cast iron, should be surrounded with 150 mm of concrete.

In the case of sewer over 450 mm in diameter the drop in level maybe accomplished by one of the following methods: -

A. cascade: -

This is a steep ramp composed of steps over which the flow is broken up and retarded. A pipe connecting the two levels is often concreted under the steps to allow small flow to pass without trickling over the steps. The cascade steps maybe made of heavy-duty bricks of class- I quality (IS: 2180-1985) cement concrete with granolithic finish or dressed granite.

B Ramp: -

A ramp maybe formed by increasing the grade of the last length of the upper sewer to about 45 degrees or by constructing a steeply graded channel or culvert leading from the high level to the low level sewer. In order to break up the flow down the ramp and minimize the turbulence in the main sewer the floor of culvert ramp should be obstructed by raced transverse ribs of either bricks or concrete at 1.50m intervals and a stilling pool provided at the bottom of the ramp.

c) By drop in previous successive manholes instead of providing the total drop require at the junction manholes, the same may be achieved by giving smaller deeps in successive manhole preceding the junction manhole. Thus, for example, if a total drop of 2.4m is required to be given, 0.6m drop maybe given in each of the previous three manholes and the last 0.6m-drop maybe given at the junction manhole.

Scraper (Service) Type Manhole: -

All sewers above 450mm diameter should have manhole at intervals for 110 to 120 m of scraper type. This manhole should have clear opening of 1200 X 900 mm at top to facilitate lowering of buckets.

Flushing manholes

Where it is not possible to obtain self-cleaning velocities due to flatness of the gradient specially at the top end of branch sewer which receive very little flow, it is essential that same form of flushing device be incorporated in the system.

This can be done by making grooves at intervals of 45 to 50m in the main drains in which wooden planks are inserted & water allow to head up which will rush on with great velocity when the planks are removed.

Alternatively, an overhead water tanks is built, from which connection are made through pipe flushing hydrants to rush water to the sewer. The relevant Indian standard IS: 4111(part two).Flushing can be very conveniently accomplished by use of fire hydrant or tanker.

Where flushing manhole is provided, they are located generally at the head of a sewer. Sufficient velocity shall be imparted in the sewer to wash away the deposited solid. The flush is usually effective up to a certain distance after which the imparted velocity gets dissipated.

The automatic systems which are operated by mechanical units gets often corroded by the sewer gases and do not generally function satisfactorily and hence are not recommended. Care should be exercised to be ensuring that there is no possibility of back flow of sewer into the water supply mains.

Constructional Details: -

Manhole is usually constructed directly over the centre line of the sewer they are usually constructed with brickwork. However in areas where sewers are to be laid in high water condition manhole shall be constructed in R.C.C. They are circular, rectangular or square in shape. Manholes should be of such size as will allow necessary cleaning and inspection of manholes.

Rectangular Manholes - The minimum internal sizes of rectangular manholes between brick face should be as follows:

a) For depth of manholes less than 0.9m, 900mm x 800mm
b) For depths of manholes from 0.9m and up to 2.5m, 1200mm x 900mm

Arch type manholes - For depth of 2.5m and above, arch type manholes can be provided and the internal size of the chambers between brick faces shall be 1400mm x 900mm. The width of manhole chamber on bends and junction of pipes with diameter greater than 450mm should be suitably increased to 900mm or more so that benching width on either side of the channel at-least 200mm.

Circular manholes -

Circular manholes are longer than rectangular and arch type manhole and thus they are preferred over rectangular as well as arch type manholes. The circular manholes can be provided for all depths starting from 0.9m circular manholes are straight down in lower portion and slanting in top portion so as to narrow down the top opening equal to internal dia. of manhole over.

Depending upon the depth of manhole, the diameter of manhole changes. The internal diameter of circular manholes may be kept as following for verifying depths.

b) For depths 0.9m and up to 1.65mm, 900mm diameter.
c) For depths above 1.65m and up to 2.30m, 1200mm diameter.
d) For depths above 2.30m and up to 9.0m, 1500mm diameter.
e) For depths above 9.0m and up to 14.0m, 1800mm diameter.

If the sewer is constructed in a tunnel, the manhole should be located at the access or working shaft and the manhole chamber maybe constructed of a size to suit the working shaft or vice-versa.

The width/diameter of the manhole should not be less than internal diameter of the sewer +150mm benching at both sides (150mm+ 150mm) The opening for entry into the manhole (without cover) should be such minimum diameters as to allow a workman with the cleaning equipments into the interior of the manhole without difficulty. A minimum clear opening of 60cm preferably circular is recommended. Suitable steps usually cast iron shall be provided for entry.

Access shaft for large sewers - Access shaft shall be circular in shape and shall have a minimum internal dia of 750mm, where the depth of the shaft exceeds 3m suitable dimensions shall be provided to facilitate cleaning and maintenance.

Access shaft where built of brick work should be carvel led on three sides to reduce it to the size of the opening in the cover frame and to provide easy access on the fourth side iron step or ladder .In determining sizes the dimensions of the maintenance equipments likely to be used in sewer, shall be kept in mind.

Where the diameter of the sewer is increased, the crown of the entering & leaving pipes shall be fixed at the same level and necessary slopes given in the invert of the manhole chamber. In exceptional cases and where unavoidable the crown of the entering sewer maybe fixed at lower level but in each cases the peak flow level of the two sewer shall be kept the same.

A slab of plain cement concrete at least 150mm thick should be provided at the base to support the walls of the manhole and to prevent the entry of foul water.

The thickness of the base shall be suitably increased up to 300mm, for manholes on large dia sewers, with adequate reinforcement provided to withstand excessive uplift pressures. In the case of larger manholes, the flow in the sewer should be carried in **U**-Shaped smooth channel constructed integrally with the concrete base of the manhole.

The side of the channel shall be equal to the dia. of the largest sewer pipe. The adjacent floor should have a slope of 1 in 10 draining to the channel. Where more than one sewer enters the manhole the flow through channel should be curved smoothly and shall have sufficient capacity to carry the maximum flow.

It is desirable to place the first pipe joint outside the manhole as close as practicable. The pipe shall be built inside the wall of the manhole flush with the internal periphery protected with an arch of masonry or cement concrete to prevent it from being crushed.

The sidewalls of the manhole are usually constructed of cement brickwork 250mm thick and corbelled suitably to accommodate the frame of the manhole cover.

The inside and outside of the brickwork should be plastered with cement mortar 1:3 (1 cement: 3 coarse sand). Inside finished smooth with a coat of neat cement.

Where subsoil water condition exist, a richer mix may be used and it shall further be water proofed with adequate quantity addition of approved water proofing compound as per manufacturer's specifications.

Hazards & Safety of manhole work:-

The element of the sewer maintenance is ignored very often, which requires careful attention and protective measures is the manhole work.

The staff should be trained for the comparatively easy act of removing a manhole cover, not only to avoid smashed toes and fingers, but also to prevent more serious back injuries.

In addition, the approaching drivers on the road should be warned from a distance about the manhole work in progress by installation of suitable signals of light.

The most serious hazards of manhole work are however flammable gas and oxygen deficiency. The workers should be thoroughly trained to carry out simple tests on every manhole before entry to detect oxygen deficiency, combustibles, carbon monoxide or hydrogen sulphide.

Ventilate the sewer line by opening two or three manholes on both the sides where work is to be carried out. This is more important when adequate blowers for ventilating sewers are not available. The manholes should be opened at least one hour before start of operations. The opened manholes should be properly fenced to prevent any person, especially children, accidentally falling into the sewer. Dummy covers with BRC welded fabric can be used.

Where it is desirable to use the blowers, operate these for at least 30 minutes before start and during cleaning operations to ventilate the lowest working levels.

Use safety harness and life line before entering the sewer line. Two helpers at the top should be provided for each person. The person standing at the top must send signals at every few minutes interval to the person in the manhole to ensure safety.

Test manhole rungs or steps for structural safety before using.

Ensure that, where portable ladders are used, they are properly seated or fixed.

Ensure that no material or tools are located near the edge which can fall into the manhole and injure the workman.

Lower all tools to the workman in a bucket.
Use lighting equipment which must be explosion and fire proof.
Use Gas masks when men have to enter into the sewer line.

Covers and frames: -
The size of manhole covers should be such that there should be clear opening of not less than 560mm diameter for manholes exceeding 0.9m depths.

When cast iron manhole covers and frames are used they shall confirm to IS 1726 (parts 1 to 7). The frames of manhole shall be firmly embedded to correct alignment and level in plain concrete on the top of masonry. After completion of the work, manhole covers shall be sealed by means of thick grease.

Where sewer are to be laid in high subsoil water conditions, manholes maybe constructed in R.C.C. of grade M20 or 1:1.5:3. The manholes in this type of construction preferably shall be circular.

Heavy reinforced concrete covers with suitable lifting arrangements could also be used instead of C.I manhole covers. However pre-cast cement concrete covers reinforced by materials other than mild steel should be used provided that those are properly tested & certified for use by competent authority. Fibre reinforcement plastic covers (FRP) conforming to relevant IS: may be used wherever such covers are available.

12. GREASE TRAP/OIL RETENTION CHAMBER

Grease Trap shall be provided on Treatment Room waste lines before discharging the waste into the main sewer line. Grease Trap shall be built in RCC masonry and shall be similar in construction to manholes. The grease trap shall be construction to size as shown at the location on drawings. The grease trap shall be provided with drop inlet, drop outlet, galvanised wrought iron sediment pan and a baffle wall. Grease trap shall be provided with 2 Nos, double seal DI Heavy duty manhole cover and frame which shall be identified with lettering `Grease trap".

13. MAKING CONNECTIONS

Contractor shall connect the new sewer line to the existing manhole by cutting the, benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manhole for the new connection. Contractor shall remove all sewage and water if encountered in making the connection without additional cost.

14. MEASUREMENT

14.1 **Pipes**

The net length of pipes as laid for fixed should be measured in running meters correct to a cm as laid, lowered and jointed from inside of one manhole to the inside of the other manhole. The length shall be taken along the center line of the pipes

All Fittings such as bends, junctions, which shall not be measure separately. Excavation, refilling, shoring and timbering in trenches and cement concreting wherever required shall be measured separately under relevant item of work.

14.2 **Gully Traps**

Gully traps shall be measured by the number and rate shall include all Excavation, Foundation, Concrete Brick Masonry, Cement Plaster inside and outside, C.I. Grating and sealed cover and frame.

14.3 **Manholes**

(a) All manholes shall be measured by numbers and shall include all items specified above and necessary Excavation, Refilling & Disposal of surplus earth.

(b) Manholes with depths greater than specified under the main item shall be paid for under "extra depth" and shall include all items as given for manholes. Measurement shall be done to the nearest cm. Depth of the manholes shall be measured from top of the manhole cover to bottom of Channel.

14.4 **Drop Connections**

Drop connections shall be measured by number for a depth of 60 cms or part thereof between invert levels. Additional depth shall be paid for as extra per meter depth as per the actual length of the drop connection, measured to the nearest cm.

14.5 **Making Connections**

Item for making connection to municipal sewer shall be paid for by number and shall include all items given in the Schedule of Quantities and Specifications.

14.6 **Masonry Drains**

Payment for masonry drains shall be made under individual items of Masonry, Cement concrete and plaster by volume or area as given in the Schedule of Quantities.

14.7 Brick Masonry and Cement Concrete shall be measured per cubic metre and shall include all items as given in the Schedule of Quantities.

14.8 For Cement Plaster, Length and breadth shall be measured correct to a Centimeter and it's area shall be calculated in Sq. M. correct to two places of decimal.

15. COMMISSIONING

15.1 After successful testing of the different sewerage and drainage pipes in parts, the Contractor shall provide all facilities including necessary pipings, labours, tools and equipments etc. for carrying out testing and commissioning of the entire external sewerage and drainage system complete as per requirement in the presence of Client representative/Consultant, whenever and as may be required. Generally, the following test/inspection has to be carried out:-

(a) For any Leakages/seepages in the external sewerage and drainage pipes.

(b) For checking the functioning of the entire external sewerage and drainage system including rainwater harvesting system and to ensure that the waste water is continuously flowing towards outfall without any intermediate stagnation.

(c) For the functioning of the valves and accessories etc. by putting ON/OFF the controlling valves of the various diversions in the sewerage and drainage and rain water harvesting system.

END OF SECTION – IV

GUIDE LIST OF APPROVED MAKES OF MATERIALS

NOTE: CONTRACTORS SHALL QUOTE FOR THE 1ST PREFERENCE ONLY, 2 NO PREFERENCE SHALL ONLY BE ALLOWED ON APPROVAL BY CLIENT/CONSULTANT

S.N	Material / Item	Code / Standard	PREFERENCE 1		PREFERENCE 2
	PLUMBING LOW SIDE				
1	Vitreous China Sanitaryware (Client/ Arch to Approve)	2556	**HINDWARE** Manufacturer: Hindustan Sanitaryware, Bahadurgarh	**CERA** Madhusudan Ceramics, N.D.S.E, Part – II, New Delhi – 110 049	**PARRYWARE**
2	Plastic W.C Seats with cover (Except where to be supplied with WC)		**ADMIRAL** Navin Industries, C-82, Mayapuri Indl. Area, Phase-I, New Delhi, Ph: 540 4543	**COMMANDER** Phenoweld Polymer Pvt. Ltd, Mumbai	
3	C.P fittings (Client/Arch to Approve)		**JAQUAR** Jaquar & Co., New Delhi	**VIJAY METAL WORKS** 3792, Street Lohe Wali, Chawri Bazar, Delhi - 110006 Tel - 23931621, 23941438 Email: info@bathroomfittingsindia.com	**AQUAPLUS** A-232, Okhla Main Road, A-232, Okhla Main Road, Phase - I
4	Concealed Flushing Cisterns		**GEBERIT** Gupta Sanitary & Hardware Store, E-14/1, Hauz Khas New Delhi – 110017 Tel: 26861541/26866566	**VIEGA** GEM Sanitary Appliances Pvt. Ltd. A-57, Wazirpur Indl. Estate, Delhi- 110052 Email: viega.delhi@gmgrindia.in	
5	Sensor Operated Flushing System		**TOSHI**	**UTEC** Utec Systems 17, New Rohtak Road, First Floor New Delhi – 110 005 Ph: 3632741/3422574	**EURONICS** C-1 / 8, Green Park New Delhi, Ph: 26521709, 26851014
6	Liquid Soap Dispensor		**TOSHI**	**UTEC** Utec Systems 17, New Rohtak Road, First Floor New Delhi – 110 005 Ph: 3632741/3422574	**EURONICS** C-1 / 8, Green Park New Delhi, Ph: 26521709, 26851014
7	Air Purifier / Aerosol Dispenser		**EURONICS** C-1 / 8, Green Park New Delhi, Ph: 26521709, 26851014	**UTEC** Utec Systems 17, New Rohtak Road, First Floor New Delhi – 110 005 Ph: 3632741/3422574	**JAQUAR** Jaquar & Co., New Delhi

8	C.P Bottle Trap		**VIJAY METAL WORKS** 3792, Street Lohe Wali, Chawri Bazar, Delhi - 110006 Tel - 23931621, 23941438 Email: info@bathroomfittingsindia.com	**JAQUAR** Jaquar & Co., New Delhi	
9	Plastic Bottle Trap		**VIEGA** GEM Sanitary Appliances Pvt. Ltd. A-57, Wazirpur Indl. Estate, Delhi- 110052 Email: viega.delhi@gmgrindia.in	**ASR** Deepak Exim Company, LG-4, J-21, South Extn – I, New Delhi – 110049, Tel: 24628121	**MCALPINE** Products Unlimited, 2nd Floor, D_1, Kalkaji Extn. New Delhi -19, Ph: 011-41675560, 26475132
10	Multi-Pan WC Connector		**VIEGA** GEM Sanitary Appliances Pvt. Ltd. A-57, Wazirpur Indl. Estate, Delhi- 110052 Email: viega.delhi@gmgrindia.in	**MCALPINE** M/s Products Unlimited, F-14, Unit No 7, 1st Floor (Opp. Khidmat Restaurant), Kalkaji, New Delhi T: +91 (11) 41675560/70/80 +91-9312290957, enquiry@productsunlimited.in	
11	C.P Angle Valve		**ARCO** Deepak Exim Company, LG-4, J-21, South Extn – I, New Delhi – 110049, Tel: 24628121	**VIJAY METAL WORKS** 3792, Street Lohe Wali, Chawri Bazar, Delhi - 110006 Tel - 23931621, 23941438 Email: info@bathroomfittingsindia.com	**SCHELL** 1003, Mercantile House 15, Kasturba Gandhi Marg, New Delhi 110001 Landphone: +91 11 45652320-26, Handphone: +91 9953554435 Fax: +91 11 45652329
12	Flexible Connectors for Water Supply to Wash Basins/Sinks/Geysers		**VILINO BRAIDEN**	**ASR**	
13	Flow Regulator Devices		**ARCO** Deepak Exim Company, LG-4, J-21, South Extn – I, New Delhi – 110049, Tel: 24628121		
14	Stainless Steel Sink		**AMC** Steel Craft Industries, 3498, Bajrang Bali Street, New Delhi – 06, Ph: 55195960, 23279199	**JAYNA** Jain Brothers Sanitation Pvt.Ltd., 12, SSI Industrial Area, GT Karnal Road , Delhi – 110033, Ph: 27252436/27452594	**NEELKANTH** Sekhri Brothers, B-57, Mayapuri Indl. Ph-I, New Delhi
15	Health Faucet		**VIJAY METAL WORKS**	**JAQUAR**	

			3792, Street Lohe Wali, Chawri Bazar, Delhi - 110006 Tel - 23931621, 23941438 Email: info@bathroomfittingsindia.com		
16	Electrical Water Heater / Geyser		**VENUS** Venus Home Appliances (P) Ltd. A-49, 2nd Floor, Mayapuri Indl. Enclave, Phase-I, New Delhi - 110 064 Tel - 28225401/5402 Email:- delhi@venushomeappliances.com	**BRAUN** Deepak Exim Company, LG-4, J-21, South Extn – I, New Delhi – 110049, Tel: 24628121	**AO SMITH**
					JAQUAR Jaquar & Co., New Delhi
17	CP / SS Grating for Floor Trap & Floor Drain		**VIJAY METAL WORKS** 3792, Street Lohe Wali, Chawri Bazar, Delhi - 110006 Tel - 23931621, 23941438 Email: info@bathroomfittingsindia.com	**NEER**	
	PLUMBING LOW SIDE (PIPES & FITTINGS)				
1	G.I. pipes	1239 Pt-I	**TATA** The Tata Iron & Steel Co. Ltd., Calcutta		**JINDAL HISSAR** Jindal Hissar
2	G.I. Fittings for Water Supply (Malleable)	1879, (Part I, to X)	**UNIK** Unique Mfg. Co., Jallandhar	**Zoloto** Contact person: Mr. Nagesh Dutt, 5 & 6 Raghushree Building, First Floor , Ajmeri Gate, Delhi – 110006, Mob: 9818671311	**NEW**
3	G.I./M.S Forged Steel pipes & fittings I.S:1239 (Part-II)		**VS** Vijay Cycle & Steel Industries, Model House Road, Basti Sheikh, Jallandhar	**DRP** DRP Metal works, Sodal Road, Jalandhar – 144004, #0181-290050, 293050	**TRUE FORGE**
4	CPVC Pipes	15778	**ASHIRVAD FLOWGUARD** Hindustan Pipes Sales corporation 319, Syndicate House Contact Person: S.N. Gupta Mob: 9810042538	**ASTRAL FLOWGUARD** 414, Ansal Chamber – II 6, Bikaji Kama Place New Delhi -110066	**FLOWGUARD**
5	Copper Pipes		**RAJCO**		

			Rajco Metal Industries,, rajcojitendra@vsnl.net, 0120-2659860, 9810475768		
6	SS Pipes	304	**JINDAL STAINLESS** M/S Reliable Metals (India) 747-A, Gali Kundewalan, Ajmeri Gate, New Delhi - 110 006 Contact Person: Mr Ashok Sanghvi Jain Mob - 9312402610 Ph- 011-23214871, 23234870 Fax- 23214871 Email: sanmetal@hotmail.com		
7	SS Pipes	316	**JINDAL STAINLESS** M/S Reliable Metals (India) 747-A, Gali Kundewalan, Ajmeri Gate, New Delhi - 110 006 Contact Person: Mr Ashok Sanghvi Jain Mob - 9312402610 Ph- 011-23214871, 23234870 Fax- 23214871 Email: sanmetal@hotmail.com		
8	PP-R Pipes	DIN 8077 & 8078	**SFMC** Savoir-Faire Manufacturing co. Pvt. Ltd.	**FUSION** Yeekay Technocrats Pvt Ltd, Plot 1 & 4, Bock H NH-2, NIT, Faridabad 122001. Ph: 9310763523, 9310263523	**VECTUS** A-101, Sector 83, NOIDA UP - 201301, Ph: 91-120-3206869, 2545892
9	Composite Pipes		**KITEC** Carewell Pipes102, Ist FloorUsha Kiran BldgAzadpur, Delhi – 110033#27682574, 32901826		
10	UPVC pipes	4985-	**SUPREME**	**PRINCE**	

		1981	The Supreme Industries Ltd., 518, Osian Building, 12, Nehru Place, New Delhi – 110 019	Hindustan Sales Corporation, 319, Syndicate House, Inderlok , New Delhi – 110 035, #23658087, 65909169	
			AKG AKG Extrusions Pvt. Ltd. Corp. Off.: B-51, Hosiery Complex, Phase-II Extension, Noida - 201305 (U.P.) Tel.-0120-4619300-316 Fax-0120.4282809 Mob. 9968454879, 9560024557 Email: akgextrusions@in.com, akgextrusions@gmail.com	**JAIN PIPES** Hindustan Pipe Sales Corporation 319, SyndicateHouse Inderlok N.D. 35 #23659349, 23658087	
11	HDPE Pipes		**JAIN PIPES** Hindustan Pipe Sales Corporation 319, SyndicateHouse Inderlok N.D. 35 #23659349, 23658087	**ORIPLAST**	**RELIANCE**
12	HDPE Pipes (For Soil & Waste)	DIN 8047/ 45	**SO SOON** Marketed in India By: GMGR Bath Fittings Pvt. Ltd. GMGR House, J-3, Block B-1, Mohan CO-operatuve Indl. Estate, Mathura Road, New Delhi - 110044 Tel - 9899199515, 9310399518 Email: ho.gmgrbf@gmgrindia.in		
14	Sand Cast Iron Pipes & fittings	1729	**NECO**	**HEPCO**	

			Jayaswal Neco Ltd.,Nagpur, B-19, Foundry Nagar, Hathras Road,Agra – 282 006, Ph: 2344596, Mob: (0)9412261473		
15	Sand Cast Iron Pipes & fittings	3989	**NECO** Jayaswal Neco Ltd.,Nagpur, B-19, Foundry Nagar, Hathras Road,Agra – 282 006, Ph: 2344596, Mob: (0)9412261473	**HEPCO**	
16	SWR Pipes	IS: 13592 for SWR Pipes and IS: 435 for Fittings	**AKG** AKG Extrusions Pvt. Ltd. Corp. Off.: B-51, Hosiery Complex, Phase-II Extension, Noida - 201305 (U.P.) Tel.-0120-4619300-316 Fax-0120.4282809 Mob. 9968454879, 9560024557 Email: akgextrusions@in.com, akgextrusions@gmail.com	**SUPREME** The Supreme Industries Ltd. 518, Osian Building 12, Nehru Place, New Delhi – 110 019 **PRINCE** Hindustan Sales Corporation, 319, Syndicate House, Inderlok , New Delhi – 110 035, #23658087, 65909169	**FINOLEX** Finolex Industries Ltd.
17	uPVC Multi Outlet Inlet Fittings for Traps		**AKG** AKG Extrusions Pvt. Ltd. Corp. Off.: B-51, Hosiery Complex, Phase-II Extension, Noida - 201305 (U.P.) Tel.-0120-4619300-316 Fax-0120.4282809 Mob. 9968454879, 9560024557 Email: akgextrusions@in.com, akgextrusions@gmail.com	**PRINCE** Hindustan Sales Corporation, 319, Syndicate House, Inderlok , New Delhi – 110 035, #23658087, 65909169	

18	Stoneware pipes & Gully Trap	651-1992	**ANAND** Lal chand Anand & Sons, 13/1 Bulandshahr Road Industrial Area, Ghaziabad 201011 , Tel: 120-4700500, 600	**BK CERAMICS INDUSTRY** Jhajjar Rohtak Road, Village Birdhana, Distt. Jhajjar, Haryana Contact No.: 09211017074, 07404290567	**Local Approved as per BIS Standards**
19	RCC PIPES	IS:458	**PRAGATI** A-1/31 Janakpuri New Delhi 110058, Tel: 25552191	**KRISHNA SPUN PIPES** Village Gubhana, Bakargarh Road, Bahadurgarh, Haryana (India) Contact Person: Mr Deepak Kumar (Proprietor) Mob:+919812591092	**OM SPUN PIPE** Booth 4 & 5, HUDA Market, Sec-1, Ballabgarh, Faridabad, Haryana, M: 9811881516, 9311011362, osp.industries@gmail.com
20	CILA pipes	1536	**ELECTROSTEEL** Electrosteel Castings Ltd., 40, Stephen House, 4, B.B.D Bag (East) , Calcutta	**KESORAM** Kesoram Spun Pipe & Foundries, Calcutta	
21	C.I. fittings	1538	**NEEL** AR Shining Foundry & Engg. Works, Delhi – 110 006	**KARTAR** Kartar valves and fittings, D-154, Fateh Nagar, Jail Road, New Delhi – 18, Mob:9312408001	**SARKAR** H.Sarker & Co., Ajit Sen Bhawan, 13, Crooked Lane, 2nd Floor, Calcutta – 69
22	D.I. pipes	1536	**KESORAM** Kesoram Spun Pipe & Foundries, Calcutta	**ELECTROSTEEL** Electrosteel Castings Ltd., 40, Stephen House, 4, B.B.D Bag (East) , Calcutta	**JINDAL HISSAR** Jindal Hissar
23	D.I. fittings		**KARTAR** Kartar valves and fittings, D-154, Fateh Nagar, Jail Road, New Delhi – 18, Mob:9312408001	**ELECTROSTEEL** Electrosteel Castings Ltd., 40, Stephen House, 4, B.B.D Bag (East) , Calcutta	
24	Insulation For Hot water Pipes		**CAREFLEX** Careflex		
25	Insulation For External / Exposed Hot water Pipes		**CAREFLEX** Careflex		
26	Pipe protection For External Water Supply Pipes		**PYPKOTE**	**MAKPOLYKOTE**	**ARMAFLEX** Goojar Mal Ganpat Rai, 3370-71, Hauz Qazi, Delhi – 110 006, Tel:3264483/32633

					80
27	Pipe Joint Sealant for Cast Iron Pipes		**PIPESEAL** Mayur Paints, 74, Shradhanand Marg, Delhi - 110006, India Phone:91-11 23963128/65366544/ 43709268 Fax:91-11-23963128	**DRIPSEAL** Homecare Agency, 12-H, Darya Ganj Opposite Traffic Kotwali New Delhi – 110 002 India, Phone : +91-11-2328 2718, +91-11-2325 1975 Fax: +91-11- 2325 1975 Email: sales@homecareindia.net	
28	Pre-Fabricated Structural supports and clamps		**CHILLY** Veer Sanitary Appliances Pvt. Ltd., B-10/3, Paras Bhawan, Group Indl. Area, Wazirpur, Delhi – 110052, Tel-20532036/9811156106	**EASYFLEX** Kanwal Industrial Corporation, B-167/168, Phase-2, NOIDA 201305, Tel: 0120-2462370-71, E: pawan@easyflex.in, marketing@easyflex.in	**CAMRY** Veer Bath Accessories Pvt. Ltd., I-2228, DSIDC Industrial Park, Narela, New Delhi – 40, Ph: - 27787172
29	Paints		**ASIAN PAINTS**	**BERGER**	
	PLUMBING LOW SIDE (VALVES & RELATED ACCESSORIES)				
1	Gunmetal Fullway Valve	778 Class I	**ZOLOTO** Zoloto Industries, Jallandhar.	**SANT** Sant Brass Metal Works, Jallandhar	**LEADER** Leader Engg. Works, Jallandhar
2	Gunmetal Fullway Valve	778 Class II	**ZOLOTO** Zoloto Industries, Jallandhar.	**SANT** Sant Brass Metal Works, Jallandhar	**LEADER** Leader Engg. Works, Jallandhar
3	Ball valve		**ARCO** Deepak Exim Company, LG-4, J-21, South Extn – I, New Delhi – 110049, Tel: 24628121	**CIM** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	**ZOLOTO** Zoloto Industries, Jallandhar.
4	Ball valve w/ In-Built Filter		**ARCO** Deepak Exim Company, LG-4, J-21, South Extn – I, New Delhi – 110049, Tel: 24628121	**CIM** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	**ZOLOTO** Zoloto Industries, Jallandhar.
5	Butterfly Valve	13095 -1991	**KSB** Aquatech Engineers, E-5/12, Basement, Malviya Nagar, N. Delhi- 17	**SKS** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	**AIP** Agriculture & Industrial Products

6	Air Release Valve		**SANT** Sant Brass Metal Works, Jallandhar	**TIEMME** Rajco Metal Industries,, rajcojitendra@vsnl.net, 0120-2659860, 9810475768	
				SKS Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	
7	C.I double flanged sluice valve	780	**KIRLOSKAR** Kirloskar Brothers, Pune	**SKS** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	**AIP** Agriculture & Industrial Products
8	C.I Disk Type non return valves (65mm dia and above – Dual plate type)	5312	**KIRLOSKAR** Kirloskar Brothers, Pune	**SKS** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	**AIP** Agriculture & Industrial Products
9	Float valve (gunmetal) upto 40mm		**LEADER** Leader Engg. Works, Jallandhar	**AIP** Agriculture & Industrial Products	
10	Float valve (C.I) 50mm and above		**LEADER** Leader Engg. Works, Jallandhar	**SARKAR** H.Sarker & Co., Ajit Sen Bhawan, 13, Crooked Lane, 2nd Floor, Calcutta – 69	**CSA** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com
11	Altitude / Equilibrium Float Valve		**CSA** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	**HONEYWELL** Products Unlimited	**DANFOSS** Dealer Goojar Mal Ganpat Rai 3370-71, Hauz Qazi Delhi – 110 006 Tel:23264483/ 23263380
12	C.I Strainer more than 65mm dia.	4308	**SKS** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	**KARTAR** Kartar valves and fittings, D-154, Fateh Nagar, Jail Road, New Delhi – 18, Mob:9312408001	**AIP** Agriculture & Industrial Products
13	Pressure Reducing Valve		**SKS** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	**NVR Valves** Vpo Randhawa Mansandan Jalandhar, 144004	**AIP** Agriculture & Industrial Products
14	Solenoid Valve		**DANFOSS**	**HONEYWELL**	

			Dealer Goojar Mal Ganpat Rai 3370-71, Hauz Qazi Delhi – 110 006 Tel:23264483/ 23263380	Products Unlimited	
15	Butterfly Valve with Electric Actuator / Motorized		**SKS** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	**AIP** Agriculture & Industrial Products	**CASTLE**
16	Thermostatic Mixing Valve		**ARCO** Deepak Exim Company, LG-4, J-21, South Extn – I, New Delhi – 110049, Tel: 24628121	**GIACOMINI** Modern Sales Agency	
17	PVC Valves		**CEPEX**	CERTKIN	
	PLUMBING EXTERNAL ITEMS				
1	D.I Manholes cover	1726	**NECO** Jayaswal Neco Ltd.,Nagpur, B-19, Foundry Nagar, Hathras Road,Agra – 282 006, Ph: 2344596, Mob: (0)9412261473		
2	SFRC Manhole Cover & Gratings		**ABC-ACCURATE BUILDCON** 1792, Sector -28 Faridabad Contact Person: Manish K. Aggarwal Mob: 9810411720, 910324423	**SURABH** Surabh Ferro Concrete Pvt. Ltd. KP-278 Maurya Enclave, Pitampura Delhi	**OM SPUN**
3	Plastic Encapsulated Foot Rest		**KGM** KGM Associates, 12/16, Basement, Sarvapriya Vihar, New Delhi – 110016		
4	Irrigation Equipment		**JAIN IRRIGATION**	**CEPEX**	**RAINBIRD**

WATER SUPPLY PUMPS, EQUIPMENTS & WATER TREATMENT UNIT

TECHNICAL SPECIFICATIONS

1. PUMPS AND WATER TREATMENT EQUIPMENT

1.1 Work under this sub-head consists of furnishing all labour, with appropriate T&P scaffolding & staging as required to completely install pumping system for various water supply services and water treatment as per drawings, specified hereinafter and given in the Bill of Quantities.

1.2 Without restricting to the generality of the foregoing, the work of pumps and water treatment equipment shall include the followings:

- Raw water pumps.
- Domestic water supply Pumping System.
- Garden Water Supply Pumps.
- Booster Pump Sets
- Sump pumps for disposal from drainage and sewerage sumps for Plant rooms / Basements etc.
- Water treatment units consisting of filters, softening plant and chlorination etc.
- Level Control & indication System
- Motor control panels, power and control cabling and allied electrical works.
- Pipes, valves, accessories, hangers, supports, delivery and suction feeders and connection to proposed pipe work.

2. RE-LIFT WATER SUPPLY PUMPSETS

2.1 Water supply pumps shall be suitable for clean water. Pumps shall be single or multistage, monoblock horizontal/vertical, centrifugal pumps with cast iron/stainless steel body and stainless steel/bronze impeller, stainless steel shaft and coupled to a TEFC electric motor by means of a flexible coupling or as specified in bill of quantities. Each pump should operate a curve 10m below specified head.

2.2 Pump and motor shall be mounted on a common M.S. structural or C.I. base plate or as required as per site conditions.

2.3 Each pump shall be provided with a totally enclosed fan cooled induction motor of required H.P. and RPM specified in the bill of quantities and as per requirement.

2.4 Each pumping set shall be provided with a 150mm dia or of suitable size gunmetal "Bourden" type pressure gauge with gunmetal isolation cock and connecting piping.

2.5 Each pump shall be provided with vibration-eliminating pads as suitable for each pump.

2.6 Each pump-set shall be provided with flow measuring meter with bypass arrangement as per requirements and instructions of the engineer-in-charge. (Flow meter items shall be paid for separately as per relevant BOQ item).

2.7 All water supply pumps shall be provided with mechanical seals, of required specifications.

2.8 Installation

Pump shall be installed as per manufacturer's recommendations. Pump sets shall be mounted on machinery isolation cork or any other equivalent vibration isolation fitting. The vibration

isolation pads, foundation bolts etc. shall be supplied by the Contractor. Contractor shall ensure that the foundation bolts are correctly embedded.

Pump-sets shall preferably be factory aligned, wherever necessary, site alignment shall be done by competent persons.

2.9 Testing

Contractor shall submit all the performance curves of the pumps supplied by them. They shall also check the capacity and total head requirements of each pump to match their own piping and equipment layout. On completion of the entire installation, pumps shall be tested, wherever possible, for their discharge, head, flow rate, B.H.P. Where it is not possible at least the discharge, head and B.H.P. (as measured on the input side) shall be field tested. Test results shall correspond to the performance curves.

2.10 Painting

After complete installation and testing, pumps accessories and fittings shall be given two coats, three mils each of approved finishing paint.

3. HYDRO PNEUMATIC SYSTEMS

3.1 Hydro pneumatic systems (With Variable Frequency Drive)

3.1.1 The scope of this section covers supply, installation, testing and commissioning of compact packaged type skid mounted, self-contained variable frequency drive hydro pneumatic system. The skid mounted, factory assembled hydro-pneumatic system shall be provided with pressure transmitters, frequency convertor for noiseless operation of the pump at varying duty point. The convertor shall be provided with short circuit safety, earthing, over current, under voltage protection. The system shall comprise of multiple pumps working and one stand-by to meet the system discharge requirements.

3.1.2 It shall confirm the following specifications:

a) Pumps shall be vertical, inline multistage centrifugal and fulfils all specifications specified in para 8.1 "Water supply pumps".

b) Pressure vessel shall be of non-corrosive FRP composite construction lined with NSF and /or FDA listed material, like high density polyethylene with fully replaceable polyurethane. Air cell burst pressure of minimum of five times the vessel operating pressure and cycle tested for 2,50,000 cycles with charging connections to discharge pipe line with necessary flanges, gaskets, isolating valve, nuts/ bolts etc. with suitable foundation bolts & other accessories, complete. Capacity provided shall be as per manufacture specifications.

c) Panel mounted microprocessor multi pump controller with large graphical display and variable frequency drive (VFD) mounted inside a panel complete with pressure sensor transmitter. The graphical display is capable to show number of pumps running & also communicate with other controllers following with open protocol through RS485 port. System should be capable to compensate for frictional losses at lower flows. All alarms should be displayed in the controller. The panel should also have provision for manual / automatic alternate (cyclic) operation of pumps, ON/OFF switch, inter connecting power and control cabling etc complete.

3.2 Hydro pneumatic systems (Without Variable Frequency Drive)

3.2.1 The scope of this section covers supply, installation, testing and commissioning of compact packaged type skid mounted, self-contained hydro pneumatic system. The skid mounted, factory assembled hydro-pneumatic system shall be provided with pressure switches. Control panel should consist of short circuit safety, earthing, over current, under voltage protection. The system shall comprise of multiple pumps working and one stand-by to meet the system discharge requirements.

3.2.2 It shall confirm the all those specifications specified above with the following:

- Panel mounted microprocessor multi pump controller with large graphical display, pressure switches, indications to indicate pump ready, pump running and fault and capable to communicate with other controllers following open protocol through RS485 port. All alarms should be displayed in the controller. The panel should also have provision for manual / automatic alternate (cyclic) operation of pumps, ON/OFF switch, complete.

- Pressure switches bellow type fitted with micro switch and having maximum pressure and differential scale should confirming BS-6134 standards and IP55 protection class, inter connecting power and control cabling etc.

3.3 Control Panel (for Hydro-pneumatic Systems With & Without VFD)

The control panel shall have terminals for:

- Remote monitoring.
- Pump fault
- Analog output signal for frequency convertor (In case of VFD operated Hydro pneumatic systems).

d) Pressure sensor / Pressure switches as per system requirement

3.4 General

The hydro pneumatic system shall be capable of maintaining a constant pressure at varied consumption. The hydro pneumatic system shall be complete with pressure sensor and microprocessor based controller for flow control by means of frequency variation (in case of VFD operated system). The controller should have time control switch to adapt pump operation to actual requirement in peak load situation. The control panel should also have manual operation.

- The pumping system shall perform the following functions:
- Shut off the pump at zero demand.
- Shut off the pump at zero suction(Dry Run protection)
- Protect the pump from overvoltage, under voltage, overload & earth fault.
- Vary the time of pump speed acceleration and deceleration (For VFD operated Hydro pneumatic system).
- Compensate for higher friction losses at high flow rates.
- Send out a signal for remote monitoring of flow as well as pressure.
- Conduct automatic test run of pumps at set times.
- Keep track of run time for pumps.
- Perform run time equalization of all pumps in system.

3.5 Installation

Hydro pneumatic systems shall be mounted on a common base frame & installed as per manufacturer's recommendations. Pump sets shall be mounted on machinery isolation cork or any other equivalent vibration isolation fitting. The vibration isolation pads, foundation bolts etc. shall be supplied by the Contractor. Contractor shall ensure that the foundation bolts are correctly embedded.

Pump-sets shall preferably be factory aligned, wherever necessary, site alignment shall be done by competent persons. The entire system along with pumps & control panel must be sourced from single manufacturer only for unit responsibility.

3.6 Testing

Contractor shall submit all the performance curves of the pumps supplied by them. They shall also check the capacity and total head requirements of each pump to match their own piping and equipment layout. On completion of the entire installation, pumps shall be tested, wherever possible, for their discharge, head, flow rate, B.H.P. Where it is not possible at least the discharge, head and B.H.P. (as measured on the input side) shall be field tested. Test results shall correspond to the performance curves.

4. SUMP PUMP

4.1 Sump pumps shall be submersible type for lifting domestic sewage or muddy water/drainage as specified in Bill of Quantities. Pump with impeller of approved material and design shall be mounted on waterproof motor. The impeller shall be suitable for handling solids as specified in Bill of Quantities.

4.2 The pump shall automatically operate with high water level and stop at low water level in the sump by means of "Electronic Level Controller", of the approved make as per manufacturer compatibility.

4.3 The sump pumps shall be complete in all respect and shall be installed as per manufacturer's requirement as shown in the drawing. All accessories shall be In-Built as per manufacturer's specification.

4.4 All pumps within a pumpset shall run in cyclic fashion under normal operating circumstances. All pumps within a pumpset shall be capable of operating simultaneously / cumulatively in case of emergency / high water level.

5. WATER FILTER

5.1 Water filter shall be of dual media pressure filter (comprising of minimum 300mm bed depth of Anthracite and support media and minimum Height on Straight 1500mm) of downward or upward flow type suitable for a rate of filtration given in Schedule of quantities.

5.2 Filter shall be vertical type of required diameter. The shell shall be fabricated from M.S. plate suitable to withstand a working pressure of 3 Kg/cm2. The minimum thickness of shell will be 10mm and dished ends shall be 12mm.The quality of Steel shall be as per IS:2062 Grade B, thickness as per ASME Section 8. The filter shall have at least one pressure tight manhole cover.

Filter shall be provided with screwed or flanged connections for inlet, outlet, individual drain connections and all other connections necessary as required. Filter shall be painted inside with two or more coats of coal tar epoxy paint, one coat of red oxide primer outside with two or more coats of synthetic enamel paint of approved shade.

The Filter media shall comprise of 0.5 to 1.00 mm fine filtering silica sand for removal of turbidity and suspended matter.

The initial charge of filter media as specified in above para's shall be the responsibility of contractor.

The pressure filter shall be complete with cleaning cycle controller adjustable to meet application requirement, actuating control valves in required sequence for back wash.

5.3 Under Drain System

Filter shall be provided with an efficient under drain system comprising of collecting pipes, gunmetal/polypropylene nozzles of manufacturer's design. The entire under drain system be provided on M.S. Plate or cement concrete supports.

5.4 Face Piping

Filter shall be provided with interconnecting face piping comprising of inlet, outlet, and backwash pipe complete with pipes, valves and accessories, as per requirement. Piping shall be G.I. piping, heavy duty, as per I.S: 1239 and valves shall be cast iron double flanged sluice valves with C.I. body and Neoprene rubber diaphragm.

5.5 Accessories

Each filter shall be provided with following accessories:-

- Air release valve with connecting piping.
- 150mm dia dial bourden type gunmetal pressure gauges with gunmetal isolation cock and connecting piping on inlet and outlet.
- SS Sampling cocks on raw water inlet and filtered water outlet.
- Individual drain connection with gunmetal fullway valve should be piped through a properly sized G.I. pipe to nearest drain point.

6.0. Water Softener

6.1 Softener shall be designed to give zero commercial hardness. Softener shall be with "cation" ION exchange resins.

6.2 Softener vessel shall be of mild steel plate with dished ends and self supporting arrangement. Vessel shall be suitable for a minimum working pressure of 3 Kg/ Sq. cm. The vessel shall be tested at 1.5 times the working pressure. The shell shall be designed to allow a minimum free board space at 50% of the mineral bed depth for adequate expansion during back washing. The shell shall have a minimum thickness of 10mm and dished ends 12mm. The quality of Steel shall be as per IS:2062 Grade B, thickness as per ASME Section 8. All internal parts of the softener shall be rubber lined as per approved specifications rubber lined and externally with one coat of red oxide and two or more coats of synthetic enamel paint of approved shade.

6.3 The vessel shall have an internal collecting and distribution system of manufacturer's design.

6.4 The softener shall have a set of interconnecting face piping consisting of inlet, outlet and brine injection system with valves and accessories complete as per requirement. Piping shall be G.I heavy duty, as per I.S: 1239 and valves shall be cast iron double flanged sluice valves with C.I. body and Neoprene rubber diaphragm. Individual drain connection with gunmetal full way valve should be piped through a properly sized G.I. pipe to nearest drain point.

6.5 The brine injection system consist of hydraulic ejector with control valve, brine delivery pipes with adjustable indicator.

6.6 One measuring tank (Brine Tank) having a capacity of minimum one regenerations or as specified in bill of quantities.

6.7 One orifice board for indicating wash and rinse rate to be fitted in drain sump.

6.8 One initial charge of supporting gravel, sand and "cation" ION exchange resin in requisite quantity.

6.9 One water testing kit with instructions for testing water samples.

6.10 One rotameter to indicate flow rate.

6.11 Inlet & outlet pressure gauges.

7. SALT SATURATOR ASSEMBLY

7.1 Tanks shall in High density Polyethylene (HDPE) construction of required capacity. The assembly shall be suitable for holding and supplying salt for softener with inlet & outlet piping with valves and accessories complete as per requirement.

7.2 The assembly shall be provided with an automatic agitator. The automatic agitator shall be motorized (motor of suitable rating operating on single phase, 50 Hz, AC supply) having Stainless steel shaft with fan blade, coupled with suitable gear box duly mounted MS Frame with Epoxy Coating .

7.3 The transfer Pump for supplying salt solution to softener shall be of multistage, Inline vertical, centrifugal pumps with cast iron/cast steel body, SS316L stage casing, SS316L impeller, stainless steel shaft, and directly coupled with TEFC induction motor of class "F" insulation & efficiency class EFF-1, 2900 RPM, IP 55 enclosure, suitable for operation on 415 volts ±10%, 3 phase, 50 Hz, A.C. supply.

7.4 The contractor has to ensure that the effective capacity of the system shall be of minimum 10% greater than actual salt required for approx. 3 Days with complete structural arrangement including suitable foundation bolts & other accessoriesetc.

8. Chlorinator

Chemical dosing should consist of electronic / electro mechanical metering pump with suction and delivery flexible connections and fittings. The pump shall be mounted on FRP tank of required capacity having in-built basket for holding alum blocks and lime blocks. The system should be completed with electrically operated single phase motor driven stirrer having stainless steel shaft. This should be suitable for working against a pressure of 1.5 kg/Sq.cm and should be capable of ejecting Sodium Hypo-chloride solution / suitable alternate chemicals with a dose of 1 ppm.

9. PIPING

9.1 Pipes for suction and delivery shall be galvanized steel pipes (heavy duty) confirming to I.S:1239 upto 150mm dia and as per I.S:3589 for dia 200mm and above or as specified in bill of quantities. . Galvanising shall conform to IS 4736. Pipes and fittings shall be jointed with screwed/flanged joints, flanges either screwed or welded complete and jointed with 3mm thick rubber gasket as per requirements complete with nuts, bolts and washers etc.

9.2 Gate valve and check valve above 65mm dia shall be C.I. double flanged conforming to I.S:780 manufactured by the reputed manufacturers or C.I. double flanged butterfly valves as specified in bill of quantities or elsewhere or as per approval of Engineer-in-charge.

9.3 Full way and check valves 65mm dia and below shall be gunmetal tested to 20Kg/cm^2 pressure certified and conforming to I.S:778.

9.4 Suction strainer or foot valves shall be C.I., confirming to I.S:4038 - 1979, as specified in bill of quantities.

9.5 Joints

All pipes and fittings shall be provided with flanged joints, with flanges either screwed or welded complete and jointed with 1.5mm thick gasket complete with nuts, bolts and washers

etc. Welded joints shall not be permitted for domestic water supply pumping systems or wherever potable water quality is required.

10. PIPING INSTALLATION

10.1 Clamps

G.I. pipes shall be supported by G.I. clamps of design approved by Engineer-in-charge. Pipes in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from M.S. structural works.

10.2 Unions

Contractor shall provide adequate number of unions on all pipes to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop cock, or check valve and on straight runs as necessary at appropriate locations as required and / or directed by Engineer-in-charge.

10.3 Flanges

The M.S flanges shall confirm to I.S:6392-1971 and shall be galvanized. Flanged connections shall be provided on pipes as required, all equipment connections as necessary and required or as directed by Engineer-in-charge. Connections shall be made by the correct number and size of the bolts and made with 3mm thick insertion rubber washer. Bolt hole dia for flanges shall conform to match the specification.

10.4 Piping layout shall take due care for expansion and contraction in pipes.

10.5 All pipes using screwed fittings shall be accurately cut to the required sizes. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. Genuine red lead with grumet and a few strands of fine hemp shall be applied and threaded in accordance with IS: 554. Open ends of the piping shall be locked as the pipe is installed to avoid entrance of foreign matter. Wherever reducers are to be made in horizontal runs, eccentric reducers shall be used if the piping is to drain freely, in other locations, concentric reducers may be used.

10.6 Contractor shall provide suitable cement concrete, anchor blocks of adequate dimensions as per spacing mentioned above & at all bends, tee connection and other places required and necessary for overcoming pressure thrusts in pipes wherever pipes are installed on-ground / underground. Anchor blocks shall be of cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size).

10.7 Drain shall be provided at all low points in the piping system and shall be of the following sizes:

Mains	Drains
Upto 300mm dia	25mm dia
Over 300mm dia	40mm dia

Drains shall be provided with forged brass ball valve of equal size. Drains shall be piped through equal size G.I. pipe to the nearest drain or floor waste or as shown on the drawings. Piping shall be pitched towards drain points.

10.8 Vibration Elimination

Piping installation shall be carried out with vibration elimination fittings wherever required.

10.9 Testing

All piping shall be tested to hydrostatic test pressure of minimum 10 kg/cm² or 1.5 times the design pressure whichever is higher for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Engineer-in-charge.

10.10 Painting

- After the piping has been installed, tested and run for at least ten days. The piping shall be given two finish coats, 3 mils each of approved color.
- The direction of flow of fluid in the pipes shall be visibly marked in white arrows or as directed by the Engineer-in-charge.

11. VALVES & ACCESSORIES

11.1 Sluice / Gate Valves

Sluice Valves above 65 mm (inside screw and non raising screw type) shall be of Cast Iron body and Gunmetal seat with double flanged ends and valve wheel. They shall conform to type PN 1.6 of IS:780. Sluice valves upto 65mm (outside screw raising spindle type) shall be of Gunmetal Full way Valve with wheel tested to 20 Kg./cm2 class-II as per I.S: 778 with female screwed ends. Valve wheels shall be of right hand type and have an arrow head engraved or cast thereon showing the direction for turning open and close.

11.2 Butterfly Valves

11.2.1 The Butterfly Valve shall be suitable for waterworks. The Valves conforming to IS : 13095 shall be provided. All valves shall be suitable to withstand the pressure in the system and rating shall be PN 1.6. All valves shall be right handed (i.e. handle or key shall be rotated clock wise to close the valve).

11.2.2 The direction of opening and closing shall be marked and an open / shut indicator fitted.

11.2.3 The material of valves shall be as under:-

Body	-	Cast iron
Disc	-	Ductile Iron
Seat	-	EPDM/Nitrile rubber
Shaft	-	Stainless Steel

11.2.4 The Valve shall be fitted between two flanges on either side of pipe flanges. The Valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages.

11.3 Non-Return Valve

Non-return valves shall be of Cast Iron body and Stainless Steel seat. They shall conform to API-594 and have companion flanges. They shall be Dual Plate Type suitable for both horizontal and vertical installation. An arrow mark in the direction of flow shall be marked on the body of the valve.

11.4 Air Release Valve

Air valves shall be provided at all high points in the piping system for air vent of the double float type, with G.M. body, vulcanite balls, rubber sealing, etc. Air valves shall be of the sizes specified and shall be associated with an equal size forged ball valve.

11.5 Ball Valve

11.5.1 The Ball Valve shall be made from forged brass and tested to 20 Kg/cm² pressure. The valve shall be internally threaded to receive pipe connections.

11.5.2 The Ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body bonnet gasket and gland packing shall be of Teflon.

11.5.3 The handle shall be of chrome plated steel with PVC jacket. The handle shall also indicate the direction of 'open' and 'closed' situations. The gap between the ball and the Teflon packing shall be sealed to prevent water seeping upto 14 Kg / cm^2 pressure.

11.5.4 The handle shall also be provided with a lug to keep the movement of the ball valve within 90 degree.

11.6 Strainer

Strainers shall be preferably of the approved type with fabricated steel bodies designed to the test pressure of 10 Kg/ cm^2 . Strainers shall be fabricated by minimum 1.2 mm thick stainless steel sheet with 3 mm dia. perforation holes. Strainers shall be provided with flanges or threaded sockets as required. They shall be designed so as to enable blowing out accumulated dirt and facilitate removal and replacement of screen without disconnection of the main pipe.

11.7 Pressure Gauges

Pressure gauges shall be of 150mm dia. dial and of appropriate range and be complete with shut off gauge valve etc. duly calibrated before installation. Care shall be taken to protect pressure gauges during pressure testing.

11.8 Flexible Connection For Pumps

All suction and delivery lines shall be provided with double flanged reinforced neoprene / Stainless Steel flexible pipe connectors. Connectors should be suitable for a working pressure of each pump. Length of the connector shall be as per specified or as per manufacturer's details.

12. ELECTRICAL CONTROL PANELS

12.1 Motor Control System

The main switchboard shall be floor mounted, free standing, cubical type, compartmentalized and shall be factory built fabricated by one of the approved switch board manufacturer. The board shall be fabricated from 2mm thick CRCA sheet and powder coated after seven tank process. The board shall be fabricated with IP 54 degree of protection suitable for operation of 415 volt ± 10% , 3 phase,4 wire,50Hz, AC supply. The switch board shall have provision for termination of cables from top as well as bottom with suitable knockouts. The layout shall be designed for convenient connections and inter-connections with various switchgears. Connections from individual compartments to cable alleys shall be such as not to shut down healthy circuits in the event of maintenance work becoming necessary on a defective circuit. A base channel of 75mm X 5mm thick shall be provided at the bottom. A maximum of 200mm space between the floor and bottom most panel of unit shall be provided. The bus bar shall be of aluminium complete with heat shrinkable PVC sleeves. The fabrication of switch board shall be taken up only after the drawings for the fabrication of the same are approved by the Engineer –in – charge.

Control panel shall contain starters and safety protection for different types of pump motors & various feeders alongwith its controls. It shall also house the switchgears for incoming as well for outgoings supply. Provision of voltmeter (for incomer) & ammeter for incomer as well as for other feeders with selector switch, a set of LED indicating light for incoming phases as well as status indication of each equipment as per the schedule of quantities. The voltmeter & indication lamps shall be protected by MCBs.

The feeders for all those motors having more than 7.5 HP capacity shall be provided with fully automatic Star Delta starters with motor duty MCCBs for short circuit protection only(ICS =

100% ICU) & Overload Relays with contactors of suitable range & ratings, for overload protection, while less than or equal to 7.5 HP motor shall have Motor protection circuit breaker(MPCB) with over load & short circuit protection of suitable rating. Single phase preventers shall be provided for all 3 phase motors. Single phase preventer shall be in conformity with relevant ISI standards. Single phase preventers shall act when the supply voltage drops down to 90 % of the rated voltage or failure of one or more phases. Single phase preventer shall be voltage operated and of approved make.

Other feeders of the panel which don't require starter, shall be housed with :

- MCCB with Thermal magnetic release & should provide adjustable setting for overload and short circuit protection with ICS = 100% ICU.
- MCB used for controlling shall be with tripping characteristics of C curve. The miniature circuit breakers shall be 1/2/3/4 pole as per requirement. The breaking capacity of MCBs shall have minimum 10KA.

ON-OFF switches for each motor / equipment should not be provided on the cover of the control panel. But at the same time interlocking shall be provided between switch and the door in such a way that the door of the panel cannot be opened when the supply is ON.

The panel shall be provided all identification tags, danger board etc as per IS standard.

All control panels shall be provided with detailed control circuit diagram indicating the terminal numbers and color coding of the wires used in the panels. This diagram shall be pasted on the inner side of the cover and protected with PVC transparent lamination.

All MCCBs / MPCB's shall be equipped with extended front operated rotary handles on the doors. Rotary handle should have provision for pad lock.

Outgoing from each of the MCCB shall be extended to the cable alley by providing necessary busbar of suitable rating and supports etc. for terminating the outgoing feeders.

The detailed specification of switch gears and other accessories shall follow as described in Package A of these tender specifications.

13. PUMP MOTOR CONTROLLER CUM WATER LEVEL INDICATING PANEL & SYSTEM

13.1 Water Level Indicators And Controllers

The hydrostatic pressure sensor (Water level indicator) shall operate on hydrostatic pressure measurement principle. The sensors shall be made of Stainless Steel for installation in storage tanks, and capable of providing 4 to 20 mA analog signal compatible with PLC signal inputs and all control outputs to MCC panel (Plumbing/Water supply),for various water tanks as per the schedule of quantities. The Pressure Transducers shall be used for water level measurement, and it shall be convenient to mount on the water tanks. Hydrostatic pressure level sensors shall be submersible or externally mounted pressure sensors suitable for measuring the level of liquids in deep tanks or water in reservoirs. Level measurement shall be based on the pressure measurement principal, also referred to as hydrostatic tank gauging (HTG). It shall work on the principle that the difference between the two pressures (d/p) is equal to the height of the liquid (h, in inches) multiplied by the specific gravity (SG) of the fluid. Following shall be the formula used for measurements / calibration: d/p = h(SG). These sensors sense increasing pressure with depth and because depth is proportional to Volume for a regular tank, the Volume of Water can be easily calculated using a PLC.

13.2 Level Indicator / Controller Panel

The Centralized PLC control panel shall be front operated, cubicle construction, wall mounted type, fabricated out of 1.6 mm thick CRCA Sheet, with hinged lockable doors, dust and vermin proof, powder coated of approved shade, inter-connections, having, internal wiring, earth terminals, Top / Bottom control cable entry, numberings etc. comprises of touch-screen display board (Minimum Diagonal size 8") along with all accessories for complete Programmable logical controls & indications, having necessary interlocks, Inputs/Outputs, required number of repeater amplifiers, all audio-visual alarms as per the requirements listed below i/c emergency stop push button on the panel etc. The panel shall have BMS compatible with open protocol.

14. CABLES

14.1 Contractor shall provide all power control cables from the motor control center to various motors, level controllers and other control devices.

14.2 Cables shall conform to I.S: 1554 and carry ISI mark.

14.3 Wiring cables shall conform to I.S 694.

14.4 All power and wiring cables shall be aluminum conductor PVC insulated armored and PVC sheathed of 1100 volts grade.

14.5 All control cables shall be copper conductor PVC insulated armored and PVC sheathed 1100 Volt grade.

14.6 All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.

14.7 All cable joints shall be made in approved manner as per standard practice.

15. CABLE TRAYS

15.1 Contractor shall provide M.S slotted cable trays at locations as shown on the drawings and of sizes as given in the bill of quantities.

15.2 Cable trays shall be supported from the bottom of the slab at intervals of 60cms at both ends by anchor fasteners. Cost of MS angle, rods and anchor fasteners etc. shall be included in the rate of the tray and no separate payment shall be made on this account.

15.3 Cost of clips, bolts, nuts, support rods and any other materials required to fix the trays in proper manner shall be included in the rate for trays.

16. EARTHING

16.1 There shall be an independent earthing station. The earthing shall consist of an earth tape connected to an independent plate made of copper or G.I. having a conductivity of not less than 100% international standard. All electrical apparatus, cable boxes and sheath/armour clamps shall be connected to the main bar by means of branch earth connections of appropriate size. All joints in the main bar and between main bar and branch bars shall have the lapping surface properly tinned to prevent oxidation. The joints shall be riveted and sweated.

16.2 Earth plates shall be burried in a pit of 1.20x1.20M at minimum depth of 3M below ground. The connections between main bar shall be made by means of three 10mm brass studs and fixed at 100mm centres. The pit shall be filled with coke breeze, rock salt and loose soil. A

G.I. pipe of 20mm dia with perforations on the periphery shall be placed vertically over the plate to reach ground level for watering.

16.3 A brick masonry manhole 30x30x30cm size shall be provided to surround the pipe for inspection. A bolted removable link connecting main bar outside the pit portion leading to the plates shall be accommodated in this manhole for testing.

17. CONTROL PANELS / STARTERS

17.1 Switch board cubicles of approved type shall be fabricated from 16-gauge M.S. sheet with dust and vermin proof construction. It shall be painted with powder-coated finish of approved make and shade. It shall be fitted with suitable etched plastic identification plates for each motor. The cubicle shall comprise of the followings:- (Switch gear as given in the bill of quantities).

- Incoming main isolation MCCB of required capacity.
- Fully Aluminum taped Bush Bar of required capacity.
- Isolation MCCB one for each motor.
- Fully automatic as specified D.O.L/Star Delta starters suitable for motor H.P. with push buttons one for each motor and on/off indicating neon lamps. (DOL upto 7.5 HP and Star Delta from more than 7.5 H.P)
- Single phase preventor of appropriate rating for each motor.
- Panel type ampere meters one for each motor with selector switch.
- Panel type voltmeter on incoming main with rotary selector switch to read voltage between phase to neutral and phase-to-phase.
- Neon phase indicating lamps for incoming main and on/off indicating lamps for each motor.
- Rotary switch for manual or auto operation for each pump (manual/auto off).
- Fully taped separate aluminum bus bars of required capacity and with required outlets.
- Space for liquid level controllers as specified + 1 extra space.
- The panel shall be pre-wired with colour-coded wiring. All interconnecting wiring from incoming main to switch gear, meters and accessories within the switchboard panel.
- Provision of main incoming cables from the top of the panel.

17.2 All switch gears and accessories shall be of approved make such as "Siemens, English Electric, Larson & Toubro" or equivalent, or as specified.

17.3 Switchboard cubicles shall be floor or wall mounted type as recommended by manufacturers. All floor-mounted switch board shall rest on minimum 225mm high platform. The contractor shall provide the shop drawings for base and panels.

18. MEASUREMENTS

18.1 Raw water, re-lift and sump pumps and swimming pool pumps shall be measured by numbers / sets and shall include all items as given in the bill of quantities.

18.2 Motor control panel and level controllers shall be measured by numbers.

18.3 Pipes for suction and delivery header and mains shall be measured per linear metre along the centre line of the pipe and shall be inclusive of all fittings.

18.4 Cable trays and cables shall be measured per linear meter.

18.5 Structural clamps including hangers shall be measured by weight calculated from sections used. No separate payment shall be admissible for bolts, anchor bolts, rawl plugs etc.

18.6 No separate payment shall be made for making connections of the existing service lines to the pumps. Vibration eliminator pads are included in the scope of this work.

19. GUARANTEE

19.1 The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.

19.2 The form of warranty shall be as approved by the Engineer-in-charge.

19.3 The warranty shall be valid for a period of one year from the date of commissioning and handing over.

19.4 The warranty shall expressly include replacement of all defective or under capacity equipment, Engineer-in-charge may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.

19.5 The warranty shall include replacement of any equipment found to have capacity lesser than the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Engineer-in-charge.

20. COMMISSIONING

After successful testing of the different items in parts, the Contractor shall provide all facilities including necessary piping, labour, tools and equipments etc. for carrying out testing and commissioning of the entire water treatment plant complete as per requirement in the presence of Engineer-In-charge or his representative whenever and as may be required.

-:-

ENERAL TECHNICAL CONDITIONS

SECTION – I SCOPE OF WORK

1.1 Work under this contract shall consist of furnishing all Labor, Materials, equipment, tools and accessories necessary and required to completely install the Fire Fighting System, specified hereinafter and given in the Schedule of Quantities.

1.2 (A) Without restricting to the generality of the foregoing the work of Fire Fighting System shall include the followings, but is not limited:

c) Hydrant Systems consisting of internal hydrant risers, external hydrant ring, hydrant stations with all accessories such as hydrant hoses, first aid hose reel, branch pipe etc., including all valves, accessories etc.

d) Pumping system consisting of Electrical Hydrant pump, Sprinkler pump, Diesel Engine operated standby pump, Jockey pumps and related equipments such as valves, strainers, piping, instrumentation and motor starting system.

e) Sprinkler system for the Basements & Towers greater than 45 meters height.

f) Sprinkler system for the Basements & Towers.

g) Excavation for Pipes, Laying of pipe, Protection for Underground pipes, Painting of pipes, Structural Supports etc. as per requirements.

h) Portable Fire Extinguishers.

(B) The Bill of Quantities includes the total works of Fire Fighting system for the project.

It will be the decisions of the Client to award the entire work either to one vendor or parts of the work to different vendors. However, the system will be ultimately commissioned in totality and therefore all party concerned shall be responsible for successful commissioning and assisting in getting approval from all concerned authorities.

END OF THE SECTION - I

1. **LICENSE, PERMITS & COMPLETION CERTIFICATES**

1.1 Contractor shall possess and maintain all necessary licenses and permits as necessary for the execution of the works.

1.2 Contractor must keep constant liaison with all relevant authorities and shall be responsible for obtaining all approvals relating to fire fighting system. He shall also be responsible for co-ordination for getting the approval, with other agencies working on the project relating to their scope of work.

1.3 It is the responsibility of the Contractor to ensure that all the works carried out are as per requirements of the local authorities having jurisdiction and as per the approved sanction drawings.

1.4 Contractor shall obtain, from the local authorities all related completion certificates with respect to his work as required for occupation of the building.

1.5 All inspection fees or submission fees paid by the Contractor shall be reimbursed by the Employer on production of valid official receipts.

2. **METRIC CONVERSION**

2.1 All dimensions and sizes of materials and equipment given in the tender document are commercial metric sizes.

2.2 Any weights, or sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

3. **REFERENCE POINTS**

3.1 Contractor shall provide permanent Bench Marks, Flag Tops and other reference points for the proper execution of work and these shall be preserved till the end of the work.

3.2 All such reference points shall be in relation to the levels and locations given in the Architectural and Fire fighting drawings.

4. GENERAL INSTRUCTIONS

4.1 Fire suppression works specified in the tender have to be executed in accordance with:

v. The rules and regulations ofLocal Fire Authority as per the statutory regulations applicable for obtaining the occupation/No objection certificate from the Local Development / Fire Authority.

vi. Applicable norms laid down by the relevant sections of latest editions of National Building Code (NBC) and all relevant codes of Bureau of Indian Standards (B.I.S.) shall be followed as applicable.

vii. The codes of the National Fire Protection Association of USA (N.F.P.A.) shall be used as a general guide for good engineering practice, design and workmanship norms. No certificate of compliance to NFPA codes will be required.

4.2 All materials used in the works shall have Bureau of Indian Standards valid certification stamped, marked or cast on the material in an acceptable and approved manner, as specified hereinafter.

4.3 It is the contractor's responsibility to ensure the competence of design to meet the above requirements.

1) Drawings issued with the tenders are schematic and indicate the concept. Contractor shall make his shop drawings on basis of Architectural and Interior design drawings issued by the Engineer-in-Charge. Work will be executed only as per approved shop drawings.

4.5 Quantities in the tender document are approximate and worked out on the tender drawing issued and may vary as per actual requirements.

4.6 Contractors are invited to highlight any aspects of the contract document that may need revision or reconsideration before the work is started. He must furnish details of any variations in the specifications or the quantities that may be necessary for him to comply with the Code and statutory requirements. These may be identified and approval of the Project managers taken before the start of the work.

4.7 Contractors shall furnish detailed Shop drawings, hydraulic and other design calculations for submission and approval of the Local Fire Authority and for Insurance Companies as may be required by the Client.

5. DRAWINGS ISSUED TO CONTRACTOR

The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site.

All corrections, 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 approved by the Engineer-in-Charge.

6. SHOP DRAWINGS & TECHNICAL SUBMITTALS

6.1 The Contractor shall submit to the Consultant two copies of Shop Drawings for Fire Fighting works as an Advance Copy to the Engineer-in-Charge for approval before start of work. Subsequent to the approval of the shop drawings, the Contractor shall submit seven copies of Shop Drawings for execution to the Engineer-in-Charge. The Contractor shall also submit four copies of the Technical Specifications and Catalogues for all items, including pump curves, single line diagrams etc. as relevant.

1.1 All Fire Fighting drawings issued to the Contractor shall be studied by them. Contractor shall also obtain the necessary architectural, structural and other services drawings, based on which they shall prepare their shop drawings as per site conditions.

1.2 Shop drawings shall incorporate all proposed Structural supports/hanging/laying and jointing details for all types of pipes as required.

1.3 Contractor shall also submit all details of fabrication items, Single Line Diagrams etc. as per requirements.

6.5 The Contractor can only commence the work after the approval of above documents by Project Manager/ Consultant.

7. COMPLETION DRAWINGS

7.1 On completion of work, Contractor shall submit one complete set of original tracings and two prints of "as built" drawings to the Engineer-in-Charge. These drawings shall have the following information:

(a) Run of all piping with diameters on all floors and vertical stacks.

(b) Ground and invert levels of all fire fighting pipes.

(c) Location of Control Valves.

(d) Location of all Mechanical equipment with layout and piping connections.

7.2 Contractor shall provide four sets of catalogues, manuals, performance data and list of spare parts together with the name and address of the manufacturer for all Electrical and Mechanical equipment provided by him in the form of a book of manuals.

7.3 All "Warranty cards" given by the manufacturers shall be handed over to the Project Manager also in the form of a comprehensive of record book / documents.

8. MATERIALS (SUPPLIED BY THE CONTRACTOR)

8.1 All materials used in the works shall conform to the tender specifications.

8.2 As far as possible materials bearing I.S. certification marks shall be used with the approval of the Engineer-in-Charge.

8.3 Unless otherwise specified and expressly approved in writing by the Engineer-in-Charge, materials of makes and specifications mentioned with tender shall be used.

9. INSPECTION AND TESTING OF MATERIALS

9.1 All material before allowing to bring at the store, will be preliminary / visually inspected at the entry gate of the project site.

This inspection will be conducted with the help of the quality approval format as prepared by the clients.

9.2 For examination and testing of materials and works at the site Contractor shall provide all Testing and Gauging Equipment as necessary.

9.3 All such equipment shall be tested for calibration at any approved laboratory, if required by the Engineer-in-Charge.

9.4 All Testing Equipment shall be preferably located in special room meant for the purpose.

10. MATERIALS SUPPLIED BY THE OWNER

10.1 The Contractor shall verify that all materials supplied by the Employer conform to the specifications of the relevant item in the tender. Any discrepancy found shall be brought to the notice of the Engineer-in-Charge.

10.2 After receipt of materials, it shall be the responsibility of the Contractor for any damage found and he shall be liable to pay the actual cost of the material as per market rate at that time.

11. RECOVERY OF COST FOR MATERIALS ISSUED TO CONTRACTORS FREE OF COST

If any materials issued to the Contractor, free of cost, are damaged or pilfered, the cost of the same shall be recovered from the Contractor on the basis of actual cost to Owner which shall include all freight and transportation, excise duty, sales tax, octroi, import duty etc. or the actual cost given by the Employer shall be final and binding on the Contractor.

12. CONTRACTORS RATES

12.1 Rates quoted in this tender shall be inclusive of cost, unless specified of materials, labour, supervision, erection, tools, plant, scaffolding, service connections, transport to site, taxes, octroi and levies, breakage, wastage, sales tax on works contract and all such expenses as may be necessary and required to completely do all the items of work and put them in a working condition.

12.2 Rates quoted are for all heights and depths required for this work.

12.3 Unless specified, all rates quoted are inclusive of cutting holes and chases in walls and floors and making good the same with cement mortar/concrete of appropriate mix and strength as directed by Engineer-in-Charge. Contractor shall provide holes, sleeves and recesses in the concrete and masonry work as the work proceeds.

12.4 Rates quoted shall be inclusive of cost incurred in testing, commissioning of works and materials.

13. MOCK UP

The Contractor shall install all pipes, clamps and accessories and fixing devices in mock-up shaft and room so constructed as directed by Engineer-in-Charge without any extra cost. The materials used in the mock-up may be reused in the works if found undamaged.

Any tiles or finished surfaces or floors damaged by the Contractor while doing his work shall be made good with new tiles or other finishing material. No payment shall be admissible for such repairs. The Engineer-in-Charge may, at his discretion get the damaged work repaired by other agencies and debit the cost of such repairs to the Contractor.

14. EXECUTION OF WORK

14.1 The work shall be carried out in conformity with the Fire Fighting drawings and within the requirements of Architectural, HVAC, Electrical, Structural / GreenBuilding consultant and other specialized services drawings.

14.2 The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction programme.

14.3. On award of the work, Contractor shall submit a programme of construction in the form of a Pert Chart or Bar Chart for approval of the Engineer-In-Charge / Owner. All dates and time schedule agreed upon should be strictly adhered to, within the stipulated time of completion/commissioning along with the specified phasing, if any.

14.4 Contractor shall be responsible for co-ordination with other agencies working on the project relating to their scope of work and shall take approval from the Engineer-In-Charge / Owner wherever required.

14.5 No structural member shall be chased or cut without the written permission of the Engineer-in-Charge.

15. TESTING

15.1 All works shall be tested as specified under the relevant clauses of the specifications.

15.2 Tests shall be performed in the presence of the Engineer-in-Charge/ Consultant.

15.3 All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.

15.4 Contractor shall perform all such tests as may be necessary and required by the local authorities to meet Municipal or other bye-laws in force.

15.5 Contractor shall provide all labour, equipment and materials for the performance of the tests.

16. SITE CLEARANCE AND CLEANUP

16.1 The Contractor shall, from time to time clear away all debris and excess materials accumulated at the site.

16.2 After the pipelines, fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints stains, stickers and other foreign matter of discoloration leaving the same in a ready to use condition.

16.3 On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done at Contractors risk and cost.

16.4 All aforesaid expenditure involved in the site clearance and cleanup are included in the contract price.

17. FINAL INSTALLATION

The Contractor shall install all fire fighting accessories, fixtures and fittings in their final position in accordance with the approved trial assemblies and as shown on the Drawings. The installation shall be complete in all respects. The connection between the piping system and the fixtures shall be through proper flanges to facilitate removal / replacement without disturbing the built in piping system. All flanges shall match in appearance with other exposed fittings.

Fixtures shall be mounted rigid, plumb and true to alignment. It shall be ensured that all pipelines are clear of obstruction. Due attention shall be paid to the possibility of movement and settlement of fixtures due to pressurization and charging of the systems..

18. PROTECTION AGAINST DAMAGE

The Contractor shall take every precaution to protect all fire fighting fixtures against damage, misuse, cracking, staining, breakage and pilferage by providing proper covering, wrapping and locking arrangement till the completion of the installation and handling over. At the time of handling over, the Contractor shall clean, and polish all the fixtures and fittings. Any Fixtures found

damped, cracked, or scratched shall be removed and new fixtures and fittings free from defects shall be installed at his own cost to complete the work.

19. **GUARANTEE / WARRANTY**

19.1 The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.

19.2 The form of warranty shall be as approved by the Engineer-in-charge.

19.3 The warranty shall be valid for a period of one year from the date of commissioning and handing over or as mentioned in the General Conditions of Contract

19.4 The warranty shall expressly include replacement of all defective or under capacity equipment. Engineer-in-charge may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.

19.5 The warranty shall include replacement of any equipment found to have capacity lesser than the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Engineer-in-charge.

19.6 The contractor shall include in his rates the operation of all mechanical equipment for a period of six months from the date of commissioning. No separate payment will be made on this account.

END OF THE SECTION - II

TECHNICAL SPECIFICATIONS

1. **GENERAL REQUIREMENTS**

1.1 All materials shall be of the best quality conforming to the Specifications and subject to the approval of the Engineer-in-Charge/ Project Manager/ Owner.

1.2 Pipes and Fittings shall be fixed truly Vertical, Horizontal or in slopes as required in a neat workman like manner.

1.3 Pipes shall be fixed in such a manner so as to provide easy accessibility for repair and maintenance and shall not cause any obstruction in Shaft, Passage etc.

1.4 Pipes shall be securely fixed to walls and ceiling by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings.

1.5 Valves and other appurtenance shall be suitably located so that they are easily accessible for operation, repairs and maintenance.

2. PIPES

2.1 All pipes within and outside the building in exposed locations and shafts shall be as follows:

- **Pipe 150mm dia and below IS: 1239 heavy class.**

The pipes shall be Mild Steel (M.S.) manufactured by electric resistant welded (ERW)/ High Frequency induction welding or hot finished welded process. The sulphur and phosphorus requirements in steel shall not be more than 0.05 percent each. The tubes shall be manufactured from hot rolled steel skelps/ strips conforming to IS: 10748.

The following manufacturing tolerances shall be permitted on the tubes and sockets:

Thickness: shall not be less than 10 percent.

Weight: shall not vary by more than 10 percent either way.

The pipes shall satisfy the following table with regards to diameter, thickness and weight of tube.

Screwed tubes shall be supplied with threads as per IS:554. Each tube shall be tested for hydrostatic test for leak-tightness as an in-process test at the manufacturer's works. The finished pipe shall be tested for tensile strength, elongation, bend test and flattening test.

- **Pipe 200 mm dia and above IS 3589 of thickness specified**.

The pipes shall be manufactured by electric resistant welding (ERW)/ High Frequency induction welding or hot finished welded process. The sulphur and phosphorus requirements in steel shall not be more than 0.05 percent each. The tubes shall be manufactured from hot rolled steel skelps/strips conforming to IS: 10748.

The pipes shall conform to the tensile test, hydraulic pressure test and mechanical tests as per IS:3589. The pipe shall also conform to the requirements of as per IS: 3589. The tolerance shall as per IS: 3589. All pipes shall be of minimum 6 mm wall thickness. Pipes shall be supplied with bevel edging.

3. PIPE FITTINGS

3.1 Pipes and fittings means tees, elbows, couplings, flanges, reducers etc. And all such connecting devices that are need to complete the piping work in its totality.

3.2 Fabricated fittings shall not be permitted for MS pipe diameters 50 mm and below only screwed jointing shall be adopted, while for pipes above 50 mm dia welded or flanged connection shall be used. Only electro galvanized nuts/ bolts shall be used.

3.3 When used, they shall be fabricated, welded and inspected in workshops under supervision of Project Managers whose welding procedures have been approved by the TAC as per TAC rule 4102 for sprinkler system and applicable to hydrant and sprinkler system. For "T" connections, pipes shall be drilled and reamed. Cutting by gas or electrical welding will not be accepted.

3.4 M.S Pipe up to 150 mm dia shall have all fittings as per IS: 1239, part II, (heavy grade) while pipes above 150 mm dia shall be as per IS: 3589 inclusive of IS marking.

3.5 For sprinkler pipes branches, fittings shall be forged type.

4. JOINTING

4.1 **Screwed**

Joint for black steel pipes and fittings shall be metal-to-metal thread joints. A small amount of red lead may be used for lubrication and rust prevention. Joints shall not be welded or caulked. (With screwed M.S. forged fittings)

4.2 **Welded**

Joints between M.S. and pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. Buried pipes will be subject to X Ray test from an approved agency as per the TAC norms at the cost of contractor. (With welded M.S. fittings heavy class with V-Groove). The welding machine shall be 3 Phase of required current and capacity.

- All welding shall be carried out by a certified welder only. The contractor must produce the

welder's certificate.

- All pipe edges shall be bevel finished to a clean edge by a electric grinder. A requisite gap determined by the thickness of the weld electrode shall be given between the joints before start of welding.
  Weld electrodes shall be of approved make of grade and type as suitable for the job. This shall be satisfied by the Project Manager before start of work.

- Joints shall be given a first weld in the full width on the full dia of the pipe. Welding shall be carried out vertically from the surface.

  After application of first coat the weld shall be cleaned by electric grinder and then another layer of welding shall be done. The weld shall also be cleaned by grinding. Similarly, a third weld shall also be applied.

4.6 All pipe cutting shall be by oxy-acetylene gas flame cutter only. The cut surface shall be cleaned by electric grinder before further welding.

4.7 **Flanges**

Flanged joints where specified in the bill of quantities shall be follows:

- Straight runs not exceeding 30 m on pipelines 80 mm dia and above.

- Both ends of any fabricated fittings e.g. bends, tees etc. of 65 mm dia or larger diameter.

- For jointing all types of flanged valves, vessels appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and required as good for engineering practice.

  d) Flanges shall be as per I.S.6392-1971, Table 17/18 with appropriate number of G.I. Washers, Nuts and Bolts, half threaded of GKW make or equivalent with 3 mm insertion neoprene gasket complete.

4.8 **Unions**

Provide approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges.

5.0 **PIPE PROTECTION**

5.1 All pipes above ground and in exposed locations shall be painted with one coat of Red Oxide Primer immediately after bringing the pipes to site and shall be painted with one coat of red oxide primer after erection and proper hydraulic testing, and two or more coats of Synthetic Enamel Paint of approved shade on finishing.

5.2 All black steel pipes under floors or below ground shall be provided with protection against corrosion after proper hydraulic testing by application of 100mm wide and 4mm thick layer of anti-corrosive protection tape over the pipe, with overlap of 25mm minimum as per manufacturers specifications.

6. **PIPE SUPPORTS**

6.1 All pipes shall be adequately supported from ceiling or walls from existing/new inserts by Structural clamps fabricated from M.S. Structural works e.g. Rods, Channels, Angles and Flats as per details given in drawings and specifications. All clamps shall be painted with one coat of red lead and two coats of black Enamel paint.

6.2 Where inserts are not provided, the Contractor shall provide anchor fasteners. Anchor fastener shall be fixed to walls and ceilings by drilling holes with Electrical drill in an approved manner as

recommended by the manufacturer of the fasteners. Load bearing capacity of Anchor Fastener will be checked at site and then approved for implementation.

Hangers/ supports for all the piping shall be approved by the Project Manger before installation. Anchoring fasteners shall be rated to take minimum 0.4 ton load and shall be as per approved make. Additional supports shall be provided at bends etc. Angles for pipe supports shall not be less than 50x50x6mm size. cutting shall be by gas cutter. All cut edges and weld surfaces shall be ground to a smooth finish.

6.3 The supports/ angle pieces shall be cut by oxy-acetylene gas and cleaned by electric grinder. All cutting for bolt inserts shall be by electric drill.

6.4 Hangers for fire hydrant pipes shall be at 30m intervals & for sprinkler pipes shall be as per I.S. 15105.

7. TESTING

7.1 All pipes in the system shall be tested to a hydraulic pressure of 1.5 times of the working pressure subject to a min of 15 kg/cm^2 including water hammer effects without drop in the pressure for at least 24 hours.

7.2 In case of any detected drop in pressure, leakages are to be rectified and the pipes re-tested as required.

7.3 Complete Flushing out Test of Sprinklers installation shall be carried out to clean the sprinkler pipes for foreign materials before fixing the sprinkler heads to avoid obstruction in the sprinklers

8. ANCHOR BLOCK

Contractor shall provide suitable cement concrete, anchor blocks of adequate dimensions at all bends, tee connection and other places required and necessary for overcoming pressure thrusts in pipes wherever pipes are installed on-ground/underground/terraces. Anchor blocks shall be of cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size).

9. VALVES

9.1 Sluice Valves above 65 mm shall be of Cast Iron body and Bronze/Gunmetal seat. They shall conform to type PN 1.6 of IS:780-1980, valves upto 65mm shall be of Gunmetal Fullway Valve with wheel tested to 20 Kg./cm^2 class-II as per I.S: 778-1971. Valve wheels shall be of right hand type and have an arrow head engraved or cast thereon showing the direction for turning open and closing.

9.2 Butterfly Valves-

a) Butterfly valves of approved quality for pressure rating of 230 P.S.I. with locking arrangement and gearbox with handle operated or gearbox with lid shall be provided or as given in the Bill of Quantities.

b) Butterfly valves shall be of specified quality conforming to IS: 13095 or BS: 5155.

c) Joints for butterfly valves shall be made with suitable tail /socket pieces on the pipe line and flanged joints made with 3mm thick insertion rubber gasket with appropriate number of bolts, nuts and washers.

d) Butterfly valves shall be provided on all branches as shown in the drawings or as specified.

9.3 Non-return valves shall be of Cast Iron body and Bronze/Gunmetal seat. They shall conform to class of IS:5312 and have flanged ends. They shall be swing check type in horizontal runs and lift check type in vertical runs of piping. They shall not be spring-loaded type. An arrow mark in the direction of flow shall be marked on the body of the valve.

9.4 Valves below 50mm size shall have screwed ends while those of 50mm and higher sizes shall have flanged connections.

10. EXTERNAL YARD HYDRANTS

10.1 The Contractor shall provide External Fire Hydrant in the Ring or on External Fire Line, as per specifications as specified in Schedule of Quantities and as shown in drawings. The spacing of the hydrants and the distance from the building shall be maintained as per relevant requirements of latest relevant codes, unless specified herewith.

10.2 Each External Fire Hydrant shall be provided with an External Fire Hose Cabinet of M.S or fibre glass, as specified in Schedule of Quantities of size 75 x 60 x 25 cms, as approved by the Architect to equip 2 nos. of 63 mm dia non percolating reinforced rubber line (RRL) hose and accessories as required. The cabinet shall be installed near the Hydrant as per details, approved by the Engineer-in-Charge/Architect. The fire hose cabinet shall have with glass fronted double door with lock and keys and break glass recess for keys, all complete. The glass shall be of minimum 8mm thickness.

The FHC shall be red painted. The words “yard hydrant”, “hydrant” etc. shall be painted in white (or red on the glass) in 75mm high letters. The hose box shall be lockable with socket spanner. Top surfaces shall be slopped for water discharge. Vents shall also be located on sides of the Hose Box.

A brick pedestal with brick wall complex with plaster shall also be constructed for supporting the hose box. All surfaces shall be plastered with 1:4 ratio (1 cement: 4 fine sand) mortar.

Yard hydrant valve shall comprise “single headed single outlet gun metal landing valve” conforming to type ‘A’ of IS: 5290-1977. The valve shall be complete with hand wheel, quick coupling connection spring and gun metal blank cap as per IS: 5290. The hydrant shall be fixed on hydrant riser through a 80mm dia tool piece pipe at approx. 1.2 meter from finished floor level. The hydrant shall be IS marked. The hydrant shall be tested to 25 kg/cm2 test pressure. All threaded joint shall be sealed with approved type of sealant such as “holdtite”. The lug shall be wing type. Sample shall be approved by Project Manager

11. INTERNAL HYDRANTS

11.1 The Internal Hydrant outlet shall comprise “Single Headed Single Outlet Gunmetal Landing Valve” conforming to type ‘A’ of IS: 5290-1977. Separate valve on the head shall form part of the landing valve construction.

11.2 A cap with chain is provided on one head of the outlet. The hydrant will have an instantaneous pattern female coupling for connecting to Hose Pipe.

11.3 The Landing Valve shall be fitted to a Tee connection on the wet riser at the landing.

12. FIRST-AID HOSE REEL EQUIPMENT

12.1 First aid hose reel equipment shall comprise reel, drum which can swing upto 170 degrees, with hose, guide fixing wall bracket, hose tubing, globe valve, stopcock and nozzle. This shall conform to

IS: 884 - 1969. The hose tubing shall confirm to IS: 444-1980 or IS: 12585 (Thermoplastic). The drum shall be fabricated from GI sheet of minimum 18 gauge thickness or as specified in the bill of quantities.

12.2 The hose tubing shall be 20 mm dia and 36.5m long, or as specified in the bill of quantities. The G.M nozzle 5mm and globe valve shall be of 20 mm size to shut off the water supply to the Hose Reel, or as specified in the bill of quantities.

12.3 The fixing bracket shall be of swinging type. Operating instructions shall be engraved on the assembly. This heavy duty mild steel and cast iron brackets shall be conforming to IS: 884 - 1969. The first-aid hose reel shall be connected directly to the M.S. pipe riser through a 25mm dia pipe..

12.4 A MS bracket shall be fixed on the wall to which the first aid hose reel shall be bolted. The bracket shall be of 40x40x5mm thick MS angle to form a square of 400x400 approx. This shall be fixed on the wall. After approval of sample by Project Manager further units shall be fabricated in factory and all joints shall be finished with grinder and shall be spray painted after single coat of primer.

13. HOSE PIPES, BRANCH PIPES AND NOZZLES

13.1 Hose pipes

a) Two numbers Hose Pipes shall be rubber lined woven jacketed (RRL) and 63mm in dia. 15m long, conforming to type A (Reinforced rubber lined) of IS:636 – 1979, or as specified in the bill of quantities. The hose shall be sufficiently flexible and capable of being rolled.

b) Each run of hose shall be complete with necessary coupling at the ends to match with the landing valve or with another run of hose pipe or with branch pipe. The couplings shall be of instantaneous spring lock type. This shall be conforming to IS: 903.

13.2 Branch Pipes

Standard short sized Branch pipe shall be of Copper, Gunmetal, Aluminum alloy, or Stainless steel, as per bill of quantities, 63 mm dia and be complete with male instantaneous spring lock type coupling for connection to the hose pipe. The branch pipe shall be externally threaded to receive the nozzle. The branch pipe shall to be tested to 20 kg/ cm^2 pressure.

13.3 Nozzles

The nozzle shall be of Copper or Gunmetal, 20 mm internal diameter. The screw threads at the inlet connection shall match with the threading on the branch pipe. The inlet end shall have a hexagonal head to facilitate screwing of the nozzle on to the branch pipe with nozzle spanner.

13.4 End Couplings, Branch pipe, and Nozzles shall conform to IS:903 - 1985.

13.5 Two RRL hoses of 15m length with couplings shall be provided with each External (Yard) Hydrant. Two RRL hoses of 15m length, as specified, with couplings shall be provided with each Internal Hydrant. One nozzle and one branch pipe with coupling shall be provided with each Yard Hydrant and Internal Hydrant.

14. HOSE CABINET (INTERNAL)

14.1 The internal hose cabinet shall accommodate the Hose Pipes, Branch Pipe, Nozzle and Hydrant Outlets and shall be fabricated from M.S sheet as specified in Bill of Quantities. The overall size shall be 2100x1000x715 mm, or as specified in the Architectural details. This shall have lockable centre opening glazed doors as per the requirement and as per Architectural details. Where the niche for wet riser is provided with shutters, separate hose cabinet as above may be dispensed with. Sample of the fire door shall be approved by Project Manager.

14.2 The hose cabinet shall be painted red and stove enameled.

15. **FIRE BRIGADE INLET CONNECTIONS**

15.1 Fire Brigade Inlet connection shall be provided near the pump house and to the wet riser system as specified and as described in the BOQ, for the following purposes:

i) Fire Brigade suction draw out connection for fire static tank with provision of foot valve.

ii) Fire brigade inlet connection to fire static tank.

iii) Fire brigade inlet connection to the wet riser system. Each connection shall be in accordance with similar dia of Sluice valve and Non return valve.

15.2 The locations of these fire brigade connections shall be suitably decided with the approval of Consultant/ Project Manager and with a view that these are easily accessible to the fire brigade, without any possible hindrance.

16. **VALVE CHAMBERS**

16.1 Contractor shall provide suitable Brick Masonry Chamber in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick in 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) 15 mm thick plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back filling complete.

17. **PORTABLE FIRE EXTINGUISHER**

Portable fire extinguishers shall be provided as per Bill of Quantities and shall conform to IS: 2190-1979.

18. **SPRINKLER SYSTEM**

a. **System Design**

4. Sprinkler system shall be designed generally as per I.S. – 15105 with reference to NFPA-13 for general practices.

5. Automatic sprinkler system shall be provided for all areas as per requirement with permitted exceptions e.g. electrical switch rooms, power transformers and D.G. rooms, Panel rooms, Electrical rooms as identified.

6. Sprinkler heads shall be provided at approximate spacing to cover 12 m^2 per Sprinkler head or as per specific requirements to meet the approval of the authority having jurisdiction. The spacing shall also be in conformity with the drawings and properly coordinated with Electrical Fixtures, Ventilation Ducts and Grills and other services along the ceiling.

7. Types of sprinklers to be used shall be as given in specifications, BOQ and approved by the Project Managers

18.2 **Sprinkler Heads**

8. Sprinkler heads shall be Chrome finished Brass/Gunmetal with quartz bulb with a temperature rating of 68°C. Sprinkler heads shall be of type and quality approved by the local fire brigade authority. The inlet shall be screwed. Sprinkler heads shall be pendent, recessed or special application side wall Sprinkler types as shown in drawings. All Sprinklers should have the Specifications, as far as maximum possible as per NFPA requirements and shall be UL/FM approved.
9. Contractor shall supply spare Sprinkler Heads of each type as per requirement and one Spanner neatly installed in a steel box with glass shutters as specified in BOQ and installed at locations approved by the Engineer-in-Charge.

10. The nominal bore shall be 15 mm dia and colour of liquid shall be red. The below false ceiling shall also be provided with a double plate captive rosette assembly to seal the junction between the pipe and the false ceiling. The sprinkler head shall be of approved make.

18.3 **Alarm Valve & Automatic Water Motor Gong Valve**

The alarm valve & water motor gong valve is to be provided on all the Sprinkler main delivery pipes or Installation Control Valves as per approval of authority having jurisdiction.

18.4 **Inspector Test Valves**

The Inspectors Test Valve assembly is to be provided on the Sprinkler System pipes in location as per approval of authority having jurisdiction.

18.5 **Flow Switches**

The Flow Switches are to be provided on the Sprinkler System pipes for each zone, complete with all necessary wiring upto Zonal Indication Panel.

19.0 **FIRE FIGHTING PUMPS**

19.1 **Fire, Sprinkler and Jockey Pumps**

10 Pumping sets shall be single/multi stage horizontal centrifugal single or multi outlet with cast iron body and bronze dynamically balanced impellers.

Connecting shaft shall be stainless steel with bronze sleeve and grease lubricated bearings.

11 Pumps shall be connected to the drive by means of spacer type love-joy coupling, which shall be individually balanced dynamically and statically.

12 The coupling joins the prime mover with the pump shall be provided with a sheet metal guard.

13 Pumps shall be provided with approved type of mechanical seals.

14 Pumps shall be capable of delivering not less than 150% of the rated capacity of water at a head of not less than 65% of the rated head. The shut-off head shall not exceed 120% of the rated head.

15 The pump shall meet the requirements of the Tariff Advisory Committee (TAC) and unit shall be design proven in fire protection services.

19.2 **Motors for Electric Driven Pumps**

PART 1 Electrically driven pumps shall be provided with totally enclosed fan cooled induction motors. For fire pumps, the motors should be rated not to draw starting current more than 3 times normal running current.

PART 2 Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.

PART 3 Motors for fire pumps shall meet all requirements and specifications of the tariff advisory committee.

PART 4 Motors shall be suitable for 415 volts, 3 Phase,50 cycles A.C supply and shall be designed for 33^{o} C ambient temperature. Motors shall conform to IS: 325.

PART 5 Motors shall be designed for two start system.

PART 6 Motors shall be capable of handling the required starting torque of the pumps.

PART 7 Contractor shall provide heating arrangements for the main fire pump motor to ensure that motor windings shall remain dry.

19.3 **Air Vessel for Fire Pumps**

- Provide an air vessel fabricated from 10mm M.S. sheet with dished ends and suitable supporting legs, air vessel shall be provided with a 100mm dia flanged connection from pump, one 50mm dia drain with valve, one gunmetal water level gauge and 25mm sockets for pressure switches. the vessel shall be 450mmx2000mm dia high and tested to 1.5 times of the working pressure or 20 Kg/Cm2, whichever is greater.

- The fire pumps shall operate on drop pressure in the mains automatically or manually as specified below:

Operating Conditions for the Service Pumps

Fire Service Pump	Nos.	Cut in Pressure	Cut Out Pressure	Remarks
Jockey pump	Two	Automatic	Automatic	To auto start and auto stop on pressure switch on air vessel to stop.
Main pump (Hydrant)	One	Automatic	Push button manual	To auto start on pressure switch on air vessel and manual off.
Diesel Fire Pump	One	Automatic	Push button manual	To auto start on pressure switch on air vessel and manual off.
Sprinkler Pump	One	Automatic	Push button manual	To auto start on pressure switch on air vessel and manual off.

(The above ratings will be adjusted finally at the time of commissioning as per site requirement and final setting shall be kept as per approval of Engineer-in-Charge/Project Consultant).

19.4 **Diesel Fire Pump**

◗ **Scope**

This section covers the details of requirements of the standby fire pump, operated by a diesel engine.

◗ **General**

The diesel pump set shall be suitable for automatic and manual 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 bed plate, fabricated from mild steel channel.

◗ **Drive**

The pump shall be only direct driven by means of a flexible coupling. Coupling guard shall also be provided. The speed shall be 1500/2900 RPM as specified in bill of quantities.

- **Fire Pump**

A. The fire pump shall be horizontal split casing centrifugal type. It shall have a capacity to deliver the discharge as specified, developing adequate head so as to ensure a minimum pressure of 3.5 Kg./cm^2 at the highest and the farthest outlet. The delivery pressure at the pump outlet shall be not less than 12 Kg./cm^2 in any case. The pump may be single stage or 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.

B. The pump casing shall be of cast iron to grade FG 200 to I.S: 210 and parts like impeller shaft sleeve, wearing-ring etc. shall be of non-corrosive metal like bronze/brass/gunmetal. The shaft shall be of stainless steel. The pump shall be provided with mechanical seal.

C. The pump casing shall be designed to withstand 1.5 times the working pressure.

D. Bearings of pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

19.5 **Diesel Engine**

- **Environmental Conditions** - The engine shall be required to operate under the conditions of environment as specified.

- **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, water cooled 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 after correction for altitude, ambient temperature and humidity for the specified environmental conditions as mentioned. 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 at least 3000 hours of operation before major overhaul. 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 upto date.

- **Engine Accessories** - The engine shall be complete with the following accessories:-

a) Flywheel dynamically balanced.
b) Direct coupling for pump and coupling guard.
c) Radiator with hoses, fan, water pump, drive arrangement and guard.
d) Corrosion Resister.
e) Air cleaner, oil bath type/dry type.
f) Fuel service tank support, semi-rotary pump and fuel oil filter with necessary pipe work.
g) Pump for lubricating oil and lub. oil filter.
h) Elect. starting battery (2x12 v).
i) Exhaust silencer with necessary pipe work.
j) Governor.
k) Instrument panel housing all the gauges, including Tachometer, hour meter and starting switch with key (for manual staring).
l) Necessary safety controls.
m) Winterization arrangement, where specified.

n) Fuel System: The fuel shall be gravity fed from the engine fuel storage tank to the engine driven fuel pump. The engine fuel storage tank shall be mounted either over or adjacent to the engine itself suitably wall / floor mounted with proper support.

All fuel tubing in the engine shall be with copper and fuel piping from day oil tank to engine shall be MS / Reinforced flexible hose connection. Plastic tubing shall not be permitted.

The fuel tank shall be welded Steel Construction (4mm Thick) and of 200 Ltrs. capacity or of capacity sufficient to allow the engine to run on full load for at least 4 hours. The tank shall be complete with necessary supports, level indicator (Protected against mechanical injury) inlet, outlet, overflow connection and drain plug and piping to the engine fuel tank. The outlet shall be so located as to avoid entry of any sediment into the fuel line to the engine.

Tank shall be provided with epoxy coat from inside and outside with one coat of Red oxide primer and two or more Coats of Synthetic enamel paint of approved shade. A semi rotary hand pump for filling the daily service tank together with hose pipe of 5 m long with a foot valve etc shall also form part of scope of supply.

- **Starting system**- The starting system shall comprise necessary batteries (2x12 v), 24 volts starter motor of adequate capacity and axle type gear to match with the toothed ring on the flywheel. By 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 battery capacity 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.

- **Exhaust system**- The exhaust system shall be complete with silencer suitable for outdoor installation, and silencer piping including bends and accessories needed to be taken out of the building as per statutory requirement. The Contractors are advised to see the drawing and site to assess the length and size of exhaust pipe required and its cost & installation included with price of pump. The total backpressure shall not exceed the engine manufacturer's recommendation. The exhaust piping shall be suitably lagged.

- **Engine shut down mechanism**- This shall be manually operated and shall return automatically to the starting position after use.

- **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.

- **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 mounted on the engine.

1 **Engine Protection Devices**– The following engine protection and automatic shut down facilities shall be provided:-

b) Low lub. oil pressure
c) High cooling water temp
d) High lub. oil temperature
e) Over speed shut down

o) **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.

p) **Anti Vibration Mounting**- Suitable anti-vibration mounting duly approved by Engineer-in-charge shall be employed for mounting the unit so as to minimize transmission of vibration to the structure. The isolation efficiency achievable shall be clearly indicated.

q) **Battery Charger**- Necessary float and boost charger shall be incorporated in the control section of the power and control panel, to keep the battery under trim condition. Voltmeter to indicate the state of charge of the batteries shall be provided.

20.0 **CABLES**

20.1 Contractor shall provide all power control cables from the motor control centre to various motors, level controllers and other control devices.

20.2 Cables shall conform to IS: 1554 and carry ISI mark.

20.3 Wiring cables shall conform to IS 694.

20.4 All power and wiring cables shall be aluminium conductor PVC insulated armored and PVC sheathed of 1100 volts grade.

20.5 All control cables shall be copper conductor PVC insulated armored and PVC sheathed 1100 Volt grade.

20.6 All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.

20.7 All cables joints shall be made in approved manner as per standard practice.

20.8 The cable jointing shall be Crimping type.

20.9 The cable shall satisfy the following tests as per relevant IS codes:

i. Insulation Resistance test sectional and overall.
ii. Continuity Resistance test.
iii. Earth continuity test.

All tests shall be carried out in accordance with relevant standard code of practice and Indian electricity rules. The contractor shall provide necessary instruments, equipments and labour for conducting the above tests and shall bear all expenses of conducting such tests.

21.0 **CABLE TRAYS**

21.1 Contractor shall provide G.I. perforated cable trays at locations as shown on the drawings and of sizes as given in the bill of quantities, with G.I. sheet thickness of 2.0mm.

21.2 Cable trays shall be supported from the bottom of the slab at intervals of 60cms at both ends by welding support rods with insert plates OR Anchor fasteners.

21.3 Cost of clips, bolts, nuts, support rods and any other materials required to fix the trays in proper manner shall be included in the rate for trays.

21.4 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 8 mm dia round headed bolts, nuts and washers.

21.5 Factory fabricated bends, reducers, tee/ cross junctions etc shall be provided as per good engineering practice. The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending the largest size of cable to be carried by the cable tray.

22.0 **EARTHING**

22.1 There shall be an independent earthing station. The earthing shall consist of an earth tape connected to an independent plate made of copper or G.I. having a conductivity of not less than 100% international standard. All electrical apparatus, cable boxes and sheath/armour clamps shall be connected to the main bar by means of branch earth connections of appropriate size. All joints in the main bar and between main bar and branch bars shall have the lapping surface properly tinned to prevent oxidation. The joints shall be riveted and sweated.

22.2 Earth plates shall be buried in a pit of 1.20x1.20M at minimum depth of 3M below ground. The connections between main bar shall be made by means of three 10mm brass studs and fixed at 100mm centers. The pit shall be filled with coke breeze, rock salt and loose soil. A G.I. pipe of 20mm dia with perforations on the periphery shall be placed vertically over the plate to reach ground level for watering.

22.3 A brick masonry manhole 30x30x30xcm size shall be provided to surround the pipe for inspection. A bolted removable link connecting main bar outside the pit portion leading to the plates shall be accommodated, in this manhole for testing.

22.4 All equipments installed shall be properly earthed to the main earthing station.

23.0 **MOTOR CONTROL CENTRES**

23.1 MCC shall be cubical type i.e. one motor feeder completely in one cubicle, and shall be fabricated from 14 gauge CRC sheet with dust & vermin proof construction. It shall have Powder Coated finish and shall be fitted with suitable etched plastic identification plates for each motor. The cubicle shall comprise of the following: -

- Incoming main MCCB of required capacity.
- Fully automatic as specified D.O.L/ Star delta starters suitable for motor H.P. with push buttons one for each motor and ON/OFF indicating LED type lamps.
- Single phasing preventor of appropriate rating for each motor.
- Rotary duty selector switch.
- Panel type ampere meters one for each motor.
- Panel type voltmeter on incoming main with rotary selector switch to read voltage between phase to neutral and phase-to-phase.

- LED type-indicating lamps for in incoming main and ON/OFF indicating lamps for each motor.
- Rotary switch for manual or auto operation for each pump (manual/auto/off).
- Fully taped separate aluminium bus bars of required capacity.
- Space for liquid level controllers as specified.
- The panel shall be prewired with colour-coded wiring. All interconnecting wiring from incoming main to switch gear, meters and accessories within the switchboard panel.
- Power wiring and Control wiring in MCC to be of Copper only and minimum size 4 & 1.5 Sqr.mm respectively.
- Provided with a degree of protection of IP-52 and of uniform height of not more than 2450mm

23.2 All switchgears and accessories shall be of approved make such as "Siemens, English Electric, Larsen & Toubro" or equivalent.

23.3 Switchboard cubicles shall be floor or wall mounted type as recommended by manufacturers.

24.0 **VIBRATION ELIMINATORS**

All suction and delivery lines shall be provided with double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump. Length of the connector shall be as per manufacturer's details. Flexible connectors shall be as manufactured by Relay Corp., New Delhi /Resistoflex.

25.0 **MEASUREMENTS**

25.1 Pumps and equipment shall be measured by numbers and shall include all items as given in the bill of quantities.

25.2 Motor control panel and level controllers shall be measured by numbers.

25.3 All pipes including hydrant lines, headers and branches for sprinkler system, risers, suction and delivery header and mains etc. shall be measured per linear meter along the centre line of the pipe and shall be inclusive of all fittings and structural supports, clamps, anchor fasteners etc.

25.4 Only if as per the approval by the engineer – in – charge in writing, any additional structural clamps are instructed to be provided by the contractor, the necessary structural supports item shall be used as per the designated BOQ item. This shall be including hangers and shall be measured by weight calculated from sections used. No separate payment shall be admissible for bolts, anchor bolts, raw plugs etc.

25.5 Cable trays and cables shall be measured per linear meter.

25.6 No separate payment shall be made for making connections of the existing service lines to the pumps. Vibration eliminator pads are included in the scope of this work.

26. **COMMISSIONING**

26.1 After successful testing of the different items in parts, the Contractor shall provide all facilities including necessary piping, labor, tools and equipments etc. for carrying out testing and commissioning of the entire fire fighting system complete as per requirement in the presence of Client's representative and during the visit of the Fire Officer whenever and as may be required. Generally, the following test/inspection has to be carried out:

(a) For the automatic operation of the Jockey/main fire pump and diesel pump as per the sequences required.

(b) For checking the pressure available at the farthest and highest point in the fire ring and for the wet riser system.

(c) For the automatic operation of the Sprinkler System either by a dummy fire below a sprinkler head or by using the Inspection Test Valves. In this case, the annunciation panel indicating the particular zone and mechanical Gong valve should work.

FIRE FIGHTING SERVICES

GUIDE LIST OF APPROVED MAKES OF MATERIALS

NOTE: CONTRACTORS SHALL QUOTE FOR THE 1ST MENTIONED SUPPLIER/MAKE FOR TENDERING, UNLESS APPROVED BY THE CLIENT/CONSULTANT

S. N	Material / Item	Code / Standard	Brand & Manufacturer/ Supplier - 1	Brand & Manufacturer/ Supplier - 2	Brand & Manufacturer / Supplier - 3
1	M.S Pipes	1239 Pt-I /Pt-II, I.S. 3589	**TATA** The Tata Iron & Steel Co. Ltd., Calcutta	**JINDAL HISSAR** Jindal Hissar	**SURYA ROSHNI**
2	Forged Steel Fittings		**SS** Sudarshan Steels/SS Traders, M: 995870773, 9999114198	**MEC (JAINSONS)** Basti Bawa Khel,Kapurthala Road,Jallandhar - 144 021	**VS** Vijay Cycle & Steel Industries, Model House Road, Basti Sheikh, Jallandhar
3	Butt Welded Fittings		**DRP** DRP MalleablesContact No. - 9810224824	**TRUE FORGE** True Forge	**SS** Sudarshan Steels/SS Traders, M: 995870773, 9999114198 Ph: 9899988865, 9717255552
4	D.I. Grooved Coupling Fittings		**VICTAULIC**	**NEW**	**MEC (JAINSONS)**

					Basti Bawa Khel, Kapurthala Road, Jallandhar - 144 021
5	Ball valve		**ARCO** Deepak Exim Company, LG-4, J-21, South Extn – I, New Delhi – 110049, Tel: 24628121	**CIM** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	**TIEMME** Rajco Metal Industries,, rajcojitendra@vsnl.net, 0120-2659860, 9810475768
6	Butterfly Valve (upto PN 16)	13095-1991	**KSB** Aquatech Engineers, E-5/12, Basement, Malviya Nagar, New Delhi- 17	**SKS** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	**ADVANCE** Advance Valves (P) Ltd B-33, Sector-2 Noida – 201 301
6	Butterfly Valve (PN 20)	13095-1991	**AIP** Agriculture & Industrial Products	**MONSHER** 403 Tantia Jogani Est. Off NM joshi Road, Lower Parel Mumbai, Tel:02240502000, E: productsales@monsher.com	**SKS** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com
7	Air Release Valve		**SANT** Sant Brass Metal Works, Jallandhar	**SKS** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	**LEADER** Leader Engg. Works, Jallandhar
8	C.I Double flanged sluice valves		**KIRLOSKAR** Kirloskar Brothers Ltd., Pune	**SKS** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	**LEADER** Leader Engg. Works, Jallandhar
9	C.I Double Flanged Non-return valve		**KIRLOSKAR** Kirloskar Brothers Ltd., Pune	**SKS** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	**LEADER** Leader Engg. Works, Jallandhar

10	Dual Plate / Wafer Type Non-return valves (upto PN 16)		**SKS** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	**KSB** Aquatech Engineers, E-5/12, Basement, Malviya Nagar, New Delhi- 17	**LEADER** Leader Engg. Works, Jallandhar
10	Dual Plate / Wafer Type Non-return valves (PN 20)		**SKS** Pipeline Products, 3374 Hauz Qazi, Delhi-06, Tel: 91-11-43211999, E: info@pipelineproducts.com	**MONSHER** 403 Tantia Jogani Est. Off NM joshi Road, Lower Parel Mumbai, Tel:02240502000, E: productsales@monsher.com	
11	Fire Extinguishers	Various relevant standards	**MINIMAX** Rapid Service Providers, 95 Harlaa Market, Naharpur, Sec-7, Rohini Delhi-85, 011-32928508, 27053932, E: delhi@rapidindia.net	**SAFEGUARD** Ashok Engineering Co. Plot # 7, Gali # 7, Anand Parbat Indstr. Estate, New Delhi 110005, Ph:01128761151, 28762151, e: sandeeplakra@firesafeguard.co.in	**LIFEGUARD** United Fire Equipment, K-960, Rithala, Rohini, New Delhi-85, Ph: 9811172242, 011-23587476, 23561617, e: greatsale123@rediffmail.com
12	First-aid Hose Reel Drum	IS:884	**SAFEGUARD** Ashok Engineering Co. Plot # 7, Gali # 7, Anand Parbat Indstr. Estate, New Delhi 110005, Ph:01128761151, 28762151, e: sandeeplakra@firesafeguard.co.in	**LIFEGUARD** United Fire Equipment, K-960, Rithala, Rohini, New Delhi-85, Ph: 9811172242, 011-23587476, 23561617, e: greatsale123@rediffmail.com	**NEWAGE** NewAge Fire Protection Engineers Pvt. Ltd101/102, Champaklal Udyog Bhavan,Sion (East), Mumbai - 400 022, IndiaPh: +91-22-24077421
13	Rubber Hose Reels for Drums	IS:444-1984	**SAFEGUARD** Ashok Engineering Co. Plot # 7, Gali # 7, Anand Parbat Indstr. Estate, New Delhi 110005, Ph:01128761151, 28762151, e: sandeeplakra@firesafeguard.co.in	**LIFEGUARD** United Fire Equipment, K-960, Rithala, Rohini, New Delhi-85, Ph: 9811172242, 011-23587476, 23561617, e: greatsale123@rediffmail.com	**NEWAGE** NewAge Fire Protection Engineers Pvt. Ltd101/102, Champaklal Udyog Bhavan,Sion (East), Mumbai - 400 022, IndiaPh: +91-22-24077421

14	Thermo Plastic Hose Reels for Drums	IS: 12585 / EN 694:2001	**KESARA PLAST** Kesara Syntex (P) Ltd., A-50, Mangolpuri Indl. Area, Phase-II, Delhi – 34	**MITRAS** Rapid Service Providers, 95 Harlaa Market, Naharpur, Sec-7, Rohini Delhi-85, 011-32928508, 27053932, E: delhi@rapidindia.net	**EVERSAFE** Eversafe Building Controls Pvt. Ltd., D-128, (Basement) Panchseel Enclave, New Delhi – 110017, Ph: 011-41749170 Mob: 9958892801
15	R.R.L. Hose & C.P. Hose	636 Type-A	**SAFEGUARD** Ashok Engineering Co. Plot # 7, Gali # 7, Anand Parbat Indstr. Estate, New Delhi 110005, Ph:01128761151, 28762151, e: sandeeplakra@firesafeguard.co.in	**LIFEGUARD** United Fire Equipment, K-960, Rithala, Rohini, New Delhi-85, Ph: 9811172242, 011-23587476, 23561617, e: greatsale123@rediffmail.com	**NEWAGE** NewAge Fire Protection Engineers Pvt. Ltd 101/102, Champaklal Udyog Bhavan, Sion (East), Mumbai - 400 022, India Ph: +91-22-24077421
16	Branch Pipe, Nozzle, Coupling etc.		**SAFEGUARD** Ashok Engineering Co. Plot # 7, Gali # 7, Anand Parbat Indstr. Estate, New Delhi 110005, Ph:01128761151, 28762151, e: sandeeplakra@firesafeguard.co.in	**LIFEGUARD** United Fire Equipment, K-960, Rithala, Rohini, New Delhi-85, Ph: 9811172242, 011-23587476, 23561617, e: greatsale123@rediffmail.com	**NEWAGE** NewAge Fire Protection Engineers Pvt. Ltd 101/102, Champaklal Udyog Bhavan, Sion (East), Mumbai - 400 022, India Ph: +91-22-24077421

17	Landing Valves	IS:5290	**SAFEGUARD** Ashok Engineering Co. Plot # 7, Gali # 7, Anand Parbat Indstr. Estate, New Delhi 110005, Ph:01128761151, 28762151, e: sandeeplakra@firesafeguard.co.in	**LIFEGUARD** United Fire Equipment, K-960, Rithala, Rohini, New Delhi-85, Ph: 9811172242, 011-23587476, 23561617, e: greatsale123@rediffmail.com	**NEWAGE** NewAge Fire Protection Engineers Pvt. Ltd 101/102, Champaklal Udyog Bhavan, Sion (East), Mumbai - 400 022, India Ph: +91-22-24077421
18	Fire Brigade Connections		**SAFEGUARD** Ashok Engineering Co. Plot # 7, Gali # 7, Anand Parbat Indstr. Estate, New Delhi 110005, Ph:01128761151, 28762151, e: sandeeplakra@firesafeguard.co.in	**LIFEGUARD** United Fire Equipment, K-960, Rithala, Rohini, New Delhi-85, Ph: 9811172242, 011-23587476, 23561617, e: greatsale123@rediffmail.com	**NEWAGE** NewAge Fire Protection Engineers Pvt. Ltd 101/102, Champaklal Udyog Bhavan, Sion (East), Mumbai - 400 022, India Ph: +91-22-24077421
19	Fire Fighting Equipment not covered else where		**SAFEGUARD** Ashok Engineering Co. Plot # 7, Gali # 7, Anand Parbat Indstr. Estate, New Delhi 110005, Ph:01128761151, 28762151, e: sandeeplakra@firesafeguard.co.in	**LIFEGUARD** United Fire Equipment, K-960, Rithala, Rohini, New Delhi-85, Ph: 9811172242, 011-23587476, 23561617, e: greatsale123@rediffmail.com	**NEWAGE** NewAge Fire Protection Engineers Pvt. Ltd 101/102, Champaklal Udyog Bhavan, Sion (East), Mumbai - 400 022, India Ph: +91-22-24077421
20	Hose Box	Reputed make as per IS: specification subject to approval of Samples/Technical Details.			
21	Sprinklers &	I.S. 15105, UL Listed	**TYCO**	**VIKING**	**HD**

	Rosette Plates (All Types)	/ FM Approved		Eversafe Building Controls Pvt. Ltd., D-128, (Basement) Panchseel Enclave, New Delhi – 110017, Ph: 011-41749170 Mob: 9958892801	
22	Motors for Fire Pumps		**KIRLOSKAR**	**ABB**	**CROMPTON GREAVES**
23	Fire Pumps	IS: 1520	**KIRLOSKAR**	**MATHER PLATT**	**HBD MUMBAI**
24	Diesel Engine	IS: 10000	**KIRLOSKAR**	**CUMMINS**	**MAHINDRA**
25	Electrical Switch Gear		**SIEMENS**	**L&T**	
26	Cables		**GRANDLAY**	**GLOSTER**	**HAVELLS**
27	Main Control panel (Power coated)		**DIAMOND**	**ADVANCE AUTOMATION**	**TRICOLITE**
28	Voltmeter & Ammeter		**AE**	**DUCATI**	**MECCO**
29	Y-Type / Pot / Suction Strainer		**KIRLOSKAR**	**LEADER**	**FIVALCO** TYCO
30	Foot valve with Strainer		**KIRLOSKAR**	**LEADER**	**KARTAR** Kartar valves and fittings, D-154, Fateh Nagar, Jail Road, New Delhi – 18, Mob:9312408001
31	Pressure Reducing		**WILKINS**	**OCV**	**AIP**

	Valves (For Fire Fighting)		NewAge Fire Protection Engineers Pvt. Ltd 101/102, Champaklal Udyog Bhavan, Sion (East), Mumbai - 400 022, India Ph: +91-22-24077421	Eversafe Building Controls Pvt. Ltd., D-128, (Basement) Panchseel Enclave, New Delhi – 110017, Ph: 011-41749170 Mob: 9958892801	
32	Batteries		**EXIDE**	**AMCO-YUASA**	**STANDARD**
33	Flexible Connectors (Drop) for Sprinklers	UL Listed	**EASYFLEX** Kanwal Industrial Corporation, B-167/168 Phase II, Noida, Tel:0120-4734500-30, E:vikas@easyflex.in	**VIKING** Eversafe Building Controls Pvt. Ltd., D-128, (Basement) Panchseel Enclave, New Delhi – 110017, Ph: 011-41749170 Mob: 9958892801	
34	Flow Switches /Monitor Modules		**MORLEY IAS**	**SYSTEM SENSOR**	**POTTER** TYCO
35	Annunciation panels		**MIRCOM**	**EDWARDS**	**MORLEY IAS**
36	Inspector Test Valves		**GIACOMINI** Eversafe	**AGF** Eversafe	**BAN CHANG** TYCO
37	Pre-Fabricated Structural supports and clamps		**CHILLY** Veer Sanitary Appliances Pvt. Ltd., B-10/3, Paras Bhawan, Group Indl. Area, Wazirpur, Delhi – 110052, Tel-20532036/9811156106	**EASYFLEX** Kanwal Industrial Corporation, B-167/168 Phase II, Noida, Tel:0120-4734500-30, E:vikas@easyflex.in	**CAMRY** Veer Bath Accessories Pvt. Ltd., I-2228, DSIDC Industrial Park, Narela, New Delhi – 40, Ph: -27787172
38	Pressure Gauge		**FIEBIG**	**H.GURU**	
39	Alarm Valve		**HD**	**MATHER + PLATT**	**NEWAGE**

					NewAge Fire Protection Engineers Pvt. Ltd101/102, Champaklal Udyog Bhavan,Sion (East), Mumbai - 400 022, IndiaPh: +91-22-24077421
40	Deluge Valve		**HD**	**MATHER + PLATT**	**SHJD (MONSHER)**
41	Water Curtain Nozzles		**HD**	**VIKING**	**NEWAGE** NewAge Fire Protection Engineers Pvt. Ltd101/102, Champaklal Udyog Bhavan,Sion (East), Mumbai - 400 022, IndiaPh: +91-22-24077421
42	Pipe Coat Material (Pipe Protection)		**PYKOTE**	**PYKOTE**	**POLYCHEM** Tyco Adhesives
43	Dash fasteners		**HILTI**	**FISHER**	
44	Paint / Primers		**ASIAN**	**JENSON NICHOLSON**	**BERGER**
45	Weld. Electrodes		**ADVANI**	**ESSAB**	
46	Anti-vibration Pads & suction & delivery flexible connectors		**EASYFLEX** Kanwal Industrial Corporation, B-167/168 Phase II, Noida, Tel:0120-4734500-30, E:vikas@easyflex.in	**RESISTOFLEX** RELAY CORPORATION	
47	Nuts/ Bolts		**LAKSHMI**	**UNBRAKO**	

48	Conduit ERW	ISI Marked	**BEC**	**AKG**	
49	Contactors & overload relays, fude links and indicating lamps		**L & T**	**SIEMENS**	**GE POWER**
50	CT/PT Transformer		**AE**	**KAPPA**	**C & S**

ELECTRICAL WORK

1. General:

The following Special Conditions shall be read in conjunction with General Conditions of Contract. If there are any provisions in these Special Conditions, which are at Variance with the provisions in the above-mentioned documents, the Provisions in this Special Conditions shall take precedence.

2. Working Agency:

The electrical work shall be done by "A" Class Electrical Contractor approved by Government having similar nature and value of work executed.

3. Inspection & approval of the work by local authority:

The contractor has to obtain all clearances & approvals from any statuary authority/local bodies pertaining to electrical installations. The contractor shall obtain all information relating to local regulations, Bye- laws, applicable if any and all laws relate to his work or profession and his having to execute work as required. Contractor shall obtain approval of the installation from the relevant inspection authorities at all stages and on completion of the installation work. Any fee payable to the statutory authority for obtaining approvals is required to be paid by the contractor. However the necessary reimbursement of the fee deposited by the contractor to any statutory authority (as mentioned above) will be made on production/submission of the valid documentary proof/evidence.

i. Training:

The contractor has to provide training to the client staff and also operate the system (if required) for a period of one month from the date of handing over free of cost.

5. Pre-delivery Inspection & approval:

The contractor shall offer the pre-delivery inspection of all the materials at manufacturers work to the Engineer-in-charge. The intimation for such inspections shall be given at least 15 days in advance from the date of proposed inspection. CLIENT representative may inspect any/all the materials required in this project. All the testing facilities and all the consumables including the fuel etc. shall be provided by the contractor and nothing extra shall be paid on this account.

6 Tender drawings and Shop Drawings:

The work shall be executed as per latest working drawings to be prepared by the contractor after award of work and submitted to the Engineer-in-charge for approval. The Drawings & data provided are for guidance to the contractor. The exact dimensions, location, distance & levels etc shall be governed by the space conditions. The tender drawings are indicative and are for the guidance of the contractor. The drawings appended with the tender documents are intended to show the space allotted for various equipment, bus duct, cable and pipe routes etc. besides general electrical layout. The equipment offered shall be suitable for installation in the spaces shown in these drawings / available at site. The contractor shall prepare and submit for approval detailed shop/working drawings of all works on award of the work. Two set of all such working drawings shall be submitted for approval, including such changes as may have been suggested by the Engineer-in-charge as required at the earliest - within 15 days of awarding of the work.

The contractor shall also take parallel action (after award of work) for submission of applications along with the drawings, documents & details etc. to various Statutory Bodies/Authorities for obtaining their approval/clearances.

The contractor shall re- submit 4 sets of all the drawings within 7 days from date of receiving comments if any from the client after incorporating the comments.

7. Completion Drawings:

After completion of work, the contractor shall have to submit the following set of drawing.

4 set of hard copies + 3 soft copies (in 'Auto CAD' applicable version) in CDof the following layout drawings. (Indicating complete Equipment like switch boards, panels, cabinets, Bus-trunking, Ducting, cable laying, piping, other works installed & single line diagrams of electrification of installations etc.) For final record & maintenance:-

1. Documents to be furnished on completion of installation

i.Completion Drawings as per Clause 7 above.

b) Manufacturer's catalogues of all equipment and accessories, operation and maintenance manuals of all major equipment, detailing all adjustments, operation and maintenance procedure.

i. Manufacturer's Guarantee /Warrantee certificates of all the equipments & materials etc.
ii. Clearances/approval of various Statutory Bodies/Authorities for this system.
iii. Any other information the Engineer-in-charge may deem fit.

No completion certificate will be issued until the above drawings and documents are submitted to the Engineer-in-charge.

2. Performance Testing at Site:

After completion of erection at site & a preliminary warm up period, acceptance trial run of a minimum period of 7 days duration shall be conducted at site. The trial shall be conducted in the presence of the Engineer-in-charge and the test results shall be recorded in an approved format. The contractor at his cost shall provide all Testing facilities like testing Engineers, assistants, instruments, materials and consumables etc. as required for the test. Tests proving the satisfactory performance of all operating switch gears, transformers and safety functions and controls shall be carried out. All calibrated instruments, materials, load configuration, fuel, lubricating oil and labour required for carrying out of the test shall be provided by the contractor free of cost. The contractor shall give ample notice of the test to the Engineer-in-charge.

1. The contractor shall be fully responsible for the maintenance including watch and ward of all the Electrical installations provided by him until the works are handed over to client. Thereafter, the work can be handed over to the Client along with all inventories, completion plans etc. as required.

11. CO-ORDINATION:

The Contractor shall co-operate with any other agency working in the same project, compare plans, specifications and the time schedules and so arrange his work that there will be no interference. The Contractor shall forward to the Engineer-in-charge all correspondence and drawings so exchanged. Failure to check plans for conditions will render the contractor responsible for bearing the cost of any subsequent change found necessary or damages done. However, contractor shall afford necessary facilities to execute the work simultaneously with other agencies executing the works like Civil, architect, horticulture, external services and other building works for the same project. The electrical work shall be executed in close coordination with the progress of building work. This being the essence of the contract, an activity chart clearly showing critical areas should be furnished before commencing the work for proper monitoring and coordination.

12. HANDING OVER THE WORKS ON COMPLETION:

On satisfactory completion of all the works as per the provision of the Contract, the Contractor shall hand over the works to the client. The Contractor shall ensure that all the testing commissioning & trial run operation of all the system are simultaneously carried out so as to make the same functional immediately on completion. It shall be the responsibility of the contractor to obtain clearances from all the Statutory Bodies like Electrical Inspector & Fire Officer etc. as required for the installations prior to commissioning & handing over the same after completion of work.

13. All material to be used on works shall bear I.S. Certification work unless otherwise the make specified in the item or special conditions appended with the tender document. In case I.S. marked materials or the materials mentioned in the tender document are not used due to non-availability, the materials used shall conform to I.S. code or CPWD Specifications applicable in this contract. In such cases the Engineer-in-charge shall satisfy himself about the quality of such materials and give his approval in writing. Only articles classified as "First Quality" by the manufacturers shall be used unless otherwise specified. All materials not having I.S. marking shall be tested as per provision of the Mandatory Tests in CPWD Specifications and the relevant IS specifications. The Engineer-in-charge may relax the condition regarding testing if the quantity of materials required for the work is small. For the products bearing ISI certification work, no further testing is required at site. In all such cases of use of IS certified materials, proper proof of procurement of materials from authentic manufactures shall be provided by the contractor to the satisfaction of Engineer-in-charge.

14. Other agencies doing work of Civil, Plumbing, Air conditioning or other building work, horticulture work etc. for this project will also simultaneously execute the works and the contractor shall afford necessary facilities for the same. The contractor shall leave such necessary holes, openings, etc. as may

be required for the electric, sanitary, air-conditioning, fire-fighting, PA system, telephone system, C.C.T.V. system etc. and nothing extra over the agreement rates shall be paid for the same.

15. The work shall be carried out in a manner complying in all respects with the requirements of relevant bye-laws of local body under the jurisdiction of which the work is to be executed or as directed by the Engineer-in-charge and nothing extra shall be paid on this account.

16. For items, where so required, samples shall be prepared before starting the particular items of work for prior approval of the engineer-in-charge and nothing extra shall be payable on this account.

17. CLARIFICATIONS OF DISCREPANCIES:

In case of any discrepancy between technical specifications, approved drawings and BOQ, or disputes in respect thereof, the interpretation of the Engineer-in-Charge shall be final and binding on the contractor.

PART – B TECHNICAL SPECIFICATIONS OF EXTERNAL ELECTRICAL WORK

1.00 GENERAL

1.01 The electrical installation work shall be carried out in accordance with Indian Standard Code of practice for Electrical wiring installation IS: 732-1989 and IS:2274-1963. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Electricity supply authority and fire insurance regulation. Electrical work in general shall be carried out as per following specifications with upto date amendment.

General Specifications for Electrical Works:

MP PWD Specification (Part-4) 2012

(Part I - Internal) - 2013.

(Part II - External) - 2007.

(Part IV - Substation) - 2013.

(Part VII – DG Set) - 2013

Wherever these specifications calls for a higher standard of material and or workmanship than those required by any of the above mentions regulations and specification then the specification here under shall take precedence over the said regulations and standards.

1.2 SCOPE OF WORK

The scope of work shall cover electrical works for proposed **CONVENTIAL CENTRE AT JABALPUR**

The items / activities covered under the electrical works shall include the following:

a. Supplying, Fixing testing and commissioning of Main LT Panel, capacitor Panel, Main Distribution Boards and Sub distribution boards complete in all respect.

b. Supplying, fixing, laying, testing and commissioning of 33KV and LT Cable complete in all respect.

c. Supplying, fixing, testing and commissioning of DG Sets of 415V complete in all respect.

d. Supplying , Fixing , testing and commissioning of 33kV HT Panel and 33KV / O.415 KV Oil Type Transformers with OLTC complete in all respect

a. Supplying, Fixing, testing and commissioning of External light pole complete in all respect.

b. Earthing complete in all respect.

c. Main Distribution Boards, Sub Distribution Boards and Distributions Boards. Switch fuses unit/MCB/Isolator for lifts, major equipment etc. complete in all respect.

d. Bus Duct complete in all respect.

ix. Cables from Main Distribution Board to Sub Distribution Boards. Sub main wiring from Main/Sub Distribution Boards to various final Distribution Boards. Power wiring for quipment, lift etc. complete in all respects.

x. RCC/GI pipes for cables, manholes, cable tray and other items required to complete with electrical installation work in all respects.

xi. Earthing of electrical installation complete in all respects.

xii. UPS System to provide the emergency backup complete in all respect.

1.03 STANDARD AND REGULATIONS

All equipments, switchgear, cables and other items of work shall conform to Indian/ **IEC** Standard specifications.

The installation shall conform in all respects to Indian Standards Code of Practice for Electrical wiring installation IS:732- 1989. It shall also be in conformity with the current Indian Electricity Rules and the Regulations and requirements of the Local Electric Supply Authority, Local laws/by laws in so far as these become applicable to the installation. Wherever these specifications call for a higher standard of materials and /or workmanship than those required by any of the above regulations, these specifications shall take precedence over the said regulations and standard. In general, the materials, equipment and workmanship shall conform to the following Indian Standards, unless otherwise called for.

* XLPE insulated PVC sheathed armoured Cables of 1.1kv grade as per — IS 7098 Part-I & II 1988/1985

* Marking and arrangements for Switchgear: Bus bars, main connection and auxiliary wiring. — IS 375 - 1963

* Specifications for normal duty air break switches and composite units for air break switches and fuses for voltage not exceeding 1000 volts. — IS 13947-1993 (Part-I to V)

* Specification for low voltage switchgear and controlgear assemblies — IS 8623 -1993 (Part-I to III)

* Specifications for enclosed distribution — IS 2675 - 1983

* Installation and maintenance of Switchgear — IS 10118-1982 (Part-I to IV)

* HRC Fuses — IS 9224 -1979

* Specification for Rigid Steel conduits for electrical wiring. — IS 9537 -1981 (Part-II)

* Specifications for accessories for rigid steel conduits for electrical wiring. — IS 3837 -1976

* Code of practice for earthing — IS 3043 -1987

* Current transformers — IS 2705 -1992 (Part-I)

* Shut capacitors for power system — IS 2834 -2986

* Exhaust Chimney — IS 6533 -1989 (Part-II)

Inspection and approval of the work by local authority: On completion of this work, the contractor shall obtain and deliver to the Client all the certificates of inspection and approval by the electrical inspectorate as required. The Client shall have access to the manufacturer's premises for inspection of any item of the tender for which contractor has to make arrangement with different manufacturers.

2.1 33kV SWITCH BOARD

2.1.01 **System Design Parameters**

Nominal system voltage	:	33KV
Frequency	:	50 Hz
System fault level	:	1000 MVA
Site Altitude level	:	Less than 1000 m above sea level

2.1.02 **33kV, 1000 MVA SWITCH BOARD**

The 33kV panels have six panel board having one incoming and five outgoing 33 KV breaker to feed five nos. Transformer. The panel shall be fully compartmentalized, with separate compartments for CT/ cable termination, busbar chamber, breaker compartment and LT chamber, housing the LT equipment, like meters/relays etc. The panels shall be suitable for fully drawout execution with horizontal isolation. The breaker truck to have three distinct positions, i.e. test, service and isolated. Necessary interlocks to be provided to prevent operation of breaker in any intermediate position.

Busbars shall be fine electrolytic copper, air insulated. The busbars shall be enclosed in separate compartments and shall be air insulated. The busbars supported on bus support insulators shall be able to withstand the dynamic stresses during short circuits.

The partitions between the breaker compartment and the bus and cable-connecting compartment respectively shall be made of metal clad plates. These plates shall carry individual metallic shutters for primary contact arms. The shutters shall operate automatically without any complex operating mechanism but under no circumstances be pushed open inadvertently when the breaker truck is removed. Sealing of the breaker room against the bus and cable compartments must be ensured even when the breaker is withdrawn.

The breaker panel is to have both power and control cable entries from bottom.

Current Transformer

For metering and protection, panel shall be provided with two core wound epoxy cast resin current transformers.

Potential Transformer

For metering, panels shall be provided with epoxy cast resin potential transformers in single phase design.

LT Compartment

A separate LT compartment shall be provided, which houses the relays, meters etc.

Earthing

Positive scrapping earth shall be provided by means of a copper busbar, which remains in contact with the breaker trolley in all positions till the breaker is withdrawn fully outside the panel.

All metal parts of the panels shall be earthed. A continuous running earth busbar of copper shall be provided which can be connected to the station earth.

Installation, Operation and Maintenance

The switchgear shall be supplied in fully assembled, transportable sections, ready for installation and connection. The details of this shall be given in the operating instructions supplied with the panel board.

2.1.03 **33kV VCB CIRCUIT BREAKER**

CONSTRUCTION OF VCB INTERRUPTER

The interrupter shall consist of the following.

ENCLOSURE

The enclosure shall be made of Air insulated, metal clad construction with high quality of CR steel.

END FLANGES

End flanges shall be provided for accommodating seal.

CONTACTS

The contacts shall be made of large stem with large disc shaped face. The material used for contacts tips shall be Cooper Chromium bismuth alloy.

ENDURANCE

10000 CO operations at normal current.

OPERATING CONDITIONS

The 33kV draw out type VCB circuit breaker shall be suitable to operate on an electric power supply system having 3 phase, 4 wire, 50 HZ, 33KV earthed system and having a fault level of 1000 MVA at 33KV.

ENCLOSURE AND PROTECTION

The breaker enclosure shall be metal clad and shall comprise of standard prefabricated cold rolled sheet steel units assembled to form a rigid free standing dead front structure.

The breaker shall be totally enclosed dust and vermin proof housing conforming to protection class IP42. It shall have opening for natural ventilation. The openings shall be louvered with wire mesh.

Doors and openings shall be provided with neoprene gaskets.

Each unit of breaker enclosure shall have internal sheet metal barriers to form separate compartments for fuses, bus bars, instruments, relays cable connections etc.

It shall be possible to extend the enclosure in either direction in future. Ends of bus bars shall be suitably drilled for this purpose.

The draw out carriage on the board shall have three positions viz. service, test and draw out. Automatic Safety shutters shall be provided to ensure inaccessibility of all live parts after the breaker is drawn out. It shall not be possible to draw out the carriage with circuit breaker closed. Suitable interlocks shall be provided to prevent faulty operation.

ACCESSIBILITY

It shall be possible to remove/check components without disturbing adjacent equipment. All auxiliary equipment shall be easily accessible. All mounted equipment shall have identification tags. Unused current transformer secondary terminals must be short circuited.

2.1.04 **BUS BARS CONNECTIONS.**

The board shall comprise of one set of 3 phase bus bars extending throughout all the units of the breaker. All phase bus bars shall be of uniform cross section and shall be sized to carry continuously the current specified on the single line diagram. Bus bars shall be made of electrolytic copper and shall be sleeved. Joints shall be shrouded. The bus bars and the supports shall be adequately sized and braced to withstand the specified short circuit level.

2.1.05 **POWER CONNECTIONS**

The incoming and outgoing power connections shall be through 33KV 1x3Core, 185sqmm aluminium cable respectively. Ample space shall be provided for connection of this cable at the rear of the breaker. The power cable shall enter the breaker from bottom.

2.1.06 **AUXILIARY WIRING AND TERMINALS**

Inside the cubical, the wiring for control, protection and instruments circuits shall be done with 1100 Volt grade PVC insulated control cables. The wiring shall be preferably enclosed in plastic channels. 10% spare terminals shall be provided on each terminal block. Conductors shall be terminated with adequately sized compression type lugs. For connection to equipment terminal and strips, elmex terminals shall be used. All spare contacts of auxiliary relays, timers etc. shall be wired up to the terminals.

Each core shall be identified at both the ends by PVC ferrules and shorting links shall be provided for all the CT terminals.

For CT circuit, 2.5 sqmm copper conductor shall be used. Other control wiring shall be with 1.5 sqmm copper conductor.

2.1.07 **CONTROL AND INDICATION**

Circuit Breaker closing devices shall be fed from the transformer at 110 volts AC supply and energy stored type power pack shall be provided for tripping and closing operation and panel lighting. The relays used shall be current operated relays.

Breaker positions ON/OFF/Spring charged/Test position/service position shall be indicated mechanically. For electric indication following colour shall be used.

Breaker ON : Red lamp

Breaker OFF : Green lamp

Auto trip : Yellow lamp

Push Buttons for ON and OFF positions shall be mounted on the panel for local operations.

2.1.08 **EARTHING CONNECTIONS**

All cubical shall be connected to an earth bus bar running throughout the length of the breaker. The earth bus size shall be 50 mm x 12 mm copper. All doors and movable parts shall be connected to the earth bus with flexible copper connection.

All non-current carrying metallic parts shall be earthed.

2.1.09 **NAME PLATE**

A name plate with the breaker designation and feeder details shall be provided at front and rear of each panel. Name-plate shall be provided for each equipment as specified.

2.1.10 **PAINTING**

All metal surfaces shall be thoroughly cleared and degreased. The fabricated structure shall be pickled and then cleansed to remove traces of acid. A coat of zinc chromate primer shall then be applied. Thereafter Synthetic enamel paint shall be applied in 2 coats. The steel part of panel shall be cadmium plated to prevent corrosion.

2.1.11 **SPACE HEATERS**

The cubical shall be provided with anti-condensation space heaters to prevent moisture condensation and maintain cubical temperature 5 degrees centigrade above ambient. The space heaters shall be located at the bottom of the board and shall be controlled through a thermostat with an adjustable setting and a manually operated switch. The thermostat shall be located in the metering relay chamber.

2.1.12 **BASE FRAME**

The panel shall be installed on a base frame. The base frame shall be fabricated from M.S. angle of suitable size and installed on concrete foundation and fixed with bolts and nuts.

Installation of breaker shall be carried out in accordance with manufactures instructions and/or as directed by the purchaser.

2.1.13 **EQUIPMENTS**

CIRCUIT BREAKER.

Fully draw out type VCB breaker shall in door type and rating shall be as under:

Rated volt : 33 KV

Rated frequency : 50 Hz

Rated current : 630 A

Rated breaking current : 1000 MVA

OPERATING MECHANISM

The Circuit Breaker shall be power operated by a motor charged spring operated mechanism.

The operating mechanism shall have anti-pumping features under every method of closing.

The main poles of the breaker shall operate simultaneously. Also there shall not be any objectionable rebound of the moving contact in the fixed contacts.

Themechanism shall be such that any failure of auxiliary spring shall not prevent tripping. When the breaker is in closed position, failure of any auxiliary spring shall not cause damage to the Circuit Breaker or danger the operation.

A mechanical indicator shall be provided on the breaker operating mechanism to indicate open and closed position of the breaker. This shall be visible to a man standing in front of the switch gear cubical with the door closed.

It shall be possible to operate the breaker mechanically. This shall be possible only after opening the cubical door.

All working parts of the mechanism shall be of corrosion resistance material. All split pins, nuts and other parts shall be property pinned and locked to prevent loosening with repeated operation of the breakers.

Auxiliary switch containing 6 nos. + 6 nos. potential free contacts rated for 10 Amp. 240 V AC (Inductive breaking) shall also be provided.

SPRING OPERATED MECHANISM

Spring operated mechanism shall be complete with motor, opening spring, Closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit.

The breaker operation shall be independent of the motor which shall be used only for tensioning/compressing of the spring. The closing operation shall automatically charge, the tripping spring.

The closing, opening shall get charged immediately after a closing operation performed.

Motor used shall be preferable universal type operate on AC supply. The motor shall operate satisfactory at all values between 85% to110% of rated voltage.

OPERATING MECHANISM CONTROL

The operating mechanism shall normally be operated by remote electrical control, when the breaker is in service position. Electrical tripping shall be performed by shunt trip coils. Provision shall be made for local electrical control also when the breaker is in the test position by a control switch on the switch gear cubical doors. Red and green indicating lamps to indicate breaker close and open respectively shall be provided on the cubical doors alongwith breakers service and test position.

INSTRUMENT TRANSFORMER

Current and voltage transformers shall be cast resin insulated. Primary and secondary terminals shall be marked indelibly. The secondary winding shall be provided with a removable and accessible link for earthing.

CURRENT TRANSFORMER

The current transformer shall generally confirm to IS 2705-1981. They shall be mounted on the stationary part of the switch gear. The CT rating shall be as shown on the single line diagram. The protective CT shall have an accuracy of class 5P and accuracy limit factor greater than 10.0 Low resistance CTs shall be used for protection. CTs for instruments shall have an accuracy of class 120P and accuracy limit factor less than 5.

VOLTAGE TRANSFORMER

The voltage transformer shall be draw out type and provided with primary and secondary fuses. MCBs with auxiliary contacts shall be used on secondary side. It shall have accuracy of class 1 for voltage ranging 10% to 120% of normal voltage.

MEASURING INSTRUMENTS

All measuring instruments shall be of a square pattern flush mounted type. Instruments shall be provided as indicated on a single line diagram.

AUXILIARY EQUIPMENTS:

RELAYS AND CONTACTORS

Auxiliary relays and contactors shall generally be used for interlocking and multiplying contacts. The auxiliary contacts shall be capable of carrying the maximum estimated current.

TRIPPING RELAYS

The tripping relays shall be lockout type with hand reset contacts and shall be suitable to operate off the specified current. They shall be mounted in on draw out case.

PROTECTIVE RELAYS

All protective relays shall be back-connected draw-out type suitable for flush mounting and fitted with dust tight covers. All relays shall preferably be mounted on the front of the panel and shall be as specified. All measuring relays shall have built-in flags to indicate relays operation. It shall be possible to reset the flag without opening the relay case.

FUSES

All control fuses shall be of link type. Fuse shall generally be mounted on the upper half of the panel. All fuse links shall have HRC cartridge. Rewirable fuses are not acceptable.

PUSH BUTTONS

Indicating colours of Push Buttons shall be as under:

STOP, OPEN, EMERGENCY RED

START, CLOSE GREEN

Red push button shall be on the left side and green push button on the right.

CONTROL SWITHCES

All control switches shall be rotary, back-connected type, having a cam operated contact mechanism. Phosphor bronze contacts shall be used on the control switches.

Circuit breaker control switch shall have 3 positions ON, NEUTRAL and OFF. Return to Neutral from both ON and OFF position shall be spring actuated. They shall have pistol grip handles.

INDICATING LAMPS

Switch board type low power consumption indicating lamps shall be used. They shall be suitable for 6 volts. The lamps shall be supplied with current limiting resistors, translucent lamp cover to defuse light etc.

2.1.14 **SCOPE OF SUPPLY**

The scope of supply covers Metal enclosure, fully draw out type Vacuum circuit breaker, cable box, bus bars operating mechanism, space heater, current transformer, voltage transformer, measuring instruments, contractors, tripping relays, protective relays for transformer protection, fuses, push buttons, control switches, indicating lamps, local/remote switch, and power pole as per single Line diagram.

2.1.15 **Detailed Technical Specifications of 33kV HT Panel near HT Meter Room.**

One (1) 33KV indoor sheet clad, dead front switchgear distribution board with 3 phase, fully insulated copper bus bars having 630 Amp continuous current rating, fully draw out type circuit breakers having short circuit interrupting rating of 1000MVA symmetrical complete with all components & accessories arranged as shown in drawing. The specifications of Breaker shall be as bellows:

- Nos. Required - 1 nos. (ONE)

Feeder Nos.	-	1.0 (Incomer)
Current Rating	-	630 A
Short Circuit Rating	-	1000 MVA
Design	-	Indoor type, metal clad, dead front, 33kV VCB breaker.
Current Transformer	-	Three (3) nos. for metering 15 VA burden, Ratio 30-15/5-5A, Double core, Accuracy class 1.0/5P10.
Potential Transformer	-	Three (3) ratio 33000/√3 to 110/√3. cast resin single pole fixed type with accuracy 0.5 of 100 VA.
Instrument & Meters	-	Three (3) ON, OFF & Trip indication lamps. ON & Trip Push Buttons.
Accessories	-	Door interlock, Safety shutters, locking of isolator in isolated position.
Termination	-	Incoming suitable for terminating 1 x 3C x 185 sqmm (Al) XLPE 33kV cable.

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Instrument & Meters	-	Three (3) ON, OFF & Trip indication lamps. ON & Trip Push Buttons.
Relaying & Protection-		1 set of Over current, short circuit and earth fault relay with instantaneous Trip arrangement, Auxiliary relays

i. for Transformer WTI protection. Oil temperature, oil level, surge relay. MOG relay with contact, Buchholz relay alarm & trip relay.

Enunciation	-	An 8-Window annunciator shall be Provided on each transformer feeder panel to indicate the various circuit conditions and shall be placed at suitable height.The various functions shall be as follows:

ii. WTI alarm & trip
iii. OTI alarm & trip
iv. Transformer surge trip
v. Breaker trip on fault
vi. MOG Alarm and trip
vii. Buchholz relay alarm & trip
viii. Gas pressure low
ix. PRV Trip

Power Pack	-	Inbuilt Power pack for protection, indicators and operation.
Accessories	-	Door interlock, Safety shutters, locking of VCB in isolated position. Trolley lever handle, Breaker Trip, Push Button.
Termination	-	Outgoing suitable for terminating 1 x 3C x 185 Sq mm (Al) XLPE 33kV cable.

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2.1.18 DATA SHEET ON HIGH VOLTAGE VCB BREAKER

Type & Nos.	:	1 Nos.
Power Supply		
Normal Voltage	:	33kV
Rated Voltage	:	33kV
Frequency	:	50 HZ
Phase	:	3 Phase
Rated current	:	630 A
Fault level at supply point	:	1000 MVA
Rated Symmetrical Breaking Current (rms) capacity	:	13.13 KA
Short Time current Withstand (RMS) capacity	:	31.5 KA
Rated Making Current Peak capacity	:	78.75 KA
Rated Insulation level	:	70/ 170 KV
Transformer		

ENCLOSURE

Material	:	Cold rolled sheet steel
Type	:	Compartmentalised, & free floor standing
Protection Class	:	IP 54
Doors & Opening	:	Neoprene gasket
Power connections	:	From bottom
Painting	:	Powder coating with stoving.
Shade	:	As per approval Engineer-in-charge

BUS BAR

Material	:	Electrolytic copper
Size	:	Adequate to carry. A current continuously as shown in the drawings at 33kV supply, at 50 Hz and 3 Phase system.
Termination	:	Resin moulded adequately sized and braced to withstand short circuit level
Joints	:	Taped/shrouded
Earth bus bar	:	Required
Auxiliary wiring	:	Required
Control and indication:		Required
Space heater	:	Required
Base frame	:	Required

3.00 33kV/0.415 KV TRANSFORMER

3.01 **GENERAL**

Power transformer shall be Oil type for outdoor use having capacities indicated in the schedule. The supply is 33KV/415 volts, 50 Hz and 3 phases. All the transformers shall be with ON LOAD TAP CHANGER type.

The design manufacture and performance of transformer shall comply with all performance of equipment status, regulations and safety codes in the location where the transformers will be installed. Transformers shall conform to the latest applicable standards.

3.02 STANDARDS:

The equipment and accessories covered by this specification shall be designed, manufactured and tested in compliance with the latest relevant standards and CBIP manual and installation of the same shall conform to the latest Indian Electricity Rules as regards safety, earthing and other essential provisions specified therein for installation and operation of electrical plants.

Generally the transformer shall conform to IS:1180 and unless otherwise stated following standards shall be applicable.

1. IS: 1180
2. IS: 3839
3. IS: 6600
4. IS: 335
5. IS: 1271
6. IS: 2099

7. IS: 3639
8. IS: 2147
9. IS: 3202
10. IS: 2705

3.03 GENERAL DESIGN AND CONSTRUCTIONAL FEATURES:

All materials used shall be of best quality and of the class most suitable for working under the site conditions and shall withstand the variations of temperature and atmospheric conditions, overloads, over-excitation, short circuits as per applicable standards, without distortion or deterioration or the setting up of undue stresses in any part, and also without affecting the strength and suitability of the various parts for the work which they have to perform.

The design shall be such that the risk of accidental short-circuit due to birds or vermin's are obviated. All apparatus, including bushing insulators and fittings shall be so designed that accumulation of water shall be avoided cannot. Marshaling kiosks, boxes etc. shall be adequately ventilated to prevent condensation of moisture and shall be treated internally to prevent growth of fungi on any coils, wires and insulating materials used.

The transformers shall operate with minimum noise and vibration. The cores, tank and other structural parts shall be properly constructed so that the mechanical vibrations are kept to the minimum, thus reducing the noise.

The design of the transformer shall be such that changes in transformer connection can be made by a simple change of link connection inside the tank. The transformers shall be designed to suppress harmonic voltages, specially the third and fifth, so as to eliminate distortion in wave form, and the possibility of circulating currents between the neutrals at different transformer stations.
All transformers shall be suitable for outdoor installation. The type of cooling and the corresponding ratings for each transformer shall be as indicated in the main specification.

The magnetic circuit of each transformer shall be so designed as to minimize eddy-current and hysteresis losses in the core.

All electrical connections and contacts shall be of ample section for carrying the rated current without excessive heating.

3.04 TANK

The transformer tank shall be made of steel plate, shaped in such a way that minimum of welding is required. The tank shall be electrically welded and all welding stresses shall be properly relieved. Tank walls shall be reinforced by adequate stiffeners to ensure mechanical rigidity permitting hoisting of complete transformers filled with oil and also to damp transformer-noise. The tank shall be sufficiently strong to withstand shocks likely to be encountered during transport of the transformer without any deformation or weakening of joints. The joints shall be oil-tight. Guides shall be welded on the inner side of the tank to facilitate tanking and untanking of the transformer core and coil assembly.

Tank cover shall be bolted on to the flanged rim of the tank with a suitable weather-proof, hot-oil-resistant gasket in between for oil-tightness. All requisite access and inspection holes shall be provided.

The exterior of tank and other steel surface exposed to the weather shall be thoroughly cleaned and have a primary coat of zinc chromate applied. The second coat shall be with oil base preferably of weather resistant nature of distinct color from the primary and finish coats. The final coat shall be of glossy, oil and weather resisting non-fading paint of specified shade. The interior of the tank shall be cleaned by sand blasting method and painted with two coats of heat resistant and oil insoluble paint.

Steel bolts and nuts exposed to atmosphere shall be galvanized.

The transformer tank shall be mounted on a substantial under-carriage.

Unless otherwise stated the tank together with radiators, conservator, bushings and other fittings shall be designed to withstand the following conditions.

a) Full vacuum of 760mm of Hg for filling oil by vacuum.

b) Internal gas pressure of 0.35 Kg/Sq.cm. with oil at operating level.

Valves shall not leak nor any welded joints sweat under above conditions.

Adequate space shall be provided at the bottom of the tank for collection of sediments.

3.5 CORE:

The magnetic circuit shall be of Cold Rolled Grain Oriented low loss steel stampings having high permeability and conforming to adopted standards. Stampings shall be insulated from each other with material having high inter-lamination insulation resistance and rust inhibiting property and also capable of withstanding pressure, mechanical vibration and action of heat and oil, thus reducing the possibility of sludge formation to a minimum.

The framework, clamping arrangement and general structure of the cores of each transformer shall be of robust construction and capable of withstanding any shock to which they may be subjected during transport, installation and service. The assembled core shall be securely clamped, on the limbs and the yoke, to build up a rigid structure. The clamping pressure shall be uniform over the whole of the core and so adjusted as to minimize noise and vibration in the core when the transformer is in service. The framework and the core bolts shall be efficiently insulated from the core so as to reduce the circulating currents to a minimum.

The core clamping frame shall be provided with lifting eyes for the purpose of tanking and untanking the core with winding mounted thereon and shall have ample strength to take the full weight of the core and winding assembly.

An approved type of core grounding system shall be used; the grounding connections being located at the top of the core for easy access from the inspection hole.

3.6 WINDING:

The coils used for transformer winding shall be circular in shape, made of paper insulated, continuous and smooth, tinned or enameled electrolytic copper conductors of high conductivity.

The transformer winding shall be designed for basic impulse insulation level not lower than that specified in the main specification.

Liberal ducts shall be provided to prevent any hot spot temperature in the winding that may adversely affect the life of the transformer. Adequate supports, wedges and spacers of hard insulating material shall be so fitted that they will neither move nor permit relative movement of any part of winding during transit of normal service or under terminal short-circuit, nor damage the winding insulation in any way. All leads and connections shall be robust, adequately insulated, protected and clamped. The winding assembly shall be dried in vacuum with tested insulating oil of approved standard. The windings shall be subjected to a thorough shrinking and seasoning process so that no further shrinkage of windings occur during service at site. However adjustable devices shall be provided for taking up any possible shrinkage of coils in service. The assembly shall be held in position under adequate axial compression to withstand the axial thrust likely to occur under terminal short-circuit.

The end turns on the high voltage winding shall have reinforced insulation to take care of the voltage surges likely to occur during switching or any other abnormal system condition.

The transformers shall be suitable for operation at full rated power on all tapings without exceeding the specified temperature rise as indicated in the applicable standards.

3.7 INSULATING MATERIALS:

The insulating oil shall conform to IS-335 and shall be suitable in all respects for operating the transformer at the rating and under conditions specified in the main equipment specification. Sufficient oil shall be supplied for the first filling of transformer, the oil circulating equipment and the tank containing tap-changing mechanism and an extra 10% shall be supplied in non-returnable drums. The tender shall contain information

about the grades of oil recommended by the transformer manufacturer for use in the transformer. Test certificates for the oil shall be furnished before dispatch of transformer and acceptance by owner.

Class A insulating materials specified in IS: 1271 shall be used. Paper insulation shall be new and free from punctures. Wood insulation, where used shall be well seasoned and treated.

3.8 ON-LOAD TAP-CHANGER:

"ON LOAD" circuit tap changing with AVR arrangement on H.V side is to be provided. The tapping is to be provided for variation on high voltage side from + 10% to - 15% steps of 1.25% each. Automatically operated "ON LOAD Tap Changing Switch" having a position indicating lights & Locking device and complete with Automatic Voltage regulator and its Control panel shall be provided separately.

3.9 COOLING EQUIPMENT:

Natural cooling by means of banks of detachable type radiators made from pressed/round tubes around transformer tank shall be provided. The tubes shall be of seamless mild steel sheet with clean bright internal surface and shall be suitably braced to protect them from shock.

The radiators shall be provided with butterfly type of shut off valves.

Cooling tubes/radiators shall permit every part of the cooling surface to be cleaned by hand.

3.10 TERMINAL ARRANGEMENT

High Voltage Side (33KV)

i. Cable box shall be provided suitable for terminating one no. 3C x 185 sq.mm, Aluminum XLPE insulated armoured 33 KV cable complete with disconnecting chamber, compression glands, tinned copper lugs, Armour earth clamp and body earth terminal.

ii. Cable box shall be fitted with bushing insulators for H.T. cable termination side.

Disconnecting Chamber

a) The disconnecting chamber shall be air insulated and complete with seal off bushing, removable flexible connectors / links and removable covers. It shall be possible to trail out the transformer without having disconnecting the bus duct.

1. Phase to phase and phase to ground clearances with in the chamber shall be such as to enable either the transformer or cable to be subjected separately to H.V. test.

Low Voltage Side (415 V)

LT Termination shall be suitable for Aluminium bus duct of suitable rating through weather proof bus duct flanges achieving highest degree of water, moisture and vermin proof suitable for outdoor installation.

Bushing :

1. Bushings shall confirm to IS: 2099 and other relevant standards.

i. Bushings shall be supplied with terminal connector clamp suitable for connecting the bushing terminal to the owner's conductor.

ii. Creepage distance of bushing shall be (41mm/kv phase ground) adequately,

3.11 ELECTRICAL & PERFORMANCE REQUIREMENT:

a) Transformer shall operate without injurious heating at the rated KVA at any voltage within variation of +/- 10% of the rated voltage of that particular tap.

b. Transformer shall be designed for 110% continuous over fluxing withstand capability.

a. The neutral terminals of the winding with star connection shall be designed for the highest over current that can flow through the winding.

Part I Overloads shall be allowed with in the conditions defined in the loading guide of the applicable standard. Under these conditions, no limitations by terminal bushings, tap changers or other auxiliary equipment shall apply.

1. Temperature Rise for continuous full load application shall be guided by Maximum temperature rise clause of IS 2026. The temperature rise shall not exceed 45 degree C by thermometer in oil or 50 degree C for winding over an ambient of 45 degree C.
(Please note maximum ambient temperature shall be considered 50 degree C).

3.12 **EARTHING :**

Two separate earthling terminals to be provided at the bottom of the tank on opposite sides. The terminals shall be of clamp type suitable for connection to owners grounding copper strip (50 x 6mm).

Internal Earthing :

The frame work and clamping arrangements of core and oil shall be securely earthed inside the tank by adequately sized copper strip connections to the tank.

3.13 **FITTINGS AND ACCESSORIES:**

The transformer shall be provided with all standard fittings and accessories specified in the applicable standard for the size and type of transformer concerned. The accessories and fittings shall generally be as specified below:

Oil Conservator
The transformer to be provided with an oil conservator with welded end plates. It is to be bolted to the cover and can be separated for the purpose of transport. It shall be provided with plain oil level gauge with marking for minimum level and an oil filling hole with a cap which can be used for filling oil. For draining purpose a plug shall be provided. An equalizer pipe between the conservator and the main tank is to be provided, which projects inside the conservator. Separate conservator shall be provided for OLTC chamber.

Breather
The transformer shall be provided with an indicating dehydrating silica-gel breather with glass window for inspection of sufficient capacity.

Explosion Vent
An explosion vent with diaphragm shall be provided for relieving the pressure within the transformer.

Diagram and Rating Plate
Diagram and rating plate of stainless steel shall be provided indicating the details of transformer, connecting diagram, vector group, tap changing diagram etc.

Earthing Terminals
Two earth terminals of adequate mechanical and electrical capacity shall be provided. One separate earthing terminal shall also be provided on each separate radiator banks.

Buchholtz Relay
Double float Buchholtz relay where specified shall have two separate sets of contacts, one for alarm and other for circuit breaker trip. The relay shall have a test cock. A small window in the wall of the relay shall be provided to show the amount of the trapped gas, if any. The construction of the transformers shall be such that all rising gas will be readily reach the Buchholtz relay. Gas sampling device at an accessible height and an air release cock for Buchholtz relay shall be provided.

Dial type oil Thermometer (OTI)
Dial type thermometer (150mm dia) with maximum set pointer at 75 degrees C and electrical contacts for

electrical alarm and trip at high temperature with thermometer pocket shall be provided.

Winding Temperature Indicator (WTI)
Shall comprise of:

i. Temperature sensing element
ii. Image coil
iii. Bushing or turret mounted C.T.
iv. Local indicating instrument with electrically independent trip/alarm contact brought out to separate terminals.

Restricted earth fault CT.

The CT shall be of Cast resin with the ratio 1600 / 1 Amp. And its wiring from CT to the Marshall box.

Magnetic Oil Level gauge
Magnetic oil level gauge to be provided with low oil level alarm and its wiring upto the marshal box.

Lifting Lugs
The arrangement for lifting the active part out of the transformer tank along with cover by means of lifting lugs without disturbing the connections shall be provided.

Swivel Type Rollers
The transformer to be provided with 4 Nos. bi-directional rollers fitted on cross channels to facilitate the movement of transformer in both directions.

Air Release Plugs
An air release plug shall be provided on the top of the tank cover/radiators to facilitate the release of the entrapped air and filling of oil.

Drain-cum-oil Filter Valves with Plug on Cover Plate
The transformer shall be provided with the following

A drain-cum-oil filter valve with blanking plate & locking arrangement of 1 1/2"BSP size at the bottom of the tank.

Filter valve of 1 1/4" BSP at top with blanking plate.

Sample valve with blanking plate (½").

Inspection cover.

Oil filling hole with cap.

Jacking Pads

Inspection covers for the tank to be provided for inspections of the winding.

Skids

Neutral bushing terminals complete with connector for earth conductor.

3.14 DRAWINGS AND O&M MANUALS:

Four copies of manual of complete instructions for the installation, operation, maintenance and repairs circuit diagrams, foundation and trenching details shall be provided with the transformers. List of spare parts shall also be indicated.

Two copies of the drawings incorporating the following particulars shall be submitted with the offer for preliminary study.

a. GA drawing showing dimension, net weight and shipping weight, quantity of insulating oil

etc.

a. Crane requirements for assembly and dismantling of the transformer.

- Drawing indicating GA of cable box and its dimension for cable entry cut out requirements etc.

The drawings in (four sets) to be furnished by the supplier for approval after acceptance of his order shall include the following.

a. GA showing front and side elevations and plan of transformer and all accessories and external features, detailed dimensions, crane lift for untanking, oil quantity, H.T./L.T. clearances etc.

a. Drawings of Bus duct termination arrangement.

a. HV cable box arrangement & disconnecting chamber GA drawings.

b. Name plate and terminal making and connection diagram.

c. Assembly of OLTC gear mechanism & details of mechanism parts, limits, contours of wearing parts, timing gear adjustments etc.

Reproducible copy of the above drawings for records

3.15 TESTING:

The transformer shall be subjected to all routine tests in accordance with IS: 2026 at the factory before dispatching the same and test certificates shall be furnished.

1. Measurement of winding resistance.
2. Ratio polarity and phase relationships.
3. Impedance voltage.
4. Load losses
5. No-load losses and No load current
6. Insulation resistance (Before & after carrying out all tests)
7. Induced over voltage withstand test
8. Separate source voltage withstand test

Bidders shall submit the test certificate for Impulse & short circuit test type on similar transformer and shall quote for the same, incase client ask for the same.

3.16 TEST REPORTS

Four copies of the test reports in bound volume shall be submitted for approval.

3.17 SPARES

The bidder shall quote item wised prices for his recommended spares for the period of operation of transformer for 5 years.

TRANSFORMER DATA SHEET

			Transformer	- IS : 1180 (Part I) : 2014
Reference Standard		:		Level-1& IS : 2026 - 2011
			Oil	- IS : 335 : 1993
Rated KVA	H V L V	:	1600 KVA 1600 KVA	
Phases		:	3	
Service		:	Outdoor	Inverter duty transformer
Mounting		:	Plinth	
Wound		:	Double	
Temp. Rise in Oil [Degree C.]		:	40	
By Resistance [Degree C.]		:	45	
Ambient temperature		:	50	
Winding Material		:	Copper	
Type of Cooling		:	ONAN	
Class of Insulation		:	Class "A"	
Vector Group		:	Dyn11	
Frequency [Hz.]		:	50	
Phase		:	3	
Insulation Level [kV/Kvp]	H.V.	:	70/170	
	L.V.	:	3	
Primary Connection [HV]		:	Delta	
Primary Volts		:	33000V	
Primary Wires		:	3	
Primary rated current		:	27.99 A	
Secondary Connection [LV]		:	Star	
Secondary Volts		:	415V	
Secondary Wires		:	4	
Secondary rated current		:	2225.93 A	
Taps on Primary Winding		:	+ 10% to – 15% in steps of 1.25%	
Voltage Variation			On Load Tap Changer	
No. of switch positions		:	17	
Terminal Arrangement	H.V.	:	**Cable Box**	
	L.V	:	**Busduct**	
Losses				
At 50% Loading		:	4838 W (Max.)	
At 100% Loading		:	14513W (Max.)	
Impedance (Z) [Percentage]				
*	HV - LV	:	6.25%	
No Load Current (% of Rated * Current)		:	Less than 1.5 %	

i. SUBJECT TO IS : 2026 TOLERANCE

Bushing - IS : 2099 & IS: 3347

Porcelain Bushings	HV	:	3
Epoxy Bushing	LV	:	4

TESTS - Routine Tests as per IS: 1180 (Part 1): 2014

i. Ratio test

ii. Polarity

iii. Phase angle error measurement

iv. I R Values

v. Winding resistance

vi. Open circuit test

vii. Short circuit & Impedance test

viii. Separate source voltage test

ix. Induced over voltage test

x. Pressure Test

xi. Oil Leakage Test

STANDARD FITTINGS AND ACCESSORIES

S. NO.	DESCRIPTION	QTY NO.S
1	Rating & Terminal Marking Plate	One
2	Earthing Terminals	Two
3	Lifting Lugs	Four
4	Drain Valve with blanking plate	One
5	Filter Valve with blanking plate	One
6	Conservator	One
7	Conservator Oil filling hole with cap	Two
8	Oil Level indicator with min. marking	One
9	Dehydrating Breather	One
10	Conservator Drain Plug	Two
11	Air Release Device	One
12	Thermometer Pocket	One
13	Explosion vent with double diaphragm	One
14	Roller Bi directional	Four
15	Radiators (Detachable Type)	Four
16	Cable Box HV	One
17	Busduct LV	One
	Separate Neutral	
18	Terminal	One
19	On Load Tap Changer	One
20	O.T.I with Alarm & Trip Contacts	One
21	Buchholz relay with Alarm & Trip Contacts	One
22	Radiator Valves	Eight
23	Marshalling Box	One
24	Drain Valve with blanking plate (OLTC)	One

25	Filter Valve with blanking plate	(OLTC)	One
26	Current Transformer		One
27	OLTC surge relay		One
28	RTCC		One
29	AVR		One
30	W.T.I with Alarm & Trip Contacts		One
31	W.T.I. Pocket		One
32	Inspection Cover		One
33	Buchholz relay shut off valve		Two
34	M.O.G. with LOLA Contacts		One
35	Neutral CT (2500/5A, > 200V, 30mA)		One
36	Pressure relief valve		One
37	Jaking pads		Four
38	Sampling valve		Two
39	Shield Earthing between HV and LV winding		

3.18 **ELECTRICAL & PERFORMANCE REQUIREMENT:**

b) Transformer shall operate without injurious heating at the rated KVA at any voltage within variation of +/- 10% of the rated voltage of that particular tap.

c. Transformer shall be designed for 110% continuous over fluxing withstand capability.

b. The neutral terminals of the winding with star connection shall be designed for the highest over current that can flow through the winding.

Part 2 Overloads shall be allowed with in the conditions defined in the loading guide of the applicable standard. Under these conditions, no limitations by terminal bushings, tap changers or other auxiliary equipment shall apply.

2. Temperature Rise for continuous full load application shall be guided by Maximum temperature rise clause of IS 2026. The temperature rise shall not exceed 45 degree C by thermometer or 50 degree C for winding over an ambient of 45 degree C.

3.19 DRAWINGS AND O&M MANUALS:

3.19.1 Four copies of manual of complete instructions for the installation, operation, maintenance and repairs circuit diagrams, foundation and trenching details shall be provided with the transformers. List of spare parts shall also be indicated.

3.19.2 Two copies of the drawings incorporating the following particulars shall be submitted with the offer for preliminary study.

b. GA drawing showing dimension, net weight and shipping weight, quantity of insulating oil etc.

b. Crane requirements for assembly and dismantling of the transformer.

- Drawing indicating GA of cable box and its dimension for cable entry cut out requirements etc.

3.19.3 The drawings in (four sets) to be furnished by the supplier for approval after acceptance of his order shall include the following.

b. GA showing front and side elevations and plan of transformer and all accessories and external features, detailed dimensions, crane lift for

untanking, H.T./L.T. clearances etc.

b. Drawings of Bus duct termination arrangement.

d. HV cable box arrangement & disconnecting chamber GA drawings.

e. Name plate and terminal making and connection diagram.

f. Assembly of OLTC gear mechanism & details of mechanism parts, limits, contours of wearing parts, timing gear adjustments etc.

3.19.4 Reproducible copy of the above drawings for records

4.0 DG SETS

4.01 SCOPE OF WORKS

The Scope of work shall include under this specification loading, unloading, storage, installation, testing and commissioning of the Diesel engine alternator sets including labour, tools, tackles and plants, hardware and consumables.

4.02 DIESEL GENERATOR SET

The Diesel Generator Sets shall consist of AC Alternator of 500kVA 0.8 P.F. capacity coupled with diesel engine with all accessories and control such as starting device, lubricating arrangements, speed control, automatic control devices, protection gear, instruments etc. as required and specific here in after. The diesel Generator shall be factory assembled and factory tested completed in all respects.

4.03 DIESEL ENGINE

Diesel engine shall be of heavy duty, robust construction, suitable for continues duty. Engine shall be enclosed construction and engine case shall be made of grey iron castings. The cylinder head shall be cast iron and shall accommodate one suction valve, one starting valve, one injection valve and one safety valve etc. Piston shall be of cast aluminium and shall be provided with adequate number of sealing ring and strapping rings . The big and small ends shall be fitted with bearings.

4.04 ENGINE

The Diesel Engine shall be naturally aspired water cooled type, four strokes, 4 cylinder direct injection type, water cooled , electric starting , multicylinder diesel engine confirming to BS: 5514/BS:649 with 10% overloading for one hour in any 12 hrs. duration.

Lubrication shall be full pressure by gear type pump with full flow filters with replace element. An oil temperature gauge, strainer and relief valve shall be fitted.

Fuel injection shall be enclosed in line fuel injection pump with diaphragm type fuel lift pump. Full fuel filters with replacement element s shall be fitted and 24 volt solenoid provided.

The speed governing mechanism shall be hydraulic type and should keep correct frequency at all possible operating condition well within the limit.

Coolant shall be circulated by a gear driven centrifugal pump through a radiator cool by a pusher flow fan completed with fan cool and a hand protection guard. Generator set shall water cooled and having radiator and fan.

Starting type shall be push button electric starting type by an axial type starter motor from a 184 volt lead acid battery.

A length of flexible exhaust pipe shall be supplied connected to the exhaust manifold. Silencer and exhaust system shall be part of the installation costs. Silencers shall be domestic type Length of exhaust pipe upto 10 mtrs. above ground level from D.G. room shall be deemed to be included in the rates.

4.05 ENGINE DETAIL

Dry type air filters shall be fitted.

Type	Multicylinder diesel.
Method of starting	Electric start
Type of cooling	Radiator
Type of governor	Electronic Governer
Type of fuel	High speed diesel
Type of lubricating oil	Heavy duty detergent oil

The above engine shall be equipped with the following :-

a. - Radiator

b. -Fuel Tank suitable for 8 hrs. running with necessary piping and fuel gauge.

c. -Fly wheel of suitable diameter and weight.

d. -Fuel and lubricating oil filter.

e. -Fuel injection equipment.

f. -Air cleaner /filter.

g. -Lubricating oil pump.

h. -Flexible coupling.

j. -Governor Electronic for 500KVA DG Set.

K. Batteries and battery charger.

Suitable stop device to stop the engine in case of the controller variable exceed the upper limit (Temperature of cooling water lub. and pressure of lub oil.)

Indicating panel of Engine shall be consisting of the following.

i. Cooling water temperature gauge.

ii. Lub. oil pressure gauge .

iii Lub oil temperature gauge.

iv Starting switch with key.

v RPM meter with hour meter.

vii Oil service tank with all accessories such as level indicator , man hole ., valved inlet and outlet, air vent , drain plug, mounting pedestals etc.

4.06 **BASE AND MOUNTING**

The DG Set shall be mounted on a MS skid base with necessary rein forcement.

4.07 **MOUNTING**

The set will be mounted on spring loaded cushy - footing pads.

4.08 **PERFORMANCE OF DG SET**

a. **Voltage regulation** : Plus or minus 2.5% from no load to full load and at power factor from 0.8 PF (lag) to unity with 4% speed regulation of the engine.

b. **Voltage wave form**: Wave form deviation shall not be greater than 10% or within NEMA MG 1-22.43.

c. **Telephone influence :** As per NEMA requirement.

d. **Interference level :** For AM/FM Radio and Television Equipment.

4.09 **ALTERNATOR.**

4.09.1 **GENERAL**

Alternator shall be of silent pole , rotating field type and shall be self exciter suitable for 415 volts , 50 Hz, A C 0.8 P.F. and 1500 RPM. The alternator shall be of drip - proof construction. Alternator shall generally confirm to IS : 4722 and BS 2613.

4.09.2 **FRAME**

Frame shall be of cast iron construction, the feet and terminal box mounting being cast integral with the frame. A terminal box (adopter) shall be used if required for proper termination of Cables.

4.09.3 **STATOR CORE** :

Stator core shall be built upto silicon steel lamination compressed hydraulically and rigidly supported by either cast iron or steel end rings. The core shall be design ed for minimum reactance, low voltage wave from distortion and maximum efficiency , stator coils shall be of tropicalized mica or leatheriod. End windings shall be taped with fiber glass tape and the complete windings shall be impregnated with fiber glass tape and complete winding shall impregnated with varnish and spray finished with moisture protection varnish. Otherwise 100% epoxy impregnating with an overcoat of resilient insulating material shall be carried out.

4.09.4 **END FRAMES**

The end frames shall be of well ribbed cast iron design. The end frames shall spigotted to the stator frame and secured by easily available set screws. Ventilation openings shall be cast into the vertical and bottom side face which shall be screen protection and drip proof.

4.09.5 **BEARING**

The bearing shall be of heavy duty prelubricated cartridge ball or roller bearings. Single bearing alternators shall have self - align ball on roller bearing. The end frame of the rotor shall be removable from stator without disturbing the bearings.

4.09.6 **ROTOR**

The rotor shaft shall be turned either from a tensile MS bar or from a MS forging. Field coils shall be wound with synthetic enamel covered or varnish bounded end glass cover copper strips of high conductivity. Poles shall be of bolt on type made of sheet steel of high permeability. The insulation between the pole and coil shall comprises of varnished fiber glass cloth backed mica around the body and thick insulating washers on the top and bottom of the coil. Coil shall be impregnated with resin and the complete rotor shall be spray finished with a moisture protection varnish suitable for tropical conditions. However 100% epoxy impregnation and an overcoat of resilient insulating material shall be preferable.

4.09.7 **DAMPER WINDING**

The damper bars of copper brazed to heavy copper and connectors shall be located in a semi closed circular slots situated in the pole faces.

4.09.8 **TYPE**

Alternator shall be brushless.

4.09.9 **COUPLING**

Engine and alternator shall be directly coupled through a sturdy flexible coupling.

4.09.10 **TEMPERATURE RISE**

The alternator shall suitable for temperature rise of 50 degree c above ambient and shall be capable of withstanding 10% over load for one hour continuously in 12 hrs. as per IS 4722.

4.09.11 **EXCITER - VOLTAGE REGULATORS**

The excitor shall be over hung, rotating type without any bearing excitor of static type or semi conductor may be provided. Solid state voltage regulator with all accessories and relays shall be providing for proper voltage regulation.

4.09.12 **BALANCING**

All the rotating part shall be dynamically balanced to ensure smooth vibration free running. of number of on load change over switches.

4.09.13 **INSTRUMENTATION CONTROL PANEL**

The 500kVA KVA DG Sets shall have the following controller:

Auto starts/ offmicroprocessor-based controller with a facility for remote start, remote annunciation, and remote communication capability through the telephone /GSM network. It should be possible to monitor the parameters of the engine and the alternator and display the status of the faults on the DG set if any and generate a complete report on the PC individually or on a network. The following minimum monitoring & protection is required for the alternators.

Alternator Monitoring

a) Current. (I1, I2, I3)
b) Frequency
c) Voltage (L-L & L-N)
d) KVA
e) KVAR
f) Power Factor
g) Percentage alternator duty heavily i.e. actual load / KW rating.

The Generator shall be protected against the following electrical faults

* Overload and short circuit

* Ground fault
* Over current
* Over frequency
* Under frequency
* Under Voltage
* Over Voltage
* Locked Rotor
* Reverse power protection.

It should be possible to read the data i.e. Parameters and Shutdown status locally on the DG Set. All the above Parameters should be displayed on The Local Control Panel through appropriate meters and status on faults should be indicated through a facia annunciator. It should be possible to display all the functions as above on a personal computer.

4.10 SOUND ATTENUATING ACOUSTIC ENCLOSURE

Sound Attenuating Acoustic Enclosure should have pleasant and aesthetical looks and should be able to bring down the noise by 25 decibels when measured at a distance of 1 meter away from the set. The DG set should be supported on a base frame in an MS Sheet enclosure with suitable ducting for air inlet and outlet. The door and enclosure should be given corrosion resistant treatment and painted to be weatherproof and long lasting. Resin bonded Glass / Mineral / Rock wool of high density (greater than 45 Kg / Cu. M) with minimum thickness of 75 mm covered with perforated MS Sheet should be provided and covered with tissue paper. Enclosures should be provided with durable locking system with doors duly gasket with neoprene rubber. Exhaust gases should be taken out from the DG Set by means of MS Pipe and a noise suppressor. Proper care should be taken for engine heat rejection in order to have safe working temperature inside the enclosure by provision of fans etc, as required. The design aspect should ensure free and uninterrupted flow of suction and exhaust air in order that the temperature rise of the enclosure with respect to the ambient is less than 7°C.

4.11 EXHAUST SILENCER PIPING

The exhaust silencer piping system shall be of heavy duty MS pipes confirming to Class - B. Suitable length of flexible piping shall be used for connecting the exhaust piping to the engine as per the recommendations of the manufacturer. Exhaust pipe along with silencer inside the building shall be provided with mineral wool insulation with chicken mesh wrapping and 26 SWG aluminum cladding. All terminal connections and pipes joint shall be of welded construction. The terminals of sizes 2" and above shall be butt welded, and of sizes 1.5" and below shall be socket welded, complete with flanges, jointing and fasteners. This welding shall be done as per relevant ASME/ASA codes. The Contractor will have to indicate beforehand the welding procedure he proposes to use. After confirmation by the Project Manager the procedure which is finalised shall be strictly adhered to.

4.12 ACCESSORIES

i Battery charging equipment and instrument for starting of the engine and control energisation. This shall be Part of Synchronising panel.

ii Cable alley for incoming and outgoing cable with glands.

iii Removal side panel for easy for access and locking arrangement to prevent tempering.

4.13 OTHER ANCILLARY EQUIPMENT

4.13.1 DAY FUEL TANK

The engine shall be provided with day service fuel tank of 285 ltrs. Capacity. Tank shall be made of 3 mm thick MS sheet. Tank shall be mounted on a pedestal. Tank shall be painted with anti- corrosive paint. Tank shall be completed with oil level indicator, inlet pipe connected, outlet pipe connection drain pipe, air vent pipe cover etc. The cost of the Tank deemed to include in rate of the DG Set.

4.14 SPECIFICATION OF MATERIALS

4.14.1 EXHAUST SILENCER PIPING

The exhaust silencer piping system shall be of heavy duty MS pipes confirming to class B. Suitable length of flexible piping shall be used for connecting the exhaust piping to the engine as per the recommendation of the manufacturer. MS screws flanges and bends shall be used as per site requirements. Exhaust pipe inside the building shall be logged with 6 mm dia. asbestos rope and suitably bonded with asbestos cloth.

4.14.2 OIL PIPING

Oil piping shall be of MS suitable to withstand the pressure as recommended by manufacturer.

4.14.3 **FOUNDATION**

Foundation shall be casted by the civil contactor.

4.14.4 **24 VOLTS DC BATTERIES AND BATTERY CHARGING EQUIPMENTS**

SMF Batteries of required voltage and Ah for the starting of the DG Set shall be fixed inside the enclosure. The battery charger is in the scope of other agency.

. The battery bank shall be provided with the following accessories.

a. Battery stand.

b. Set of connectors with ends take off suitable for connection.

4.15 **EXHAUST SILENCER PIPING**

The exhaust silencer piping system shall be of heavy duty MS pipes confirming to class B. Suitable length of flexible piping shall be used for connecting the exhaust piping to the engine as per the recommendation of the manufacturer. MS screws flanges and bends shall be used as per site requirements. Exhaust pipe inside the building shall be logged with heat resistive glass wool of 48 kg / mtre cube and then cladded with Al. foil all along the pipe.

a. The Vendor shall be submitted the Vibration Level data and the sound level data of the DG Set alongwith the quotation of the DG Set and after the commissioning of the DG Set.

4.17INSTRUMENTATION CONTROL PANEL FOR DG SET SHALL BE OF EQUIVALENT TO THE PCC 3.3 OF CIMMINS MAKE FOR THE SYNCHRONISING, AMF AND THE PROTECTION FOR 500 KVA DG.

5.00 33kV HT CABLES

5.01 **GENERAL**

The high-tension cables shall be aluminium conductor XLPE insulated armoured construction. The conductors shall be made from electrical purity aluminium wire. The conductor shall be sector shaped stranded conductors. The cables shall conform to IS: 7098 Part -II 1985.

5.02 **Rating**

The cables shall be rated for a voltage of 33000 volts..

5.03 **CoreIdentification**

Core shall be identified by numbers 1, 2 & 3 printed on the insulation.

5.04 **Current Rating**

The current rating shall be based on the following conditions.

a)	Max. conductor temperature		:	65 C
b)	Ambient Air temperature	:	40 C	
c)	Ground temperature		:	30 C
d)	Depth of laying	:	90 C	

5.05 **Short Circuit Ratings**

Short circuit rating for the cables shall be as per IS: 692 (Latest Edition). However, the rating shall be based on the following.

a)	Max. conductor temperature under full load conditions	:	65 C
b)	Max. S. C. Conductor Temperature	:	140 C

5.06 **Selection of Cables**

The cables have been selected considering the following:

a) Max. connected load.
b) Ambient temperature.
c) Grouping of cables.
d) Short circuit level.

5.07 **LAYING CABLES IN GROUND**

Cables shall be laid by skilled experienced workmen using adequate rollers to minimize stretching of the cables. The cable drums shall be placed on jacks before unwinding the cable. With great care it shall be unrolled on over wooden rollers placed trenches at intervals is not exceeding 2 metres. Cables shall be laid at depth of 1.2 – 1.5 metres below ground level. A cushion of sand total of 250mm shall at provide both above and below the cable, joint boxes and other accessories. Cable shall not be laid in the same trench or alongside a water main. The cable shall be laid in excavated trench over 80mm layer of sand cushion. The relative position of the cables, laid inthe same trench shall preserved. At all changes in direction in horizontal and vertical planes, the cables shall be bent smooth with a radius of bend not less than 19 times be provided at both end of cable.

5.07.1 **PROTECTION OF CABLES**

The cables shall be protected by bricks laid on the top layer of the sand and both side of the cable for the full length of underground cable. Where more than on cables is laid in the same project a minimum of approximately 80mm on either side of the cables. Cable under road crossings and any other places subject to heavy traffic, shall be protected by running them through Hume Pipes of suitable size.

5.07.2 **EXCAVATION & BACK FILL**

All excavation and back fill required for the installation of the cables shall be carried out by the contractor in accordance with the drawings and requirements laid down elsewhere. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layer not exceed 150mm. Each layer shall be properly rammed and consolidated before laying the next layer.

The contractor shall restore all surface, road ways, side walks, curbs, wall or the works cut by excavation to their original condition to the satisfaction of the Engineer.5.07

5.08 **Cable Jointing**

Cable jointing shall be made as per the instructions of the cable manufacturer. Cable jointing shall be carried out only by qualified and competent cables jointers. A copy of manufacturers recommendations shall be submitted to the consultants for approval of consultant. Cable shall be jointed using standard cable joining boxes with a lead sleeve and MS/CI rectangular box.

Cable shall be jointed using standard cable joint boxes with a lead sleeve and CI protection box. The box shall be of split type with compound filling hole and plug. The lead sleeve shall be free from pores, impurities etc. The cable box shall be provided with holes and lead seals. Cable shall be jointed as per colour coding or numbering of the cores. The cable seal shall not be removed until all preparations for jointing are completed. Jointing the glands and armour clamp shall establish good electrical contact between cable armour, lead sheath and body of the switchgear. The cable box and gland shall be bonded to the main earth bus with suitable size copper tapes.

5.09 **Testing**

a) Insulation resistance of both sections of the cables to be jointed should be checked by 1000 V megger.

b) H.T. Cables shall be pressure tested to withstand a voltage after the jointing is completed. However, the test voltage and duration of test shall be in conformity with local standards. Before carrying out the DC high voltage test, the cable shall be laid in its final position with all the end terminations kept unfinished so that substation equipments are not subjected to the test pressure.

6.00 L.T. CABLES AND CONTROL CABLES

6.01 **General**

MV cables shall be supplied, inspected laid tested and commissioned in accordance with drawings, specifications, relevant Indian Standards Specifications and cable manufacturer`s instructions, The cable shall be delivered at site in original drums with manufacturers name clearly written on the drum.

The recommendation of the cable manufacturer with regard to joining and sealing shall be strictly followed.

6.02 **Material**

The MV cable shall be PVC insulated. Aluminium conductor armoured cable conforming to IS : 7098 Part I & II 1988 / 1985 laid in trenches/ducts as shown on drawings.

6.03 All cables shall be inspected upon receipt at site and checked for any damage during transit.

6.04 **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 joining cables. This apportioning shall be got approved by the architect before the cables are cut to lengths. straight joints are prohibited.

6.05 **Testing of cables**

Prior of burying of cables, following tests shall be carried out :

a) Insulation test between phases and phase and earth for each length of cable before and after jointing.

On completion of cable laying work, the following test shall be conducted in the presence of owner`s representative.

a) Insulation Resistance Test. (Sectional and overall)
b) Continuity Resistance Test.
c) Sheathing continuity Test.
d) Earth Test.

All tests shall be carried out in accordance with relevant Indian Standard Code of Practice and Indian Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above test and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Architect/Consultant.

7.0 LT PANEL, SYNCHRONISING PANEL, MAIN DISTRIBUTION BOARDS AND SUB DISTRIBUTION BOARDS:

7.01 GENERAL:

Main Distribution Board/Sub Distribution Boards shall be metal clad totally enclosed, rigid, floor mounting, air insulated, cubicle type for use on 415 volts, 3 phase, 50 cycle system. System shall be suitable for a fault withstand capacity of 50KA RMS symmetrical. Equipment shall be designed for operation in high ambient temperature and high humidity tropical atmospheric conditions.

7.02 STANDARDS:

(A) The equipment shall be designed to conform to the requirements of **:**

i) IS-8623 - Factory Built Assemblies of switchgear and control gear.
ii) IS-4237 -General requirements for switchgear and control gear for voltages not exceeding 1000 volts.
iii) IS-2147 -Degrees of protection provided by enclosures for low voltage Switchgear and Control gear.
iv) IS-375 - Marking and arrangement of busbars.

(B) Individual equipment housed in the Main & Sub Distribution Board shall conform to the following IS specifications**:**

i) Moulded Case Circuit Breakers - IS 2516 (Parts I & II/Sec 1) - 1977
ii) Fuse Switch and Switch Fuse Units - IS 4064 - 1978
iii) H.R.C. Fuselinks - IS 2208-1962 or IS 9224-1979.
iv) Current Transformers - IS 2705
v) Voltage Transformer - IS 3156
vi) Relays - IS 3231
vii) Indicating Instruments - IS 1248
viii) Integrating Instruments - IS 722
ix) Control Switches & Push Buttons - IS 6875
x) Auxiliary Contractors - IS 2959.

7.03 CONSTRUCTIONS:

Main LT Panel, Main Distribution Board/Sub Distribution and Meter Boards shall be metal enclosed, indoor, floor mounted free standing type made up of the required vertical section, which when coupled

together shall form continuous dead front Distribution Board. Main Distribution Board/Sub Distribution Board shall be dust and damp protected the degree of protection being no less than IP-45 to IS 2147. All Panels & Main Distribution Board shall be extensible on both sides by the addition of side section after removal of end covers. Main Distribution Board/Sub Distribution Board shall be fabricated with a framed structure with rolled/folded sheet steel channel section of minimum 2mm thickness, doors and covers shall be of minimum 2mm thick sheet steel. Sheet steel shroud and partitions shall be of exterior of Main Distribution Board/Sub Distribution Board shall be smoothly finished, leveled and free from flaws. The corners to be rounded. Front and rear doors to be fitted with dust excluding neoprene gasket with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be ensured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

Following minimum clearances to be maintained after taking into account connecting bolts, clamps etc. **:**

i)	Between Phases	-	32 mm
ii)	Between Phases and neutral	-	26 mm
iii)	Between Phases and earth	-	26 mm
iv)	Between neutral and earth	-	26 mm

All insulating materials used in the construction of the equipment shall be of non hygroscopic materials, duly treated to withstand the effect of high humidity, high temperatures, tropical ambient service conditions. Functional units such as fuse switch / switch fuse unit/ moulded case circuit breakers shall be arranged in multi-tier formation. The design of the Main Distribution Board/Sub Distribution Board shall be such that each fuse switch/switch fuse units/MCCB shall be fully compartmentalized.

Insulated barriers shall be provided with a vertical section and between adjacent section to ensure prevention of accidental contact with main busbars and vertical risers during operation, inspection or maintenance of functional units. All doors/covers providing access to live power equipment/circuits shall be provided with tool operated fasteners to prevent unauthorised access, The panel shall be so constructed that the cable alley shall be sufficient enough to accommodate all the outgoing and incoming cables. For each cable, there shall be separate cable gland plate of detachable type at the bottom and/or top of the panel as required. Gland plate shall be 3mm thick.

7.04 METAL TREATMENT AND FINISHING:

All metal work used in the construction of the main Distribution Board/Sub Distribution Board should have under gone a rigorous metal treatment process as follows:

i) Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.

ii) Pickling in dilute sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.

iii) A recognised phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.

iv) Passivating in de-oxalite solution to retain and augment the effects of phosphating.

v) Drying with compressed air in a dust free atmosphere.

vi) Primer coating with two coats of a highly corrosion resistant primer, applied wet on wet and stove dried under strictly controlled conditions of temperature and time.

vii) A finishing coat of stoving synthetic enamel paint of gray colour of approved colour / or powder coating.

7.05 BUSBARS :

The busbars shall be air insulated and made of high conductivity, high strength aluminium alloy complying with the requirement of grade E-91E of IS-5082.The busbars shall be suitable braced with non hygroscopic SMC supports to provide a through fault withstand capacity of 50KA RMS symmetrical for one second and a peak short circuit withstand capacity of 105KA for Main LT Panel & 50KA RMS symmetrical for one second for Main Distribution boards and other Panels

The neutral as well as the earthbar should be capable of withstanding the above level. Ridges shall be provided on the SMC supports to prevent tracking between adjacent busbars. Large clearances and creepage distances shall be provided on the busbar system to minimize the possibility of fault. The main phase busbars shall have continuous current rating throughout the length of the panel. The cross section of neutral busbars shall be same as that of the phase busbar for busbars of capacity upto 500 Amp., for higher capacities, the neutral busbar shall not be less than half (50%) the cross section of that of the phase busbars. Connections from the main busbars to functional circuits shall be so arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Busbars shall be colour coded with PVC Sleeves.

The Main Distribution Board/Sub Distribution Board shall be designed that the cables are not directly terminated on the terminals of switch fuse/fuse switch etc. but are terminated on cable termination links. Capacity of aluminium busbars shall be considered as follows :

Sr.No.	Current Rating (Ampere)	Current Carrying Capacity of Al. Bus Bars (Amp. Per sq.mm)
1	100 Amp – 500 Amp	1.0 Amp./ sq.mm
2.	600 Amp – 1600 Amp.	0.8 Amp. / sq.mm
3.	2000 Amp – 3200 Amp.	0.7 Amp. / sq.mm

7.06 DRAW OUT TYPE AIR CIRCUIT BREAKERS :

Power circuit breakers shall comply with standards IEC 60947 – 2 and IS: 13947:1993. The circuit breakers shall have a breaking capacity justified by calculations taking into account their installation location. The Number of circuit – breaker poles is indicated on the appended single – line diagram. It shall be suitable for switching duty of transformer, motors and other devices.

It shall be possible to push in and withdraw the breaker easily and without much effort. Insulating plugs and sockets for power as well as for control circuit shall be of robust design and fully self aligning. The breaker shall have three distinct positions namely services, test and isolated positions. In test position, it shall be possible to operate the circuit breaker without energizing the power circuits.

The Circuit breaker shall have the breaking capacity justified by calculation taking into account their installation location having no deration at ambient temperature 50degC. Circuit Breaker shall be designed in such a way that maintenance may be carried out as function of their use. The operating mechanism shall be of Open / Close type.

All ACBs should have Icu = Ics = Icw (1 sec) with rated Impulse Withstand Voltage 12kv

OPERATING MECHANISM :

The Circuit Breaker shall be power operated by a motor charged spring operated mechanism.The operating mechanism shall have anti-pumping features under every method of closing.

The main poles of the breaker shall operate simultaneously. Also there shall not be any objectionable rebound of the moving contact in the fixed contacts.

The mechanism shall be such that any failure of auxiliary spring shall not prevent tripping. When the breaker is in closed position, failure of any auxiliary spring shall not cause damage to the Circuit Breaker or danger the operation.

A mechanical indicator shall be provided on the breaker operating mechanism to indicate open and closed position of the breaker. This shall be visible to a man standing in front of the cubical with the door closed.

It shall be possible to operate the breaker mechanically. This shall be possible only after opening the cubical door.

All working parts of the mechanism shall be of corrosion resistance material. All split pins, bolts, nuts and other parts shall be properly pinned and locked to prevent loosening with repeated operation of the breakers.

Auxiliary switch containing 4 No. + 4NC potential free contacts rated for 240 V AC (Indicative breaking).

SPRING OPERATED MECHANISM :

Spring operated mechanism shall be complete with motor, opening spring, closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit.

The breaker operation shall be independent of the motor which shall be used only for tensioning/compressing of the spring. The closing operation shall automatically charge the tripping spring.

The closing, opening shall get charged immediately after a closing operation performed. Motor used shall be preferably universal type operated on AC supply.

CONTACTS :

The main contacts shall be designed such that no maintenance shall be required under normal condition of use. The jaw contacts shall be on the breaker portion to enable faster and easier maintenance and replacement of the contacts. Provision for replaceable of arcing contacts.

CONNECTION/ DISCONNECTION MECHANISM :

It shall be possible to disconnect the circuit breaker without having to open the door. The three possible positions (connected , disconnected and test) shall be indicated.

Before carrying out a disconnection or connection operation, the operator shall be required to press a release button located on the front of the chasis.

The door shall be equipped with a locking system preventing door opening with circuit breaker in the connected position. Safety shutters shall be placed over the main incoming and outgoing circuits. A mismatch – prevention system shall block insertion of a drawout circuit breaker with a power rating greater than that of the fixed part.

ELECTRICAL AUXILARIES :

All electrical auxiliaries should be continuous rated, shall be installable on site without requiring adjustments or any tools other than a screw driver. The auxiliaries shall be placed in a compartment which, under normal operating conditions, shall not contain any conducting parts capable of entering into electrical contact with the circuit-breaker poles. It shall be possible to connect all auxiliary wiring from the front of the circuit breaker.

MECHANICAL INDICATORS :

Mechanical indicators on the front panel of the power circuit breakers shall indicate the following status conditions **:**

1. "ON" (main contacts closed) Spring charged
2. "ON" (main contacts closed) Spring discharged
3. "OFF" (main contacts open) Spring charged – circuit breaker ready to close
4. "OFF" (main contacts open) Spring charged – circuit breaker not ready to close
5. "OFF" (main contacts open) Spring discharged

PROTECTION / CONTROL UNIT :

Sensors shall be of the Rogosky type for accurate current measurements. The release of the breaker should display current metering and last 10trip history. The control unit shall measure the true rms value of the current. The control unit shall offer the following protection (LSIG) functions as standard **:**

1. Long-time (LT) protection with an adjustable current setting from 0.2 to 1Ir and time delay ;
2. Short-time (ST) protection with an adjustable setting of 0.2 to 12Ir and time delay ;
3. Instantaneous (INST) protection with an adjustable setting from 2 to 15Ie and an OFF position.
4. Earth-fault (G) protection with an adjustable setting from 0.1 to 1In and time delay shall be provided if indicated on the appended single line diagram.
5. Current and time-delay settings shall be indicated in amperes and seconds respectively on a multi- line digital display.
7. Release should be self-powered

Measurements :

	LSIG+ Current Metering+10Trip History +Multi Line display	Communication	Current +Voltage	Energy	Power(Real, Apparent, Reactive, Total, Peak , Demand)	ZSI	24V DC Aux supply
I/c ACB	Yes	Yes	Yes	Yes	Yes	Yes	Yes
O/g ACB	Yes	-	-	-	-	-	Yes

TESTING :

Original test certificate of the ACB as per Standard IEC 60947-2/3 shall be furnished.

7.07 MOULDED CASE CIRCUIT BREAKERS :

GENERAL :

Moulded case circuit breakers shall be incorporated in the Main Distribution Board and Sub Distribution Board wherever specified. MCCBs shall be suitable either for single phase AC 230 volts or three phase 415 volts. The Circuit breaker shall comply with IEC60 947-2 and IS 13947 part 2.Icu=Ics=100%

The MCCB shall be with Electronic/Microprocessor trip unit for ratings higher than 250A and with thermal magnetic releases upto 250A .All circuit breakers shall have a rated operational voltage of 415V AC (50 / 60 Hz).

The rated insulation voltage shall be 600 V and 660 V at 50 / 60 Hz for low breaking and high breaking capacity of MCCBs Respectively.

There should be total discrimination b/w ACBs and MCCBs upto the breaking capacity level of downstream device. Total discrimination shall be supported by selection chart for various combinations along with recognized authority test certificates.

All MCCB 's shall have provision for spreaders and phase barriers on each terminal.

The Breaker shall be maintenance free

CONSTRUCTIONS :

The MCCB cover and case shall be made of high strength heat treatment and flame retardent thermo setting insulating material. Operating handle shall be quick make/ quick break, trip-free type. The operating handle shall have suitable "ON" "OFF" and "TRIPPED" indicators. Three phase MCCBS shall have common operating handle for simultaneous operation and tripping of all the three phases.

Suitable for extinguishing device shall be provided for each contact. Tripping unit shall be of thermal magnetic or static type provided in each pole and connected by a common trip bar such that tripping of any one pole operates all three poles to open simultaneously. Thermal magnetic or static tripping device shall have IDMT characteristics for sustained over loads and short circuits.

Contacts trips shall be made of suitable are resistant, sintered alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

CHARACTERISTICS:

The Protection unit shall have overload and short circuit protection . The setting knob should be centrally adjustable from front, MCCB cover need not be opened for carrying out adjustment. It shall be possible to combine the Auxilary contact, alarm contact , shunt release and under voltage release to the Circuit breaker.

OPERATION:

If required, the breaker shall be provided with the facility for padlocking and door interlocking.

The Electrical and mechanical endurance of the MCCB should be as defined by IEC 60947-2 standard.

The MCCB shall be equipped with "Push to trip" Button in front to test operation and the opening of the poles.

The circuit breaker rating, the " push to trip" button, outgoing circuit identification and the contact position indication must be clearly visible and accessible from the front, through the front panel or the door of the switchboard.

THE OPTIONAL :

It shall be possible to combine the earth fault protection if specified in the BOQ for i/c MCCB

MEASUREMENTS:

	Electronic/ Microprocessor Release	Thermal Release	Overload Protection	Short Circuit Protection	Accessories (UV, Shunt, Alarm)	Earth Fault Protection
Upto 250A MCCB	-	Yes	Yes	Yes	Yes	-
Above 250A MCCB	Yes	-	Yes	Yes	Yes	Yes

INSTALLATION :

It should be possible to terminate cable of required size for the defined current carrying capacity. The requisite size should be made available by means of extended terminals in case the direct terminals are not of adequate size. Adequate phase to phase clearance has to be ensures in case of extended terminals.

TESTING :

Original test certificate of the MCCB as per IEC 60947-2 shall be furnished.

7.08 SYNCHRONISATION SYSTEM

7.08.1 The synchronisation panel shall be complete in all respects for auto operation of D.G.Sets. the minimum requirement for D.G. set operation shall be as detailed below, however, the vendor shall indicate in details the additional features and facilities being offered by them.

7.08.2 .The parallel operation of D.G. set in Synchronisation mode shall be completely through Power Control Center Module (PCCM). The PCCM shall be mounted on DG SETs on the DG Set (the supplying and fixing of the PCCM is in the scope of Supplying and fixing of DG Set vendor). The Synchronising Panel is place in the basement of the building. The PLC for the further operation shall be mounted on the Synchronising panel of Allen Bradley / ABB / Schneider make. The wiring between the DG Sets, PCCM and Synchronising Panel is in the scope of LT Panel Vendor.

- During the parallel operation, the system take care of the load sharing i.e. active and reactive both for all the D.G. sets and issue commands for voltage / frequency raise / lower,
- Depending upon the load requirements, the system shall start / stop the D.G. sets.
- Monitoring & logging of the electrical data and events through existing P C.

7.08.6 Alarms and necessary remedial commands for D.G. and electrical system fault.

7.08.7. D.G. Local Control and Manual Synchronization

(Common for all D.G.Sets Part of the Synchronizing Panel)

7.08.8 The minimum equipment shall be as follows:

a. D.G selector switch

i. PLC / manual selector switch

ii. Double scale voltmeter

iii. Double scale frequency meter

iv. Synchronoscope for Manual sysnchronising.

v. Check synchronisation relay

vi. Synchronisation lamps

vii. Solo parallel selector switch

viii. Manual synchronisation circuit "ON"/"OFF" selector switch

ix. Push buttons & indicating lamps

x. Control P. T

7.08.09 The minimum of following shall be provided for each DG Set

- Breaker control Switch
- Trickle boost selector switch for battery charger
- Ammeter and Voltmeter selector switch
- Auto/Manual selector switch for priming pump
- Breaker control switch (only for one number bus-coupler required)
- Indicating lamps (LED type) for following:
- R_1Y_1B, phase indication
- D.G breaker "ON"/"OFF" spring charged
- Neutral contactor "ON" /"OFF"
- Engine running
- Battery charger "ON"
- Control supply healthy
- Priming pump "ON" /"OFF"
- Speed raise /low joystic
- Voltage raise / low joystic
- 12 window annunciator with alarm Accept/Test/Reset push buttons, Hooter.
- Temperature Scanners for RTD and BTD

- Becon light
- Hour meter

t Under voltage relay "

- Over Voltage relay "
- Earth fault relay "
- Reverse power relay "
- Trip circuit supervision relay "
- Master trip relay "
- Power factor meter (Analog)
- Frequency meter (Digital)
- Ammeter (Digital)
- Voltmeter (Digital)
- KW and KVA meter (Digital)
- Kwh meter (Digital)
- D.C. Ammeter (Analog)
- D.C.Voltmeter (Analog)
- Breaker Control Switch
- Battery Charger with boost and trickle charger facility
- Trickle / booster charger selector, switch
- Push buttons (lot)
- P. T
- Aux. Contactor (lot)

- Automatic Generator Sequencing

i. Automatically start & stop Gensets based on plant bus on process demand.
ii. Configurable plant bus demand start / stop levels and timers.
iii. On line engine priority sequence configurability from any synch. Unit or PC to equalize run time of all DG sets.

7.09 POWER FACTOR IMPROVEMENT SYSTEM

7.09.1 General

The power factor improvement system shall comprise of capacitors and associated switchgear and control gear as per the requirements.

7.09.2 Capacitors

Power factor correction capacitors shall be heavy duty conform in all respects to IS: 2834-1964 or BS:1650-196. The capacitors shall be suitable for 3 phase, 460 V. at 50 Hz. frequency and shall be available in three phase units of 12.5 KVAR, 25 KVAR, 50 KVAR, 100 KVAR capacitors shall be suitable for indoor use up to ambient temperature of 50 C. the permissible overloads shall be as given below:

a) Voltage overload shall be 10% for continuous operation and 15% for 6 hours in a 24 hours cycle.

b) current overload shall be 15% for continuous operation and 50% for 6 hours in a 24 hour cycle.

c) Overload of 30% continuously and 45% for 6 hours in a 24 hours cycle.

Capacitors shall be hermetically sealed in sturdy corrosion proof, sheet steel containers and impregnated with non-inflammable synthetic liquid. Every element of each capacitor unit shall be provided with its own built in silvered fuse. The capacitors shall have suitable discharge device to reduce the residual voltage from crest value of the rated voltage to 50 V, or less within one minute after capacitor is disconnected from the source of supply.

The capacitors shall withstand voltage of 2500 V. AC (Power frequency test voltage) for one minute. The insulation resistance between capacitors, terminals and containers when test voltage of 500 V. DC is applied shall not be less than 50 megohms.

709.3 Capacitor Control Panel

The capacitor control panel shall generally comprise of the following:

a) Power factor correction relay.

b) Fully Electroinc type

d) Protection fuses.

e) Capacitor duty contactor and MCCB's for for individual capacitor banks.

f) Change over switch for either manual or automatic operation.

g) Current transformers.

h) Power factor meter with protection fuses.

i) Indicator lamp for each bank with push buttons for Auto On.

7.09.4 CONTROL AND SELECTOR SWITCHES

Control selector switches shall be :

i) of the rotary type with enclosed contacts.

ii) adequately rated for the purpose intended (Minimum acceptable rating is 10A continuous at 240 V AC and 1 A (inductive break) 220 V D.C.

iii) Provided with nsme plated clearly marked to show the positions.

Control switches shall be:

i) of the spring return to normal type.

ii) provided with pistol grip type handles.

Control switches for circuit breaker control shall be provided with:

i) contact development as specified.

ii) Sequencing device.

Wherever specified in data sheets, control switches with built-in flashing type discrepancy lamps shall be provided to control circuit breakers in lieu of the normal control switch, red, green and amber indicating lamps. The discrepancy lamp shall be replaceable from the front of the module door.

Selector switches shall be:

i) of the maintained contact stayput type. Switches in ammeter circuits shall have make be for break type contact.

ii) provided with oval handles.

7.09.5 PUSH BUTTONS

Push buttons shall be:

i) of the momentary contact, push to actuate type rated to carry 10A at 240V AC and IA (inductive breaking) at 220V DC.

ii) fitted with self reset, 2 No. and 2NC contacts.

iii) provided with integral escutcheon plates marked with its function.

'Start', 'Open', 'Close' push buttons shall be green in colour.

'Stop' push buttons shall be red in colour.

All other push buttons shall be black in colour.

'Emergency stop' push buttons shall be of the lockable in the pushed position type and shall be shrouded to prevent accidental operation. Key shall not be required for the operation of the push button.

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7.10 MEASURING INSTRUMENTS FOR METERING :

GENERAL :

All the meters shall be of digital type. The accuracy of direct reading shall be 1.0 for voltmeter and 1.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The errors due to variation in temperature shall be limited to a minimum. The meter shall be suitable for continuous operation between 10 degree C to+50 degree C. All meters shall be of flush mounting type of 96mm square pattern. The meter shall be enclosed in a dust tight housing. The housing shall be of steel or phenolic mould. The design and manufacture of the meters shall ensure the prevention of fogging of instruments glass. Instruments meters shall be sealed in such a way that access to the measuring element and to the accessories with in the case shall not be possible without removal of the seal. The meters shall be provided with white dials and black scale markings.

The indications shall be of LED type red in clour and shall have zero position adjustment device which could be operated from outside.

Suitable selector switches shall be provided for all ammeters and voltmeters intended to be used on three phase supply.

The specifications here in after laid down shall also cover all the meters, instrument and protective devices required for the electrical works. The ratings, type and quantity of meters, instruments and protective devices shall be as per the schedule of quantities.

AMMETERS :

The ammeter shall be of Digital type. Ammeters shall be instrument transformer operated, and shall be suitable for 5A secondary of instrument transformer. The scales shall be calibrated to indicate primary current, unless otherwise specified. The ammeters shall be capable of carrying sustained overloads during faults conditions without damage or loss of accuracy.

VOLTMETERS :

The Voltmeter shall be of digital type. The range for 415 volts, 3 phase voltmeter shall be 0 to 500 volts. Suitable selector switch shall be provided for each voltmeter to read voltage between any two lines of the systems. The voltmeter shall be provided with protection fuse of suitable capacity.

CURRENT TRANSFORMERS :

Current transformers shall be in conformity with IS:2075 (part I, II & III) in all respects. All current transformers used for medium voltage applications shall be OF Cast resin type rated for 1 kv. Current transformers shall have rated primary current, rated burden and class of accuracy as required. However, the rated secondary current shall be 5A unless otherwise specified. The acceptable minimum class of various applications shall be as given below:

Measuring : Class 1 Protection 08

Class 5 Protection10

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 65KA on medium voltage system. Terminals of the current transformers shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each CT shall be provided with rating plate.

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT's shall be copper conductor, PVC insulated FRLS wires with

proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner. The Panel builder to be produced the original invoice of the manufacturer of the current Transformers.

MISCELLANEOUS :

Control switches shall be of the heavy duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.

Indicating lamps shall be of the filament type of low watt consumption, provided with series resistor where necessary, and with translucent lamps covers. Bulbs & lenses shall be easily replaced from the front.

Push buttons shall be of the momentary contact, push to actuate type fitted with self reset contacts & provided with integral escutcheon plates marked with its functions.

7.11 CABLE TERMINATIONS :

Cable entries and terminals shall be provided in the distribution board to suit the number, type and size of aluminium conductor power cables and copper conductor control cable specified.

Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided with the position of cable gland and terminals such that cables can be easily and safely terminated.

Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

CONTROL WIRING :

All control wiring shall be carried out with 1100V grade single core PVC cable conforming to IS:694/ IS 8130 potential standard copper conductors of minimum 1.5sq. mm for potential circuits and 2.5sq.mm for current transformer circuits. Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance. Wiring shall be identified by numbering ferrules at end. All control fuses shall be mounted in front of the panel and shall be easily accessible.

TERMINAL BLOCKS :

Terminal blocks shall be 500Volts grade of the stud type. Insulating barriers shall be provided between adjacent terminal. Terminal blocks shall have a minimum current rating of 10amps and shall be shrouded. Provisions shall be made for label inscriptions.

THE LABELS :

Labels shall be of anodized aluminium, with white engraving on black background. They shall be properly secured with fasteners.

All cables should be Numbering or Tag

7.12 TEST AT MANUFACTURES WORK :

All routine tests specified in IS: 8623--1977 shall be carried out and test certificates submitted to the Engineer.

TESTING AND COMMISSIONING :

Commissioning checks and tests shall be included all wiring checks and checking up of connections. Primary/secondary injection tests for the relays adjustment/setting shall be done before commissioning in addition to routine meggar test. Checks and tests shall include the following.

a) Operation checks and lubrication of all moving parts.

b) Interlocking function check.

c) Insulation test: When measured with 500V meggar, the insulation resistance shall not be less than 100 mega ohms.

d) **Insulation Test of Oil:** When tested as per IS: 6792-1972, the oil shall withstand a voltage of 40 KV for a minute without break down.

e) Trip tests & protection gear test.

8.00 BUS DUCTS

The Bus duct / Rising mains shall be Compact Sandwich in construction for 415 Volts, 3 Phase, 50 Hz, 4 wire AC supply for providing connection between Transformer to L.T. Switchgear shall be provided as indicated in the schematic diagram and the BOQ. The complete work of Bus ducting /shall be as per **CPWD GENERAL SPECIFICATIONS for Electrical work PART – IV 2013/ PART -1 - 2013. (SUB STATION, INTERNAL ELECTRICAL WORKS) and shall complied the following specifications.**

The Bus duct shall be Compact and Sandwich in construction for 415 Volts, 3 Phase, 50 Hz, 4 wire AC supply for providing connection between Transformer to L.T. Switchgear , DG Set to Synchronizing panel and from synchronizing panel to LT Panel. The enclosure will be of 1.6 mm Thick (16 SWG) of GI with powder coated. Bus bars shall be in Sandwich construction and of aluminum , confirming to IEC-60439/IS 8623 for short circuit withstand of one second as specified.

The busbars shall be provided with class '**B**' insulation.

The Individual sections shall be of maximum 3 mtrs length and Busbars of one section shall be connected to adjacent section by Uniblock system of joint assembly operated by single bolt. The Joint assembly shall be removable as separate sub-assembly without disturbing the connected sections.

The busduct shall conform to standard IE-60439/IS 8623 in all respects and nominal rating shall be for ambient temperature of 40 Deg C.

The adaptor chambers shall be provided at two ends for connecting Busduct to Transformer/ LT Panel, sysnchronising panel / DG Set terminals at ends by copper flexible connections. The Busduct shall be complete with necessary Bends, (Vertical or Horizontal), as required by layout.

Two Aluminium Earth strips shall be provided outside the enclosure running throughout the length and bolted/riveted to the enclosure at appropriate intervals.

Busbar: The busbar shall be of aluminium grade.

Enclosure protection: The enclosure shall provide IP-54 Protection.

Short Circuit withstand: The short circuit withstand capacity shall be as per system requirement as indicated in BOQ.

Temperature Rise: The Bus bar shall be designed foe an ambient temperature of 40 deg. C and temperature rise restricted to 55 deg. C. above ambient on conductor above ambient. The temperature rise of the enclosure shall be of 40 deg. C maximum. Temperature rise on terminals 70 deg.

Earthing strips: The Bus duct shall be provided with 2 Nos earthing strips of aluminium of appropriate size as per short circuit withstand specified and as per IEC 60439. Earthing strips shall be rivited or bolted to the enclosure at regular intervals.

The busbar trunking system shall pass seismic tests with actual physical product and being certified complying with UBC seismic Zone 4 condition by an international recognized earthquake research body, e.g. Asian Pacific Network of Centers for Earthquake Engineering Research (ANCER).

The whole busbar trunking system shall be capable of withstanding the short circuit of the electrical installation without damaging the electrical, mechanical and thermal stress under fault condition at a service voltage of 1000V (600V) 50Hz. The minimum rated insulation voltage shall be 1000V. Rated impulse withstand voltage shall be of 12 KV at 1000 V (600 V).

Plug in Boxes

Plug in Boxes will be of draw out type, contact shall be of silver plated copper and spring loaded, earth connection shall be the first to make and last to break during insertion and withdrawal. The short circuit breaking capacity of MCCB in Plug in box shall be same as of short circuit withstanding of bus bar

for one second.

Fire barrier shall be provided inside the bus duct or rising mains at every point crossing from one floor to another and one room to other room.

9.0 EXTERNAL & STRUCTURAL LIGHTNING PROTECTION SYSTEM AS PER INTERNATIONAL & NATIONAL STANDARDS- IS / IEC 62305-3/IS 3043

GENERAL

Lightning Protection System shall be in accordance with IS / IEC 62305-3 & IS 3043

ZONE OF PROTECTION

The zone of protection of a lightning conductor defines the space within which Air Terminal provides protection against a direct lightning strike with probability of protection as per LPL.

LPL (LIGHTNING PROTECTION LEVEL)

LPL is a number associated with a set of lightning current parameters relevant to the probability that the associated minimum & maximum values do not exceed the normally occurring lightning. LPL can be determined by Risk analysis as explained in IS / IEC 62305-2.

LPL levels and probability of protection:

Lightning protection Class	Lightning current peak value MINIMUM	Lightning current peak value MAXIMUM	Interception probability
LPL 1:	3 kA	200 kA	98%
LPL 2:	5 kA	150 kA	95%
LPL 3:	10 kA	100 kA	88%
LPL 4:	16 kA	100 kA	81%

Components of External LPS

1.) Air terminal (as per rolling sphere or mesh or protective angle method or any combination thereof.)
2.) Down conductor
3.) Earthing

AIR TERMINATION SYSTEM

No drilling is allowed in the terrace for fixing the air terminal, if the roof is made of concrete. Parapet wall is exception to this.

AIR TERMINAL HOLDER

Concrete Roof structure: Conductors shall be securely fixed on the terrace by means of air terminal holder which is fixed on the roof by adhesive of good quality taking care of varying weather conditions. Air conductor holder is an insulator & should be of minimum 50 mm height so that even small amount of water logging on terrace is below the level of conductor holder.

Metal Roof structure: Conductors shall be securely fixed on the terrace by means of air terminal holder which is fixed on the roof by metal conductor holder of good quality which is tested for lightning

current as per IEC standard. Vendor need to give proof. As metal roof structures are normally tapered at an angle, there is no min. height criteria for metal conductor holder.

RECOMMENDED DISTANCE BETWEEN AIR TERMINAL HOLDERS

Arrangement	Recommended distance for SOLID TAPE	Recommended distance For ROUND conductors
Horizontal conductor on horizontal surface	500 mm	1000 mm
Horizontal conductor on vertical surface	500 mm	1000 mm
Vertical conductor from Ground to 20m height	1000 mm	1000 mm
Vertical conductor above 20m height	500 mm	1000 mm

If antenna, Solar Panels and air cooler or any other electrical equipment is present above terrace level, the same have to be protected by using vertical air terminal after calculating the safety or separation distance. The vertical air terminal has to have suitable supports to hold it. Wind speed need to be taken into account. Vertical air terminal must be connected to horizontal air terminal by using suitable connectors.

t the crossings of the horizontal air terminals, suitable Cross connector has to be used for secure connection which is tested for lightning current as per IEC standard. Vendor has to provide proof.

SAFETY OR SEPARATION DISTANCE

It is must to calculate safety or separation distance in order to avoid flash over to the electrical equipment when the lightning current is passing through the vertical air terminal.

EXPANSION PIECE

In order to take care the expansion of the metal in summer and contraction of the metal in winter, expansion piece with suitable connectors have to be used at every 20m distance of horizontal air terminal.

JOINTS AND BONDS

The lightning protective system shall have few joints as far as possible & air terminal & down conductor have to be straight. Where it is not possible, it should NOT be bent at 90 degree (right angles) & should have a curved path of 45 degree bend.

TEST JOINTS

At the connection of the earth terminal, a test joint should be fitted on each down conductor at a height of 1 m from the ground, except in the case of natural down conductors combined with foundation earth electrode. The purpose of test joint is to measure the earth resistance value. The remaining portion of down conductor (i.e., after the test joint should be mounted inside a plastic pipe of minimum 3 mm thickness.)

EARTH TERMINATIONS

Earth Fixing Point or terminal to connect external down conductor should be taken out with suitable material to avoid the corrosion in case of dissimilar material.

REFERENCES

IS / IEC62305 – PROTECTION AGAINST LIGHTNING:

Part 1: General Principles
Part 2: Risk Management
Part 3: Protection of structures
Part 4: Protection of Electrical & Electronic equipment within structure
IS3043: 1987: Code of practice for Earthing.

10.00 UNINTERRUPTIBLE POWER SUPPLY (UPS)

10.01 GENERAL

This specification describes a three-phase, on-line, continuous operation, solid-state uninterruptible power supply (UPS) with the option to run in parallel with identical units. The UPS shall operate as an active power control system, working in conjunction with the building electrical system to provide power conditioning and on-line power protection for the critical loads.

The UPS shall consist of the following easy to repair modular rectifier/inverter sections and easy to install either with internal and external modular battery units.

The UPS shall be provided with separate feeds for rectifier/inverter section and the static bypass switch.

Modes of operation: The UPS shall operate as an on-line system in the following modes:

10.02.2 Normal: The inverter and the rectifier shall operate in an on-line manner to continuously regulate the power to the critical load. The rectifier shall derive power from the AC input source and supply DC power to float charge the battery.

10.02.3 Battery: Upon failure of the AC input source, the critical load shall continue being supplied by the main inverter without any switching. The inverter shall obtain its power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the AC input source.

10.02.4 Recharge: Upon restoration of the AC input source, the UPS shall simultaneously recharge the battery and regulate the power to the critical load.

10.02.5 Static Bypass: The static bypass switch shall be used for transferring the critical load to input supply without interruption. Automatic re-transfer to normal operation shall also be accomplished with no interruption in power to the critical load. The static bypass switch shall be fully rated and shall be capable of manual operation. The UPS shall be able to recharge the batteries while supplying full power to the load via the static bypass switch.

10.02.6 External Maintenance Bypass Panel (MBP): The external Maintenance Bypass Panel shall be used for paralleling of multiple UPS units to supply the load directly from the mains supply, if the UPS system has to undergo maintenance or service. An UPS input, output, common output and bypass breaker shall be housed in the same low-voltage assembly. The manual bypass breaker must be monitored by each UPS via an auxiliary contact. The Maintenance Bypass Panel must be housed in a wall mounted low-voltage assembly and painted in a black colour that complements the appearance of the UPS.

10.02.1 The UPS shall be provided with RS-232 signalling and WEB/SNMP integration. This system must provide a means for logging and alarming of all monitored points plus email notification.

10.02.2 The UPS shall have nominal voltage of 3×400/230V (adjustable for 3×380/220V, 3×415/240V), 50Hz, L1,L2,L3,N,PE.

10.02.3 The UPS shall be capable of paralleling up to max 4 numbers likewise kVA (Present Requirement – 1UPS of 20 kVA).

10.02.4 The UPS shall be compatible with all types of application. Dedicated service to one specific environment shall not be acceptable.

STANDARDS

Directives for CE marking	89/336/EDC73/237EEC
Safety	EN/IEC62040-1-1
Emissions	EN50091-2 / IEC62040-2
Performance	EN/IEC62040-3
Electro Static Discharge criteria A	EN/IEC 61000-4-2 level 3, performance
Continuous Electromagnetic Susceptibility criteria A	EN/IEC 61000-4-3 level 2, Performance
Electrical Fast Transient Compatibility criteria A	EN/IEC 61000-4-4 level 2, performance
AC Surge Susceptibility	EN/IEC 61000-4-5 Level 3 criteria A

CLASSIFICATION

Classification according to EN/IEC 62040-3: VFI-SS-112

- SUBMITTALS

10.02.1 Proposal Submittals

i) Bid system bill of materials
ii) Product catalogue sheets or equipment brochures
iii) Product guide specifications
iv) System single-line operation diagram
v) Floor layout
vi) Capacity data
vii) Piping connection drawing
viii) Installation guide
ix) Drawings for requested optional accessories

- Delivery Submittals

j) Installation manual, which includes instructions for storage, handling, examination, preparation, installation, and start-up of all systems.
k) User manual, which includes operating instructions.
l) As built equipment drawings.

10.03 QUALIFICATIONS

Manufacturer experience: The manufacturer shall have a minimum of 20 years experience in the design, manufacture, and testing of UPS and cooling systems.

ISO 9001 Certification: The manufacturer shall be ISO 9001 & 14001 certified. Certification assures that the vendor's quality control & environmental measures have been certified by an accredited registrar and meet internationally recognized standards.

10.04 ENVIRONMENTAL REQUIREMENTS

Storage ambient temperature: –50°C to 40°C
Operating ambient temperature: 0°C to 40°C.
Relative humidity: 0 to 95%, non-condensing.
Storage elevation: 0 to 15000m.
Operating altitude with no de-rating: 0 to 1000m feet above sea level.

- PRODUCT
  - STATIC UPS

GENERAL

1. The UPS shall be housed in a free standing enclosure. The cabinet shall be equipped for fork truck lifting. The UPS cabinet shall be painted with the manufacturer's standard colour, black. All service and installation access shall be from the front and top
2. The UPS should be able to line up and match and bolt together with other similar kVA and type UPS' to have the appearance of one entity.
3. The UPS shall be in a self contained cabinet and comprise 30 kVA power section respectively; Bypass Static Switch; Battery for standard run time and interface LCD display all mounted in a separate cabinet.

   The power section shall be of the Double Conversion On-Line topology with power factor corrected input.

- The UPS battery shall be sized for 20 kVA / 16 kW load at power factor 0.8.

4. The UPS shall have a short circuit withstand capability of 20kA

SYSTEM INPUT

9. Nominal Input voltage rating: 3×400/230V (adjustable for 3×380/220V or 3×415/240V)
10. Input Voltage range: 304-477V
11. Earthing principle: [TN-S] [TT] or [IT].
12. Input frequency: 40-70 Hz (auto sensing)
13. Input power factor: 0.98
14. Magnetizing inrush current: NONE, if optional input isolating transformer is installed then 500% of nominal input current for less than one cycle
15. Input current distortion with no additional filters.
16. < 5% THD at 100% load
17. Power walk-in/Soft-Start: Shall be linear from 0 to 100% of the load over a 15-second period

SYSTEM OUTPUT

6 Nominal Output voltage rating: 3×400/230V.
7 Earthing principle: [TN-S] [TT] or [IT].

Output voltage regulation for steady state and transient variations (at default parameter settings):

- ± 1% steady state for a static 100% balanced load.
- ± 1% steady state for a static 100% unbalanced load.
- ± 5% for a 0 to 100% load step.

9 Max. Voltage transient recovery time: 50 milliseconds to nominal.
10 Output frequency regulation:
- Synchronized to mains over the range of 47-53Hz or 57-63Hz in normal operation
- 50 Hz ± 0.1 Hz in battery operation.

11 Output voltage harmonic distortion:
- <2% THD maximum and 1% single harmonic for a 100% linear load
- <5% THD maximum for a 100% non-linear load

12 Overload capability:
- 150% for 1 minute in normal operation
- 125% for 10 minutes in normal operation
- 110% continuous in bypass operation
- 800% for 500 milliseconds in bypass operation

13 Phase displacement:
- 20 degrees ± 1 degree for balanced load.
- 20 degrees ± 1 degree for 50% unbalanced load.
- 20 degrees ± 3 degrees for 100% unbalanced load.

14 Output Power Factor Rating: For loads exhibiting a power factor of 0.5 leading to 0.5 lagging, no de-rating of the UPS shall be required.
15 Short circuit withstand: The UPS must withstand a bolted-fault short circuit on the output without damage to the UPS module.
16 System AC-to-AC efficiency > 95 % for loads greater than 25 % to 100% of system load.
17 Acoustical noise: dB(A) of noise, typically, measured at 1 meter from the operator surface: < 60dBA

COMPONENTS

- Rectifier

10 Each UPS power module shall include an active power factor corrected, Insulated Gated Bipolar Transistor (IGBT) rectifier.
11 DC buss voltage shall be ±192Vdc nominal.
12 The battery charging shall keep the DC bus float voltage of ±220v, ±1%
13 The DC buss voltage shall be compensated against temperature variations (Battery Temperature Compensation) to always maintain optimal battery float charging voltage for temperature excursions above or below 25°C. Temperature compensation rate shall be 320mV/°C for ambient temperatures > 20°C and 0mV/°C for ambient temperatures < 20°C.
14 DC ripple voltage shall be less than ±1% of nominal with no battery connected.
15 Input power factor shall be 0.98 lagging at 100% load with out the use of passive filters. Rectifier shall employ electronic waveform control technology to maintain the current sinusoidal.
16 Pulse Width Modulation (PWM) current control shall be used. Digital Signal Processors (DSP) shall be used for all monitoring and control tasks. Analogue control is not acceptable.
17 Reflected input current Total Harmonic Distortion (THD) shall not exceed 5% at 100% load.
18 Input voltage window: 304-477V.
19 Typical batteries recharge time per IEEE 485.

- Batteries

A) Standard battery technology shall be Valve Regulated Lead Acid (VRLA).
B) Battery Backup:
C) The battery charging circuit shall remain active when in Static Bypass and in Normal Operation.

- Inverter

7 The inverter shall consist of fast switching IGBT power module.
8 Inverter shall be PWM controlled using DSP logic. Analogue control shall not be acceptable.
9 The inverter modules shall be rated for an output power factor at 0.8.
10 Nominal output voltage shall be 3×400/230V and adjustable for 3×380/220V or 3×415/240V, 50Hz, L1,L2,L3,N,PE.

11 Efficiency of UPS module at full load: Not less than 95.4 %
12 Output Voltage Total Harmonic Distortion at full load:
7 Less than 2% for 100% resistive load.
8 Less than 5% for computer load as defined by EN50091-3/IEC 62040-3.
13 Output voltage regulation
9 Static: Less than 1% at full linear load.
10 Dynamic: 5% at 100% step load.
14 Output frequency: 50Hz free running.
15 Crest factor: Unlimited but regulates it down to 2.7.
16 Remote Emergency Power Off (EPO) shall be standard (wall switch and wiring shall be provided by the electrical contractor).

- Static Bypass Switch

a. The static switch shall consist of fully rated Silicon Controlled Rectifiers (SCRs). Part rated SCRs with a wrap around contactor are not acceptable.
b. The static bypass switch shall automatically transfer the critical load to bypass input supply without interruption after the logic senses one of the following conditions:
11 Inverter overload beyond rating.
12 Battery runtime expired and bypass available.
13 Inverter failure.
14 Fatal error in control system.
c. The static bypass switch shall automatically retransfer from bypass to the inverter, when one of the following conditions occurs:
15 After an instantaneous overload-induced transfer has occurred and the load current has returned to less than 100% of the system rating.
16 The inverter is active (on).
d. The static bypass switch shall be equipped with a manual means of transferring the load to bypass and back to inverter.
e. If more than 10 transfers from and to inverter occur in a 10 minutes period, the load shall be locked on static bypass. An alarm communicating this condition shall be annunciated.

- <u>MECHANICAL</u>

The UPS power section, Static Bypass Switch, internal manual bypass switch and the VRLA batteries shall be housed in a free standing enclosure in a matching black colour having the following specifications:

- Colour finish. Black
- Dead front construction
- Caster fitted for mobility. Levelling feet shall be supplied as standard.
- The cable entry shall be from the bottom on the back of the UPS.
- The UPS enclosure shall meet an ingress level of min. IP20.

- DISPLAY, CONTROLS AND ALARMS

- A microprocessor controlled display unit shall be located on the front of the system. The display shall consist of an alphanumeric display with backlight, an alarm LED, and a keypad consisting of pushbutton switches.
- The following metered data, shall be available on the alphanumeric display:
(a) Year, Month, Day, Hour, Minute, Second of occurring events
(b) Input AC Voltage
(c) Output AC voltage
(d) Output AC current
(e) Input Frequency
(f) Battery voltage
(g) Highest Internal Battery temperature

- The display unit shall allow the user to display an event log of all active alarms and minimum of the 60 most recent status and alarm events.
  The following minimum set of alarm conditions shall be available:
  - Static bypass switch on
  - EPO Active
  - Mechanical bypass activated
  - External bypass switch activated
  - Battery discharged
  - Return from low battery
  - Low battery
  - Load not powered from UPS
  - UPS in bypass
  - Fan fault
  - SBS fault
  - System not in sync.
  - Bypass not available, frequency/voltage out of range
  - Mains voltage/frequency out of range
  - Site wiring fault
  - Low battery voltage shut down
  - Load is above alarm threshold
  - Battery over-voltage warning
  - Battery over-temperature warning
  - Emergency power supply fault
  - Output overloaded

- The following controls or programming functions shall be accomplished by use of the display unit. Push button membrane switches shall facilitate these operations.

  PART 1Silence audible Alarm
  PART 2Set the alphanumeric display language
  PART 3Display or set the date and time
  PART 4Enable or disable the automatic restart feature
  PART 5Transfer critical load to and from static bypass
  PART 6Test battery condition on demand
  PART 7Set intervals for automatic battery tests
  PART 8Adjust set points for different alarms
  PART 9Program the parameters for remote shutdown.

- The following shall make up the UPS front panel user interface.
  - Indicating LED's
    17 Load On — When Green, this LED indicates the load is being supported by the UPS output
    18 On Battery — When Yellow, this LED indicates the UPS is running from Battery power
    19 Bypass — When Yellow, this LED indicates the load is being supported by static bypass/mechanical bypass
    20 Fault — When Red, this LED indicates there is a fault condition present in the UPS.
  - Push Button User Controls
    21 Up Arrow
    22 Down Arrow
    23 Help Key
    24 Escape Key
    25 Enter Key
- Potential Free (Dry) Contacts
  - The following potential free contacts shall be available on an optional relay interface board:
    26 Normal Operation
    27 Battery Operation
    28 Bypass Operation

29 Common Fault
30 Low Battery
31 UPS Off

- For purposes of remote communications with the UPS the following shall be available and contained within the UPS on a removable, "hot swappable" "smart slot" interface card:
  - RJ-45 Interface port for remote communications with a network via web browser or SNMP.
  - Environmental monitoring feature, capable of locally monitoring temperature and humidity as well as one additional generic set of user determined dry contacts capable of taking an input signal such as water detection, smoke detection, motion, or fire detection.

- ACCESSORIES

1. MAINTENANCE BYPASS PANEL (MBP)

i. A MBP should be offered as a standard option either for single module or multi module configurations. The maintenance bypass panel shall provide power to the critical load bus from the bypass source, during times where maintenance or service of the UPS system is required. The MBP shall provide a mechanical means of complete isolation of the UPS system from the mains supply. The MBP shall be constructed in a free-standing or wall-mounted IP20 enclosure unless otherwise stated in this specification.
ii. As a minimum, the MBP shall contain the following features and accessories:
iii. Current limiting breakers of the appropriate size – limiting the short circuit level to max. Icc = 30 kA for the system.
iv. Minimum 1 NO/NC auxiliary contact per unit in the parallel system for the purpose of relaying status information of the manual maintenance bypass switch to the UPS.
v. In the case of parallel operation sufficient CAN bus PCB's to provide adequate communications of the MBP status to the UPS system parallel control system.
vi. CE marked according to at least EN/IEC60439.

2. INCASE OF PARALLEL OPERATION

i. For purposes of paralleling UPS units in the event of increased capacity or redundancy, the UPS shall contain as a standard feature, the ability to parallel up to4 modules. In this mode of operation the output voltage, output frequency, output phase angle, and output impedance of each module shall operate in uniformity to ensure correct load sharing. This control function shall not require any additional footprint and shall be an integral function of each UPS.
ii. Multi-drop Bus Network: Communication between modules shall be connected in a multi-drop bus network comprising two parallel redundant busses so that the removal of any single cable shall not jeopardize the integrity of the parallel communication system.
iii. Load Sharing: A load sharing circuit shall be incorporated into the parallel control circuits to ensure that under no load conditions, no circulating current exists between modules. This feature also allows each UPS to share equal amounts of the total critical load bus. Load sharing communications shall be galvanically isolated for purposes of fault tolerance between UPS modules. A UPS module's influence over load sharing shall be inhibited in any mode where the UPS inverter is not supporting its output bus.

SOFTWARE AND CONNECTIVITY

- The Ethernet Web/SNMP Adaptor shall allow one or more network management systems (NMS) to monitor and manage the UPS in TCP/IP network environments. The management information base shall be provided in DOS and UNIX "tar" formats. The SNMP interface adaptor shall be connected to the UPS via the RS232 serial port on the standard communication interface board.

- Unattended Shutdown
- The UPS, in conjunction with a network interface card, shall be capable of gracefully shutting down one or more operating systems during when the UPS is on reserve mode.
- The UPS shall also be capable of using an RS232 port to communicate by means of serial communications to gracefully shut down one or more operating systems during an on battery situation.

REMOTE UPS MONITORING

- The following three methods of remote UPS monitoring shall be available:
  - Web Monitoring: Remote monitoring shall be available via a web browser such as Internet Explorer.
  - RS232 Monitoring: Remote UPS monitoring shall be possible via either RS232 or contact closure signals from the UPS.
  - Simple Network Management Protocol (SNMP): Remote UPS Monitoring shall be possible through a standard MIB II compliant platform.

SOFTWARE COMPATIBILITY

- The UPS manufacturer shall have available software to support graceful shutdown and or remote monitoring for the following systems:
  32 a. Microsoft Windows 95/98/XP
  33 b. Microsoft Windows NT 4.0 SP6/2000
  34 c. OS/2
  35 d. Netware 3.2 – 5.1
  36 e. MAC OS 9.04, 9.22, 10
  37 g. Digital Unix/True 64
  38 h. SGI 6.0-6.5
  39 j. SCO UNIX
  40 k. SVR4 2.3, 2.41
  41 m. SCO Unix Ware 7.0 - 7.11
  42 n. SUN Solaris 2.6-2.8
  43 o. SUN OS 4.13, 4.14
  44 p. IBM AIX 4.3x-4.33g, 5.1
  45 q. HP-UX 9.x-11.i

- EXECUTION

- FACTORY ASSISTED START-UP

  If a factory assisted UPS start-up is requested, factory trained service personnel shall perform the following inspections, test procedures, and on-site training:

  4 Visual Inspection:
  - Inspect equipment for signs of damage.
  - Verify installation per manufacturer's instructions.
  - Inspect cabinets for foreign objects.
  - Inspect Battery Units.
  - Inspect Power Module(s).

  5 Mechanical Inspection:
  - Check all UPS and external maintenance bypass cabinet internal power wiring connections.
  - Check all UPS and external maintenance bypass cabinet terminal screws, nuts, and/or spade lugs for tightness.

  6 Electrical Inspection:
  - Verify correct input and bypass voltage.
  - Verify correct phase rotation of all mains connections.
  - Verify correct UPS control wiring and terminations.

- Verify voltage of all battery modules.
- Verify neutral and ground conductors are properly landed.
- Inspect external maintenance bypass switch for proper terminations and phasing.

7 Site Testing:

- Ensure proper system start-up.
- Verify proper firmware control functions.
- Verify proper firmware bypass operation.
- Verify proper maintenance bypass switch operation.
- Verify system set points.
- Verify proper inverter operation and regulation circuits.
- Simulate utility power failure.
- Verify proper charger operation.
- Document, sign, and date all test results.

8 On-Site Operational Training:

During the factory assisted start-up, operational training for site personnel shall include

- key pad operation
- LED indicators
- start-up and shutdown procedures
- Maintenance Bypass Panel operation
- Battery breaker operation
- Alarm information.

10.08 MANUFACTURER FIELD SERVICE

i Worldwide service: The UPS manufacturer shall have a worldwide service organization available, consisting of factory trained field service personnel to perform start-up, preventative maintenance, and service of the UPS system and power equipment. The service organization shall offer 24 hours a day, 7 days a week, 365 days a year service support.

ii Replacement parts: Parts shall be available through the worldwide service organization 24 hours a day, 7 days a week, and 365 days a year. The worldwide service organization shall be capable of shipping parts within 4 working hours or on the next available flight, so that the parts may be delivered to the customer site within 24 hours.

10.09 MAINTENANCE CONTRACTS

- A complete offering of preventative and full service maintenance contracts for the UPS system and the battery system shall be available. All contract work shall be performed by factory trained service personnel.

10.10 TRAINING

- UPS service training workshop: A UPS service training workshop shall be available from the UPS manufacturer. The service training workshop shall include a combination of lecture and practical instruction with hands-on laboratory sessions. The service training workshop shall include instruction about safety procedures, UPS operational theory, sub-assembly identification and operation, system controls and adjustment, preventative maintenance, and troubleshooting.

PART – C INTERNAL ELECTRICAL WORKS

1.00 GENERAL

1.01 The electrical installation work shall be carried out in accordance with Indian Standard Code of practice for Electrical wiring installation IS: 732-1989 and IS:2274-1963. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Electricity supply authority and fire insurance regulation. Electrical work in general shall be carried out as per following specifications with upto date amendment.

General Specifications for Electrical Works:

MP PWD Specification (Part-4) 2012

Wherever these specifications calls for a higher standard of material and or workmanship than those required by any of the above mentions regulations and specification then the specification here under shall take precedence over the said regulations and standards.

The items / activities covered under the electrical works shall include the following:

i. Point wiring of all lights points, Ceiling fan points, exhaust fan points, cabin fan points, light plug points, general power points, metal clad plug & socket outlet points etc. including supply and fixing of light & power accessories etc. complete in all respects.

ii. Under floor raceways for power and LAN / Voice cabling with junction boxes complete in all respect.

iii. Light fixtures, ceiling fans, exhaust fans and cabin fans.

iv. Provision for telephone system consisting of conduit and cabling from telephone distribution board upto each outlet including main & sub tag blocks, telephone outlets, EPABX and phones etc. complete in all respect.

v. Provision of LAN cabling, racks, server ,conduit, outlet box, junction boxes etc., complete in all respect.

vi. Cables, Raceways, cable tray and other items required to complete with electrical installation work in all respects.

vii. Earthing of electrical installation complete in all respects.

viii. Supplying, Fixing testing and commissioning of Addressable Fire Alarm and detection system including Hooters, Manual call point, wiring / cabling Response indicators and the Main Panels and the central monitoring system.

ix. CCTV System with internal and external cameras and NVR complete in all respects.

x. Access control system complete in all respect.

xi. UPS System to provide the emergency backup complete in all respect.

xii. Scope of work shall include supply installation, testing and commissioning of complete electrical installation as described above.

Technical Specifications.
Section –I - STRUCTURED CABLING

Face Plate, UK Style, Almond Color, Square with Shutters

Details	Specification	Compliance
Type	Simplex/Duplex	
Material	Fire -retardant Plastic, ABS, Almond color, UK Style.	
Acceptability	Should be able to accept Cat6A, Cat6 and Cat5e information outlets	
Approvals	UL94V0	
No. of plates	2 Plates/Pieces Face Plate for better aesthetic look (Premium Type)	
Mounting screws	2 pcs, M3.5 x 25mm, with covers	
Compliant	RoHS	
Dimensions	(H x W x D) 86 x 86 x 14.42 mm	

CAT6 U/UTP 4 Pair CABLE, IEC 60332-3-22 (Cat A) Flame Retardant

Details	Specification	Compliance
Type	23 AWG Solid Bare Copper, Unshielded Twisted 4 Pair, Category 6, TIA / EIA 568 C.2, ISO/IEC 11801& UL 444 standard.NEMA WC-63.1 Category 6	
Conductors	Solid bare copper	
Insulation	Polyethylene/Polyolefin Nominal Diameter of 1.0 mm	
Pair Separator	Cross-member (+) fluted Spline.	
Approvals	UL & Third Party verified to ANSI/TIA Cat 6, ISO 11801 for Class E	
Frequency tested up to 250 Mhz ONLY	250 MHz; Third Party Verified channel performance upto 250 MHz to be provided.	
Packing	Box of 305 meters	
Cable Outer Diameter	5.8 mm	
Delay Skew	45 ns @ 100Mhz	
Bend Radius	4 * Cable Diameter	
Impedance	100 Ohms + / - 15 ohms,	
Mutual Capacitance	5.6 NF MAX /100 Mtr.	
Conductor Resistance	9.38 Ohms Max /100 mtr	
Velocity of Propagation Delay	65%	
Performance characteristics @ 250 MHz	Max. Attenuation : 33 dB/100m Min. NEXT : 39.3 dB Min. PS NEXT : 36.3 dB Min. Return Loss : 17.3 dB	
ROHS Compliant	ROHS/ELV Compliant	
Operating Temperature Range	-20 to +75 Deg C	

24 Port, 1U Jack Panel, loaded

24 PORT ANGLED LOADED JACK PANEL, 1U		
Parameters	Specifications	Compliance
Type	-24 Port 1U loaded Straight Patch Panel with Discrete Angled Modules -Patch panels IDC (IDC of Information Outlet) Connectivity should be at rear end & RJ-45 jack on front panel, 19" rack mountable. -Patch panels Ports should be individually replaceable & Consistent port-to-port performance.	
Availability	Patch Panel should be available with 24 Ports in 1U and 48 ports in 2U.	
Cable management	-The modules in Patch panel should have sideways orientation of Information Outlet that makes patch cord routing easier and eliminate the need for Horizontal Cable Management. -Patch Panel to be supplied with four removable Inserts/modules with 6 no. of IO slot per Module	
Compatibility	Patch Panel should be able to accept Cat6A, Cat6 and Cat5e information outlets for backward and forward compatibility	
Height	1U (1.75")	

Storage Temperature Range	-40Deg C to +70 Deg C	
Operating Temperature range	-10Deg C to +60 Deg C	
Applicable Standards &Environmental Programs	RoHS complied with ACA safety	

CAT6+ Unshielded Modular Jack, Keyconnect Style

Parameters	Specifications	Compliance
Type	Cat6+Modular Jacks shall meet and exceed channel specification of Category 6transmission requirements for connecting hardware, as specified in Commercial building telecommunications Cabling standard and ISO/IEC 11801:2002 second edition.when used as a component in a properly installed UTP channel.	
Front Connection	Lead Frame : Copper Allow with 50u inch Gold over Nickel	
Rear Connection	IDC: Copper Allow with Nickel Plating	
Connector Body	Plastic: UL940V-0	
Housing	Encapsulated Lead Frame technology	
Accessories	-Jack should support uniform hassle free termination technology and be able to ensure performance in each termination without dependency on expertise of technician.-Integrated bend-limiting strain-relief unit for cable entry with locking facility at IDC contact point-Support cable pair termination process on the jacks at 90 degree angle.	
Termination Interface	Front Mated Connection: 1000 Cycles	
	Rear Mated Connection: 20 Cycles (Gas Tight IDC Connection)	
Jack Details	Connector/hardware retention of at least 88.5 NPlug /connector retention of at least 50N Storage temperature range of -40 Deg C to +70 Deg C.	
IEEE Specification (PoE)	IEEE 802.3at type 1 and 2 (up to 30W). CoC to be provided.	
Termination Pattern	TIA / EIA 568 A and B	
Performance	4.8 Gbps support for 100 MT Channel Link	
Approvals (Proof to be provided along with Bid)	UL Listed	
	ETL verified to TIA / EIA Cat 6. Should be part of the registered 4 connector channel as per Intertek / ETL report	
UL Rating	UL 94V-0	
Other Specifications	UL 1863, IEC 60603-7, FCC part 68-F	
RoHS	Compliant	
Safety listing	ACA and Bi-national standard listed.	
Operating Temperature	-10° to 60°C	
Dielectric Strength	1,000 V RMS @ 60 Hz for 1 minute (Signals to Ground)	
Performance Characteristics to be provided with bid for 1 – 300 MHz	Technical Datasheet should have Worst Case Performance parameters for IL, NEXT, FEXT, Return Loss and Balanced TCL	
Electrical Performance @ 300Mhz	Insertion Loss: Max. 0.31 dB NEXT: Min. 44.5 dB FEXT: Min. 37.6 dB RL: Min. 18.5 dB Balanced TCL: Min 22.5 dB	
Termination Process	Termination of cable on IO through Universal Termination Tool to minimize any manual termination like punch down. All the four pairs should get crimped and cut together with the help of the tool. Pairs should be separated via T-Bar in termination process to avoid any cross talk issue at Jack.	

Cat6 Jack	Should be covered under 25 year warranted solution from OEM. All the four pairs should get crimped and cut together with the help of the tool.	

Cat6 Unshielded Patch Cords, 2 MT & 3 MT, Dark Blue

Details	Specification	Compliance
Type	Unshielded Twisted Pair, Category 6, TIA / EIA 568-C.2 &ISO/IEC 11801, IEC 60603-7, FCC Part 68 Subpart F Specifications.	
Conductor	Cat6 Patch Cord should be 4 Twisted Pair, 24 AWG Stranded Bare Copper Conductors. Contact Blade should be Phosphor bronze plated with 50u" gold over 100u" nickel undercoat.	
Length	2 MT , 3 MT	
Plug Protection	Factory fitted Strain relief boots on either side	
Performance Characteristics	Max. Current Rating should be 1.5 Amp Min. Insulation Resistance should be 100MOhm Max. Contact Resistance should be 20mOhm Dielectric Strength should be 1000 VAC (RMS) Voltage Rating should be 30 VAC Maximum.	
Color	Dark Blue	
Operating Environment Range	The patch cord should have Insertion Life of 750 mating cycles Pull force of min. 89 Newton, Humidity 10% to 90% R.H., Temperature range of -10 Deg C to +60 Deg C	
Boot	Injection Molding Technology for better strength	

SECTION - III- LOCAL AREA NETWORK (LAN)
24 port Core Switch

Sl. No	Specification/Requirement	Compliance
1	Minimum 24 ports of 1G/10G SFP ports and 4 x 40G ports	
2	1 U Rack mountable and should provide stacking of minimum 10 switches with 160Gbps of dedicated stacking/ equivalent bandwidth	
3	464 Gbps or higher Backplane capacity and minimum 600 Mpps of forwarding rate	
4	Should support Non-blocking and distributed forwarding hardware architecture	
5	All interfaces should provide wire speed forwarding for both Fiber and copper modules	
6	Support for at least 4k VLANs & 64k MAC address	
7	It should support IGMP snooping v1,v2 & v3	
8	It should support advanced static IP routing, RIP, RIPnG, OSPF, OSPFv3, PIM and vrf lite	
9	Switch should support 8 hardware queues per port	
10	Dynamic Host Configuration Protocol (DHCP) snooping	
11	Switch should support LLDP and LLDP-MED capabilities	
12	Should support IP source guard & DAI	
13	Should support Secure Shell (SSH) Protocol and Simple Network Management Protocol Version 3 (SNMPv3).	
14	Switch needs to have console port for administration & management	

15	Management using CLI, GUI using Web interface should be supported	
16	FTP/TFTP for upgrading the operating System	
17	IEEE 802.1x support	
18	IEEE 802.1D Spanning-Tree Protocol	
	IEEE 802.1p class-of-service (CoS) prioritization	
	IEEE 802.1Q VLAN	
	IEEE 802.3 10BASE-T specification	
	IEEE 802.3u 100BASE-TX specification	
19	Switch should have internal redundant power supply.	
20	Switch should able to support management via CLI, Web interface	
21	SNMP v1, v2, v3	
22	Switch should be manageable through both IPv4 & IPv6.	
23	Switch should be FCC Part 15, ICES-003, VCCI Class A, EN 55022, EN 55024, EN 300386, CAN/CSA 22.2 No.60950-1, Reduction of Hazardous Substances (ROHS) 6 certified	
24	Should have modular OS and should support configuration roll back to recover mis-configured switch to last known good configuration	
25	The Switch should be EAL3/ NDPP certified.	

24 port POE Access Switch

S. No	Detailed Technical Specifications- 24 Port POE Switch	Compliance
	General Specification:	
1	a) switch should support the functionality to work as part of a single cluster consisting of multiple switches interconnected over uplink ports/dedicated ports and managed as a single logical device utilizing a single OS image and a single configuration file, reducing the overall number of units to monitor and manage.The functionality can be enabled by adding required software/hardware/license in future.	
2	b) 19" rack mountable	
3	c) All offered switches and transceivers should be from the same OEM.	
4	**I/O ports and slots:**	
5	a) 24 RJ-45 autosensing 10/100/1000 ports with POE	
6	b) 4 nos. SFP/SFP+ ports , all 4 ports should be capable of supporting 1G speed using SFP transciever and 10G speed using SFP+ transciever.	
7	c) Switch should have min of POE/POE+ power budget of 370W.	
8	d) Switch should support 2 QSFP+ ports.	
9	e) Switch should have internal redundant power supply.	

10	**Performance:**	
11	a) Switching Capacity: 260 Gbps or more	
12	b) Packet Forwarding Capacity: 200 Mpps of more	
13	c) Memory: 2GB DRAM, 2GB Flash	
14	d) Should have stacking capacity of 160 Gbps with at least 8 switches in the single logical device	
15	**Layer 2 Switching:**	
16	a) Port VLAN, MAC VLAN	
17	b) IEEE 802.1AB: Link Layer Discovery Protocol (LLDP)	
18	c) IEEE 802.3ad Link Aggregation	
19	d) MAC Address: 30000 or more	
20	e) VLANs: 4000 or more	
21	f) Spanning Tree Protocol (STP)	
22	g) Multiple Spanning Tree Protocol	
23	h) Rapid Spanning Tree Protocol	
24	**Layer 3 Routing:**	
25	a) Address Resolution Protocol (ARP)-6500 entries	
26	b) IPv4 unicast routes:12,000 , IPv4 multicast routes:2000	
27	c) IPv6 unicast routes: 3000 , IPv6 multicast routes: 2000	
28	d) Static,RIPv1/v2, RIPng from day 1	
29	e) should support OSPFv2/v3, Bidirectional Forwarding Detection (BFD), VRRP,Internet Group Management Protocol (IGMP): v1, v2, v3	
30	f) IPv6 ACL	
31	**Security:**	
32	a) Port ACL, VLAN ACL, Router ACL	
33	c) L2-L4 ACL	
34	d) MAC limiting	
35	e) Dynamic ARP inspection (DAI)	
36	f) Proxy ARP	
37	g) Control plane denial-of-service (DoS) protection	
38	**Management:**	
39	a) Command-line interface (CLI)	
40	b) The switch should have support for configuration verification and roll-back.	
41	c) Zero Touch Provisioning using DHCP	

42	d) Network Time Protocol (NTP)	
43	e) Out-of-band management: 10/100/1000BASE-T Ethernet (Separate Data and	
44	Control plane)	
45	f) RADIUS/TACACS+	
46	g) AAA	
47	Switch should be FCC Part 15, EN 55022, EN 55024, EN 300386, IEC60950-1, Reduction of Hazardous Substances (ROHS) certified	
48	**NMS**	
49	The switch shall support command line and NMS based configuration management.	
50	a) The Network Management System (NMS) shall provide full featured management and control of all the offered network elements (for the switches).	
51	b) The NMS shall include the functionality of system configuration, network monitoring, alarm management, data acquisition for analog monitoring, performance monitoring, reporting, housekeeping etc.	
52	c) The offered NMS system shall support management of up to at least 200 switches, as the network grows and expands in the future.	
53	d) Proposed NMS should be from the same OEM	

SECTION - FIRE DETECTION AND ALARM SYSTEM - ANALOG ADDRESSABLE

I. INTELLIGENT ADDRESSABLE FIRE DETECTION & ALARM SYSTEM

1. DESCRIPTION OF WORK

a. This specification outlines the requirements for an Intelligent, addressable fire detection and alarm system.

b. The work described in this specification consists of all labor, materials, equipment and services necessary and required to complete and test the automatic fire detection and alarm system. Any material not specifically mentioned in this specification or not shown on drawings but required for proper performance and operation shall be furnished and installed for a complete and operational system, by the contractor at no extra cost.

c. The contractor shall furnish, and install complete and ready for intended use and operation, an automatic fire detection and alarm system including control panel (s), initiating devices (manual pull stations, intelligent smoke and heat detectors, etc.) indicating devices (hooters, bells, visual warning signals, etc.) and supervisory devices, annunciators, wiring apparatus and accessories.

d. The installation and locations of equipment and devices in the building shall be governed by the specifications and drawings with due regard to actual site conditions, manufacturers' recommendations, ambient factors affecting the equipment and other operations in the vicinity. If any departure from the specifications or drawings is necessary, approval shall be obtained from the Project Manager before work is started thereon.

e. Materials and equipment shall be new, first grade, standard; current models of the manufacturer and shall be suitable for this system. Where two or more pieces of equipment performing the same function are required, they shall be exact duplicates produced by the same manufacturer.

f. All materials, devices, and equipment shall be compatible with the circuits or systems in which they are utilized.

g. The system shall have provisions for interfacing the same with BMS in future.

2. APPLICABLE CODES, STANDARDS AND APPLICABLE PUBLICATIONS

IS : 2175: Heat Sensitive Detectors.

IS : 2189: Automatic Fire Detection and Alarm System.

IS : 11360 : Smoke Detectors.

NFPA 71 & 72 : Commissioning Tests for Fire Alarm Systems.

BS : 5839 : Commissioning Tests for Fire Alarm Systems.

BS : 5445, UL/FM/ NFPA : Fire Detection and Alarm System.

3. SUBMITTALS

3.1 Drawings and Data

a) Shop drawings showing location of all the detectors, control modules, Fire Alarm panel, Repeater Panel etc.

b) Conduit & wiring layout.

c) Block diagram indicating connection of detectors, numbering, loop connections etc.

d) Specific catalogue cuts of all the items to be installed.

e) Control panel interior wiring diagram identifying all symbols.

f) Point-to-point wiring diagrams showing the points of connection and terminals used for all electrical field connections in each system, all equipment or systems which are supervised and controlled by the fire alarm system. Diagrams shall show all connections from field devices to the control panel initiating modules, output modules, switches, relays and terminals. Diagrams shall show interconnection of all devices, modules, output modules, switches, relays and terminals.

g) Custom Build software details for project with loop/device annunciation description and automatic control functions for each specific loop/device.

3.2 Tests & Test Reports

a) Tests certificates will be furnished for approval of all Fire alarm devices and system devices.

b) All routine tests as per relevant codes for the Fire Alarm Panel, shall be conducted and results furnished to the Project Manager.

4. SPECIFICATIONS

4.1 FIRE ALARM SYSTEM DEVICES

4.1.1 General

i. Each device shall be assigned a unique address via easily understood switch. Address selection via binary switches or by jumpers is not acceptable. Devices which take their address from their position in the circuit are unacceptable because if devices are later added, existing addresses, descriptors and commands need to be reprogrammed.

ii. Devices shall receive power and communication from the same pair of conductors. For fault isolating modules a separate power wiring which shall be fault tolerant shall be provided.

iii. Each device shall contain screw terminals with rising plates for positive termination of wiring specified in schedule of quantities.

4.1.2 **Addressable Manual Stations**

i. Manual stations shall be of rugged die cast /lexan construction designed for semi-flush mounting. Stations shall be of the pull design. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

ii. Provisions shall be made such that the address cannot be changed merely from opening the station.

4.1.3 **Addressable Analog Heat Detectors**

The Heat Detector shall be Analog, Addressable Detector with its own manually set digital code and be able to give a single digitized output to the Fire Alarm Panel regarding its condition. The Detector shall employ the thermistor principle for heat sensing and the fixed temperature setting shall be at 57 degrees Centigrade or Heat detectors shall provide a 15 °F (9 °C) per minute rate-of-rise heat sensor for the detection of heat due to fire.. It shall be able to communicate with the Fire Alarm Panel by the Pulses emitted from the Panel.

The Base of the Detector shall be interchangeable with other Smoke Detectors and the construction shall be of flame retardant material. LEDs shall be provided to indicate locally alarm condition.

It shall be able to withstand temperature variations from 0° C to 38° C. Further, relative Humidity (non Condensing type) upto 93% shall not hamper its performance. The Voltage rating shall be from 15.5 V DC to 19.95 V DC, though the voltage may be changed depending upon the working voltages of a proprietary Fire Alarm Panel.

The Detector shall meet the requirements of either NFPA72 and shall be listed with UL. It shall be possible to test the Detector's working both from the Panel as well as locally by means as designed by the Contractor and approved by the Project Manager. The approved coverage per Detector for unhampered areas shall not be less than 30 sq. M. The detector shall be capable of being reset automatically after any alarm condition.

4.1.4 **Addressable Analog Photo Electric Smoke Detectors**

i. The Addressable Analog Photo Electric Smoke Detector shall have an optical sensing chamber that operates on the light scattering principle and responds to those particles in smoke. When smoke enters the sensing chamber it scatters light which is received by a photo cell. The signal is amplified and digitized for reception by the panel. Detector shall be completely solid state with LED indication at the detector.

ii. The Detector shall be able to sense incipient fire by detecting the presence of visible and invisible products of combustion.

iii. The coverage per Optical Smoke Detector shall be upto a minimum of 50 M. Sq. This coverage area will reduce depending upon structural configurations or partitions etc. It shall be possible to connect Smoke Detector with Heat Detector or Manual Push Buttons in the same circuit. The sensitivity of Detector shall be adjusted and set by the contractor to suit the site requirement.

iv. It shall have in built safety device to monitor the removal and pilferage of the Detector. The Detector also must have facility for remote indication. The quiescent current flow must not exceed 50 milli amps. and alarm condition current shall be maximum 60 milli amps.

v. The Photo Electric type Smoke Detector shall be intelligent Analog; Addressable Detector with its own manually set digital code and be able to give Analog output to the Fire Alarm Panel regarding any changed condition. It shall be able to communicate with the Fire Alarm Panel by the pulses emitted from the Panel.

vi. The Base of the Detector shall be interchangeable with other Smoke or Heat Detectors. LED shall be provided to indicate locally alarm condition.

vii. It shall be able to withstand temperature variations from 0° C to 49° C. Further, Relative Humidity (non Condensing type) upto 93% shall not hamper its performance. The voltage rating shall be from 17 V DC to 28 V DC, though the voltage may be changed depending upon the working voltages of a proprietary Fire Alarm Panel.

viii. The Detector shall meet the requirements of either NFPA 72 or shall be listed with UL/FM/ULC. It shall be possible to test the Detector's working both from the Panel as well as locally by means as designed by the contractor and approved by the Project Manager.

ix. It shall be possible to mount the Detectors in Duct Casting units for sampling of Supply Air from the AHU.

Photoelectric smoke sensor shall be provided as indicated on the place. Each shall contain an optical sensing chamber with nominal sensitivities of 2.3% foot obscuration.

xi. The sensor/daughterboard module shall be field-replaceable.

4.1.5 **Strobe cum Alarm Hooters (Addressable)**

Strobe cum Alarm hooters shall be suitable for indoor, or outdoor, application with the appropriate 4 x 4 in. electrical box. All hooters shall be 24 V DC operated. The minimum sound level shall be 90 db at 10 feet. Hooters shall be surface semi-flush mounted.

4.1.6 **Input Devices**

i. The Input Device shall provide an addressable input for N.O. or N.C. contact devices such as manual stations, water flow switches, sprinkler supervisory devices, etc.

ii. The input device shall provide a supervised initiating circuit. An open-circuit fault shall be annunciated at the Fire Alarm panel (Subsequent alarm shall be reported.)

iii. The device shall contain an LED which blinks upon being scanned by the Fire Alarm panel. Upon determination of an alarm condition of an alarm condition, the LED shall be latched on.

4.1.7 **Control Switches**

i. The Output Device shall provide an addressable output for a separately powered alarm indicating circuit or for a control relay.

ii. The Output Device shall provide a supervised indicating circuit where indicated on the plans. An open circuit fault shall be annunciated at the Fire Alarm panel.

iii. The Output Device shall provide a control relay where indicated on the plans. The relay contacts shall be SPDT rated at two amps 24 V DC.

iv. The device module shall contain an LED which blinks upon being scanned by the Fire Alarm panel. Upon activation of the device, the LED shall be latched on.

4.1.8 **Fault Isolator Device**

i. The Fault Isolator Device shall detect and isolate a short-circuited segment of a fault-tolerant loop.

ii. The device shall automatically determine a return to normal condition of the loop and restore the isolated segment.

iii. The fault isolator device shall be placed every [20] devices to limit the number lost in the event of a short-circuit.

Audio:

The system shall be capable of delivering multi-channel audio messages simultaneously over copper and/or fiber media.

All audio messages and live pages shall originate at the one-way audio control unit.

The one-way digital voice evacuation control unit shall store pre-recorded audio messages digitally. These messages shall be automatically directed to various areas in a facility under program control.

The system shall support remote cabinets with zoned amplifiers to receive, amplify and send messages through speakers over supervised circuits.

The one-way emergency audio control shall provide control switches to direct paging messages as follows:

"All Call" to direct the page messages to all areas in the facility, overriding all other messages and tones.

"Page to Evacuation Area" to direct the message to the evacuation area(s), overriding all other messages and tones.
"Page to Alert Area" to direct page messages to the area(s) receiving the alert message and tones, overriding all other messages and tones.
"Page to Balance Building" to direct page messages to the areas) in the facility NOT receiving either the evacuation area or alert area messages.
"Page by Phone" switch to select the firefighter's telephone system as the source for paging.

The system shall be capable of delivering multiple audio messages simultaneously over copper and / or fiber media.

All audio messages and live pages shall originate at the one-way digital voice evacuation audio control unit. The one-way digital voice evacuation audio control unit shall store pre-recorded audio messages digitally. These messages shall automatically direct to various areas in a facility under program control.

The system shall support remote panels with zoned amplifiers to receive, amplify and distribute messages through speakers over supervised circuits.

The two-way voice communications control unit shall provide two-way communications between remotely located phones and the command center.

The control unit shall provide the ability to individually select and display each two-way voice communication circuit support up to five (5) remote telephones in simultaneous two-way voice communications.

4.1.10 **Intelligent Audio Amplifier**
Amplifiers shall have two input channels supporting dual channel or single channel audio applications. Amplifiers shall be ideally suited for distributed audio applications and small centrally banked applications. The audio output shall be configurable as 25Vrms or 70Vrms in Class B or Class A wiring configurations. Speakers shall be able to be connected directly to the output of the amplifier or the amplifier output shall run as an audio riser to Signal modules where speaker zone selection is made. Each amplifier shall have a built-in 1kHz tone generator and provision for a back up amplifier. On-board status LEDs shall be provided for quick visual indication of amplifier status. The Amplifiers shall be placed in a Cabinet with the capability to incorporate two amplifiers. The Cabinet shall also incorporate a supervised power supply (to power the amplifiers) of the same make as amplifiers and Fire Alarm and evacuation Panel.

4.1.11 **2 W Ceiling/ Wall Speakers**
The ceiling speakers shall be small, compact, and attractive audible emergency signaling devices. Protruding no more than one inch from the ceiling, Speakers shall blend with any decor. The Speakers shall feature textured housings in architecturally neutral white or eye-catching fire alarm red. Speakers shall feature ¼ W. 1/2W, 1W and 2 W operations, which is selectable with a conveniently-located switch. The wattage tap setting shall remain clearly visible even after final installation, yet it shall be locked in place to prevent movement after installation.

Speakers shall include a DC blocking capacitor to allow electrical supervision of the audio distribution circuit. Models for 25 VRMS and 70 VRMS audio circuits shall be available. The speaker with shall have a sealed back construction that shall make it extra durable, and impervious to moisture and thus provide improved audibility. The Speakers shall be UL/ULC Listed.

4.2 **FIRE ALARM PANEL (FAP)**
4.2.1 Fire Alarm panel shall be provided with Liquid Crystal Display (LCD) Module, function key pad, and printer as specified below.

4.2.2 **Functions**

The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 80 character liquid crystal display, individual, color coded system status LEDs, and an alphanumeric keypad for the field programming and control of the fire alarm system.

All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.

The main FACP shall perform the following functions:

a. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.

b. Supervise all initiating signaling and notification circuits throughout the facility by way of connection to monitor and control modules.

c. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed.

d. Visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.

When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

a. The system alarm LED shall flash.

b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.

c. The 960-character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

e. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

4.2.3 The Fire alarm control panel shall provide the following features:

- Block Acknowledge for Trouble Conditions
- Rate Charger Control
- Control-By-Time (Delay, Pulse, time of day, etc.)
- Automatic Day/Night Sensitivity Adjust (high/low)
- Device Blink Control (turn of detector LED strobe)
- Environmental Drift Compensation (selectable ON/OFF)
- Smoke Detector Pre-alarm Indication at Control Panel
- Smoke Detector Sensitivity Test
- System Status Reports
- Alarm Verification, by device, with tally
- Multiple Printer Interface
- Multiple CRT Display Interface
- Non-Fire Alarm Module Reporting
- Automatic Detector Test
- Programmable Trouble Reminder
- Upload/Download System Database to PC Computer
- One-Man Walk Test
- Smoke Detector Maintenance Alert
- Security Monitor Points
- Alpha-numeric Pager Interface
- On-line or Off-line programming

4.2.4 **Central Processing Unit / Signal Loop**

The Central Processing Unit shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the Central Processing Unit.

The Central Processing Unit shall contain and execute all control-by-event (including ANDing, ORing, NOTing, CROSSZONEing) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure.

The Central Processing Unit shall also provide a real-time clock for time annotation of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.

The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.

The CPU and associated equipment are to be protected so that they will not be affected by voltage surges or line transients consistent with UL864 standards.

Each peripheral device connected to the CPU shall be continuously scanned for proper operation. Data transmissions between the CPU and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques.

The Signaling Line Circuit (SLC) Interface Board shall monitor and control a minimum of 198 intelligent addressable devices. This includes 99 intelligent detectors (Ionization, Photoelectric, or Thermal) and 99 monitor or control modules.

The SLC interface board shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.

The SLC interface board shall not require any jumper cuts or address switch settings to initialize operations.

The SLC interface board shall provide power and communicate with all intelligent addressable detectors and modules on a single pair of wires. This SLC Loop shall be capable of operating as a NFPA Style 7 (Class A) circuit.

The SLC interface board shall be able to drive an NFPA Style 4 twisted shielded circuit up to 3500 meter in length. The SLC Interface shall also be capable of driving an NFPA Style 4, no twist, no shield circuit up to 800 meter in length. In addition, SLC wiring shall meet the listing requirements for it to exit the building or structure. "T"-tapping shall be allowed in either case.

The SLC interface board shall receive analog information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

The control panels shall be housed in a cabinet suitable for surface or semi-flush mounting. Cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.

4.2.5 **POWER SUPPLY**

a. The control panel shall derive 230 Volts power from main supply. A standby power supply shall be immediately available in the event of failure of normal supply and shall automatically be connected so as to maintain the equipment in condition such that fire alarm originating from the operation of Detector can be given. The standby battery as secondary supply shall be such that when charged by associated battery charging equipment it can operate independently for a period of 12 hours. It shall have enough

power supply to cope with additional load resulting in alarm originated from two separate zones for the one hour. Batteries shall be of Lead Acid type and sealed Maintenance free.

b. Suitable arrangements shall be incorporated to prevent secondary batteries from discharging through the charging equipment in the event of its breakdown or a failure in the supply.

c. Necessary automatic changeover from normal to standby DC supply in case of main supply failure shall be provided by the Contractor.

d. In addition to the batteries, a battery charger suitable for operation on the auxiliary power available in the plant as specified above shall be supplied. The capacity of the charger shall be such that the same can boost charge the battery (within 8 hrs) while supplying the rated load of the fire detection and annunciation system. Facilities shall be provided to limit the voltage supplied to fire detection and alarm system to their rated values during he time of boost charging. The charger shall normally supply the battery trickle charging current and the DC load of the fire detection and alarm system. In case the AC supply on the input side of the charger fails the necessary power for the complete fire detection and alarm system shall be supplied by the battery.

e. Visible and audible annunciation for troubles or failure in the power supply system like "charger Failure", "Battery Low Voltage", etc. shall be provided.

f. Battery earth/fault indication/annunciation shall be included in the panel.

4.3.1 **Networking**
An additional output drive card must be provided to facilitate networking between two or more panels.

4.3.2 **Wiring**
Writing shall be carried out with 2 core, 1.5 sq. mm. stranded copper conductor which shall be PVC insulated with Aluminum foil, screen 50% ABC braided and PVC sheathed.

4.4 DEFINITIONS

a. **Alarm Indicating Circuits**
Circuits to which alarm indicating devices are connected. Alarm indicating devices are audible or visual devices for warning building occupants. They include but are not limited to alarm bells, hooters and visual warning signal lights.

b. **Alarm Initiating Circuits**
Circuits to which automatic or manual alarm initiating devices are connected. Alarm initiating devices include manual pull stations, automatic fire (smoke and heat) detectors and other emergency reporting devices.

c. **Alarm Signal**
A signal which signifies a state of emergency requiring immediate notification of the fire services.

d. **Photo Electric Type Smoke Detector (Optical)**
A detector which detects smoke, works on light scattering principle and is Analog Addressable type with switches/codes etc. to define the Detector.

e. **Heat Detector**
A detector which detects heat and is Analog Addressable type with switches/codes etc. to define the Detector.

f. **Manual Call Point**
A device which shall be addressable type with switches/codes etc. to define the station. Function shall be similar to that of a conventional Manual Call Box.

g. **Strobe cum Hooter**
A device which shall be addressable and shall be able to give audible alarm through it and also give indication and controlled from the Fire Alarm Panel.

h. **Fault Isolator**

This equipment shall be placed in the electrical wiring and shall be able to isolate electrical short circuiting and loose wiring. The isolator shall be able to keep the part of the electrical circuit in operation that is connected directly to the Fire Alarm Panel.

i. **Fire Alarm Panel**
This refers to the micro processor based Panel that shall be connected to the various Detector loops. There shall be multiple looping/zoning as indicated on the drawing. The panel shall be able to watch individual Detectors for performance as well as to give pin point location of fire alarm. Hooter Alarm as well as facility for cutting off of AHUs and electrical power is also included in this panel.

j. **Loop**
A loop or a zone shall mean a 2 wire circuit connecting at least 198 addressable analog devices.

k. **Control Switches**
Switches shall mean points from the Fire Alarm Panel with potential free contacts for tripping of AHUs power supply etc. as required. Any switch shall be able to trip an individual AHU.

5 TESTING AND COMMISSIONING

5.1 PHOTOELECTRIC TYPE SMOKE DETECTOR:-

The testing shall be carried out for each loop initially one detector in a loop and subsequently two or more disassociated detectors in each loop with time gap between the detectors for alarm acknowledge and Reset.

An identified detector will be subjected to smoke aspiration from burning paper or cigarette puffs, held at 0.3 m distance from the detector. The panel should indicate through piezo sounder and hooter that alarm signal has been transmitted throughout the system.

This test shall be carried out in different loops as well as two loops simultaneously. This part of the detector test shall be repeated again after 24 hours gap.

5.2 HEAT DETECTOR:

The same test in the same sequence shall be carried out for this type of detector but with the application of heat from a hair dryer-held at approximately 60 cm distance. Repeat testing of the same detector shall be carried out at 24 hours interval.

5.3 Combined Test:-

The next test will be in combination of lionization/heat detector, simultaneously with a time gap between application of smoke or heat or as required by the Employer's representative.

5.4 The panel shall be checked for basic tests, such as, visual checking of input voltage and amperage. All loops one by one, shall be D-wired to check for fault signal indication in the panel.

Subsequently, in every loop of panel, a detector shall be subjected to smoke or heat test and signals shall be checked on the panel.

The hooter shall sound automatically and the piezo sounders shall also sound. It shall also be possible to check that the hooters of all panels sound automatically when the panels are auto moded.

The power source shall be cut off and checked for standby supply from the batteries. After six hours the power source shall be switched on to check for auto switch over to mains mode. The trickle charger shall take over the charging of the battery to its maximum cut off level with auto cut off. A set of discharged batteries shall be connected to the panel in place of the new batteries and the trickle/boost switch checked for charging of the batteries.

Tests shall be conducted for AC failure, charger failure, battery disconnected or battery failure. In all such cases the relevant indication should come and the sounder shall also sound alarm.

5.5 Manual Call Box:

The manual call box glass shall be removed by unscrewing the back. The micro switch shall instantaneously give a fire signal in the panel. In case of pull type stations test procedures as recommended would be carried out.

5.6 **Random Sample Testing:**
About 5% of all fire alarm components shall be subjected to random testing by connecting to the panels. All smoke detectors shall be tested as given above and later cleaned with a vacuum cleaner. Hooters shall also be tested through direct 24V supply. It shall be tested for 10 minutes.

5.7 **Testing of Earthing system:**
The earth continuity conductor including metallic parts of the equipments shall be tested for earth to electrical continuity. All tests shall be carried out as per IS 3043 and resistance of complete installation shall not be more than one ohm.

5.8 **COMMISSIONING AND ACCEPTANCE TESTS**
The commissioning and acceptance tests shall be apart from the standard or routine tests prescribed and normally conducted by the manufacturer /Design-Build Contractor and will be irrespective of the fact whether the same are covered by such tests or not.

Each sounder circuit shall be energized separately and the sound level reading taken to check for conformity with the minimum standards.

b. Mains failure performance.

c. Battery disconnection test.

d. Open circuit of each sounder circuit to be tested.

e. Short circuit of each sounder circuit to be tested.

The results of the above tests either by fault warning or fire alarm shall be recorded in the log books which will be signed both by the Design-Build Contractor and the employer's Representative.

5.9 **TESTS AT SITE**

i) All commissioning tests at site will be in line with NFPA 71 and 72.

ii) Following test shall be conducted:-

a. Loop Checking

b. Checking of smoke detectors, Heat detectors etc. by simulation.

c. Functional tests for fire alarm panel.

d. The Mock trial of the complete Fire Detection and Alarm system.

PREAMBLE TO BILL OF QUANTITIES

1. The Bill of Quantities should be read with all the other sections of this Tender. All the items of work mentioned in the Bill of quantities covered by this contract shall be carried out as per the drawings, specifications and directions of the Owners and shall include the cost of all labor, materials, tools and plants, materials, testing if any with sub-Contractor's testing appliance, all octroi, royalties, taxes and Contractor's profit and overheads etc.

2. The Tenderer shall be deemed to have studied the drawings, specifications and details of work to be done within the time schedule and to have acquainted himself of the conditions prevailing at site. The Quoted Rates shall be applicable for all works in any section/size/shape and Design etc.

3. In case where the specifications given in the Description of the item of work given in Bill of Quantities are found wanting, the General Specification for Electrical Works Part – I (Internal), 1994 (with upto date corrections slips) shall be followed: where not specified the latest edition of relevant I.S. Specifications shall be applicable. In case of any ambiguity in interpretations the Owners decision shall be final and binding.

4 The rate(s) shall include the cost of providing / executing all ancillary – jobs / activities e.g. necessary excavations of earth, back filling, lean current concrete 1 : 4 : 8, RCC 1 : 2 : 4 with reinforcement & Shutterings, Brick Masonry in Cement mortar 1 : 4; Cement Plaster 1 : 5 (1 Cement : 5 Sand); Cutting holes, fixing clamps, lugs, M.S. Bolts / Nuts, Dashfastners, M.S. / G.I. screws, drilling holes, grouting in cement concrete 1 : 2 : 4; primer & painting to all steel works, welding, locking devices to Meter / Panel Boards etc. in any items for the scope of works contained in the tender documents, whether mentioned in description of item of work or not; and the contractor shall make the job complete as per drawings and direction of PROJECT MANAGER, and nothing extra shall be payable on all such activities / jobs.

5. The rates quoted for items of work shall include working in all conditions at all heights/depths including in/under water, liquid mud, foul conditions etc. and shall also include bailing or pumping out water from the foundations basements or any other place of construction collected from rain or any other source whatsoever at any time, till the completion of work including all suspension period and delays whatsoever.

6. The Quantities in this schedule are provisional. The Contractor will be paid for the actual quantity of work executed at site at the rates quoted in his tender. The Owner reserves the right to increase or decrease any of the quantities or to totally omit any item of work and no claims by the Contractor on these accounts shall be entertained.

7. All the items of work given in this schedule of quantities shall be executed strictly in accordance with Indian Electricity Rules and requirements of the Electric Supply Authority and British Standards Read in conjunction with the relevant drawings, specifications and the appropriate Indian Standards.

8. The contractor shall visit the site and shall satisfy himself as to conditions under which the wok is to be performed. No extra claim consequence of ignorance or on grounds of insufficient description will be allowed at a later date.

9. No Alteration whatsoever is to be made to the text or quantities of this Bill of quantities unless alteration is authorized in writing by the Owner. Any such alterations, notes or additions shall, unless authorized in writing be disregarded when tender documents are considered.

10. In the event of error occurring to the amount column of the Bill of quantities, as a result of wrong extension unit rate and quantity, the unit rate quoted by the Tenderer shall be regarded as firm and the extension shall be amended on the basis of the rates.

11. All error in totaling in the amount column and in carrying forward totals shall be corrected by owner. Any error in description or in quantity or omission of items from the contract Bill of quantities shall not viiate this contract but shall be corrected and deemed to be a variation required by the owner.

12. Approved make of materials shall be adopted, as listed in Appendix - I

13. Any approvals required from local authorities shall become part of the contractual obligations of the CONTRACTOR and nothing extra shall be payable to him.

14. All measurements shall be taken in accordance with Indian Standard Electrical Installation in buildings, method of measurement of IS-5908 unless otherwise specified.

15. Any error in description of items or change / omission / deletion of quantities from the BOQ shall not vitiate the contract but shall be corrected and deemed to be a variation requested by the owner.

SUB-HEAD -IP CCTV SYSTEM

24 port access Switch

SL No	Specification	Comply (Y/N)
1	Switch should be Enterprise grade switch.	
2	Port type/density: 24 port 10/100/1000 Base T with Poe+ (802.3at) and 4 SFP (total active 28 Ports)	
3	Switch should support single IP management of minimum 8 switches or more	
4	End user can be authorizeded via IEEE 802.1X , MAC address or web based authentication.	
5	Non blocking switch with support for Redundant Power supply and PoE Budget of 100W	
6	Switches can be managed via the CLI or the excellent web interface.	
7	Command Line Interface (CLI) with four access levels	
8	Multi–configuration File Support	
9	Full/half duplex auto – sense support on all ports (Auto – MDIX)	
10	One–to–One and Many–to–One Port Mirroring Port Description	
11	IGMP Snooping v1/v2/v3	
12	MLD Snooping	
13	Mixed Queuing Control – Strict and Weighted Round Robin	
14	TACACS+ authentication	
15	SYSLOG – up to 4 servers supported Authentication, Authorization and Accounting (AAA) management	
16	RMON (Stats, History, Alarms, Events)	
17	RADIUS Accounting for network access	
18	Dual IPv4/IPv6 Management Support	
19	Should support 16 K MAC address	
20	Secured Socket Layer (SSL v3)	
21	Denial of Service (DoS) Attack Prevention	
22	BPDU Attack Protection	
23	Multi–user Authentication Per Port .	
24	Web–based Port Authentication	
25	Should support 8 QOS Queues per port and 250 active Vlans, Support for multiple queuing control Should suport ingress and egress bandwidth control with 64 kbps granularity	
26	Should support IP source Guard , Arp Spoof protection, Loopback detect, DHCP snooping	
27	Should support CFM and OAM tools and Cable Diagnostics in the PHY for detecting Copper Cable issues	
28	Should support one to many mirroring and remote mirroring/ RSPAN	
29	Should support Private Vlan for port isolation , MAC based VLAN , Protocol Based Vlan / 802.1V and IEEE 802.1 Q-in-Q	
30	Should support Static Routes for IPv4 and IPv6, DHCP relay/ Helper	
31	Should support 802.1x , EAP , Local Data Base for authentication	

32	Should also Support Web based Authentication for port access for guest access	
33	Should support traffic analysis with sFlow / Netflow	
34	Should support minimum 12K Jumbo Frame	
35	Should be IPv6 ready in hardware and software from day 1, TELNET, Web, SSL, SNMP, and SSH over IPv6	
36	Should support ACL rules for L2, L3, L4 and also user defined packet content	
37	Should support G.8032/ ERPS for fast recovery	
38	Link Aggregation support 802.3ad	
39	IEEE 802.1p – Traffic classification	
40	Should support multiple config file and auto configuration for ease of management	
41	Should be equipped with minimum128 MB RAM and 32 MB flash or more	
42	Operating Temp: 0° C to +50° C	
43	Packet Buffer 1.5 MB or more	
44	MTBF (Mean Time before Failure) to be provided by the OEM. Should be minimum 500 khr or more	
45	Humidity 5 to 95 % non condensing	
46	Should be supported for 5 years by replacement from direct OEM depot in India	
47	Should have operational India Toll free support number	
48	OEM should be present in India with RND operation (Office address should be provided in website) for atleast past 5 years	

1 TECHNICAL SPECIFICATIONS INDOOR DOME CAMERAS

Specification	Description	Compliance
Image Sensor	1/3" Progressive Scan CMOS	
Min. Illumination	0.01Lux @ F1.2, 0.001 Lux @ F1.2 , 0 Lux with IR	
Shutter time	1/5s ~ 1/20,000 s	
Slow shutter	Supported	
Lens	2.8-12mm Motorized, Auto-focus	
Day & Night	IR cut filter with auto switch	
Wide Dynamic Range	Ultra WDR (120 dB)	
Digital noise reduction	2D / 3D DNR	
Video Compression	H.265 / MJPEG / H.264	
H.265 code profile	Main Profile	
Video bit rate	256K ~ 8M	
Max.Image Resolution	3MP (2048*1536)	

Frame Rate	Triple Streams: Mainstream (default 30fps / 3MP) 3MP (2048*1536), 1296P (2304*1296), 1080P (1920*1080), 960 (1280*960), 720P (1280*720) (1-30FPS optional default 3MP / 30fps) Substream (default 30fps / D1) D1(704*480) VGA (640*480), QVGA (320*240) (1-30fps optional, default D1 / 30fps) Mobilestream (default 10fps) QVGA (320*240) (1-30fps optional, default 10fps)	
Image Settings	Rotate Mode, Saturation, Brightness, Contrast, Sharpness adjustable by client software or web browser	
Edge Video Content Analysis	Motion Detection, Perimeter Intrusion, Line Crossing, Stationary Object	
Day/Night Switch	Auto / Schedule / Triggered by Alarm In	
Protocols	TCP / IP, UDP, ICMP, HTTP, HTTPS, FTP, DHCP, DNS, DDNS, RTP, RTSP, RTCP, PPPoE, NTP, UPnP, SMTP, SNMP, IGMP, 802.1X, QoS, IPv6, Bonjour	
System Compatibility	ONVIF Profile S	
Communication Interface	1 RJ45 10M / 100M Ethernet interface	
POE	Yes	
SD Card Support	Yes	
Alarm Triggers	1 x Input / 1 x Output	
Audio Interface	1 x Input / 1 x Output	
Video Output	1 x BNC	
Reset Button	Yes	
Waterproof Connector	Tail wire RJ45 interface for waterproof interface	
Operating Conditions	,-30 °C ~ 60 °C (-22 °F ~ 140 °F) Humidity 95% or less (non-condensing)	
Power Supply	12 VDC ± 10%, PoE (802.3af)	
Weather Proof	IP66, IK10	
IR Range	30 meters	
Certifications	UL, CE, FCC	

2 TECHNICAL SPECIFICATIONS BULLET CAMERAS

Specifications	Description	Compliance
Image Sensor	1/3" Progressive Scan CMOS	
Min. Illumination	0.05Lux @ F1.2, 0.001 Lux @ F1.2 , 0 Lux with IR	
Shutter time	1/5s ~ 1/20,000 s	
Slow shutter	Supported	
Lens	2.8-12mm Motorized, Auto-focus	
Day & Night	IR cut filter with auto switch	

Wide Dynamic Range	Ultra WDR (120 dB)	
Digital noise reduction	2D / 3D DNR	
Video Compression	H.265 / MJPEG / H.264	
H.265 code profile	Main Profile	
Video bit rate	256K ~ 8M	
Max.Image Resolution	3MP (2048*1536)	
Frame Rate	Triple Streams: Mainstream (default 30fps / 3MP) 3MP (2048*1536), 1296P (2304*1296), 1080P (1920*1080), 960 (1280*960), 720P (1280*720) (1-30FPS optional default 3MP / 30fps) Substream (default 30fps / D1) D1(704*480) VGA (640*480), QVGA (320*240) (1-30fps optional, default D1 / 30fps) Mobilestream (default 10fps) QVGA (320*240) (1-30fps optional, default 10fps)	
Image Settings	Rotate Mode, Saturation, Brightness, Contrast, Sharpness adjustable by client software or web browser	
Edge Video Content Analysis	Motion Detection, Perimeter Intrusion, Line Crossing, Stationary Object	
Day/Night Switch	Auto / Schedule / Triggered by Alarm In	
Protocols	TCP / IP, UDP, ICMP, HTTP, HTTPS, FTP, DHCP, DNS, DDNS, RTP, RTSP, RTCP, PPPoE, NTP, UPnP, SMTP, SNMP, IGMP, 802.1X, QoS, IPv6, Bonjour	
System Compatibility	ONVIF Profile S	
Communication Interface	1 RJ45 10M / 100M Ethernet interface	
POE	Yes	
SD Card Support	Yes	
Alarm Triggers	1 x Input / 1 x Output	
Audio Interface	1 x Input / 1 x Output	
Video Output	1 x BNC	
Reset Button	Yes	
Waterproof Connector	Tail wire RJ45 interface for waterproof interface	
Operating Conditions	,-30 °C ~ 60 °C (-22 °F ~ 140 °F) Humidity 95% or less (non-condensing)	
Power Supply	12 VDC ± 10%, PoE (802.3af)	
Weather Proof	IP66	
IR Range	60 Meters	
Certifications	UL, CE, FCC	

3 TECHNICAL SPECIFICATIONS PTZ CAMERAS

Specification	Description	Compliance

Camera Image Sensor	1/2.8" Progressive Scan CMOS Sensor	
Max Video resolution	2M (2048x1536) or better	
Scanning Mode	Progressive scan	
Shutter Speed	1 ~ 1/10000 sec.	
Day/Night	IR Cut Filter	
Minimum Illumination Color	0.1 lx at F1.6	
Minimum Illumination B/W	0.01 lx at F1.6 or better; 0 Lux with IR On.	
Zoom	30x Optical Zoom; 10x Digital Zoom; Autofocus	
Focal Length	4.4-129 mm or better	
Pan	360°endless	
Tilt	-20°~ 200°	
Pan Manual Speed	0.1°~ 85°/s	
Tilt Manual Speed	0.1°~ 50°/s	
Presets	256 or more	
Preset Pan Speed	9°~ 270°/s	
Preset Tilt Speed	7°~ 280°/s	
Number of Sequences	8	
Privacy Mask	16	
Speed by Zoom	On / Off (Pan and tilt speed proportional to zoom ratio)	
Resume after Power loss Home	No downtime power switching support	
Function	Preset / Sequence / Auto pan / Cruise	
Auto Flip	Mechanical / Off	
Motion Detection	Motion Detection Window x 4 sets or more	
Day / Night: IR Cut Filter Image	On / Off	
Rotation	Flip / Mirror / Inverse	
Auto Calibration	On / Off, Servo Feedback Support required for increased accuracy	
Noise Reduction	2D, 3D	
IR Distance	150 meters or better	
Network Interface	RJ-45, 1Gbps Ethernet	
Angle of View	64.1° (Wide); 2.4° (Tele)	
Wide Dynamic Range	120 dB or better	
Video Motion Detection	Yes	
No. of Streams	4 streams or more with at least 2 x H.264 streams at Full HD (1920 x 1080p) or better simultaneously	
Supported Resolutions	3M (2048x1536)/ Full HD 1080P / SXGA / 720P / XGA / SVGA / D1 / VGA / CIF	
Supported Protocol	IPv4/v6, TCP/IP, UDP, RTP, RTSP, HTTP, HTTPS, ICMP, FTP, SMTP, DHCP, PPPoE, UPnP, IGMP, SNMP, QoS, ONVIF, ARP	
SD Memory Card Feature	SD card support	

Alarm I/O	Input: 4 Output: 2	
Alarm Reaction	Preset / Sequence / Auto Pan / Cruise	
Security	HTTPS / IP Filter / IEEE 802.1X	
Image Compression.	MJPEG / H.264 (MPEG-4 Part 10/AVC) Baseline / Main Profile / High Profile	
Configurable Image Parameters	Backlight Compensation, White Balance, Noise Reduction, Brightness, Exposure, Sharpness, Contrast, Saturation Hue, Privacy Mask, Day/Night Threshold	
Input/ Monitor Output	Support (CVBS 1Vpp, 75 Ω)	
Audio	Two-way audio	
Audio Compression	G.711, G.726, AAC	
Event Notifications	HTTP / FTP / SMTP	
RS-485 (external control)	Supported	
Max number of user accounts	20	
Certifications	CE,FCC	
Power Source and Consumption	Should support 802.3at (PoE+) 4-Pair 60W, AC 24V, DC 12V	
Ambient Operating	-10 °C ~ +55 °C	
Temperature/Humidity	90 % or less (without condensation)	
Dust and water protection	IP 66	
Onvif	ONVIF Profile S	

PART –C DRAWINGS / PROCURMENT / INSPECTION AND LIST OF APPAROVED MAKES

1.00 <u>DRAWING/PROCUREMENT & INSPECTION OF EQUIPMENT</u>

1.01 Based on the tender drawings and the equipment/scheme finally selected, the contractor shall supply layouts, GA drawings to be submitted for approval are given below :-

a) General Arrangement drawings of all items.

b) The Original documents and the specifications in details of all equipment's and items switchgears and material to be used in the manufacturing and commissioning.

c) Wiring diagram, schematic diagrams and control diagrams for equipment, Switchgear, PCC and the whole system. Schedule and termination details shall also be provided.

d) Technical catalogue for all equipment, switchgear, cables and materials including complete write up/details of operation, interlocks and controls etc.

e) Operation and maintenance manuals along with list of spare parts for all equipment, Switchgear, Cables and materials etc.

1.02 **PROCUREMENT & INSPECTION OF EQUIPMENT**

Approved makes and vendors are given in approved make list. The makes of equipment/materials supplied shall be strictly as mentioned therein. For items not specially mentioned, prior approval shall be taken before procurement of the same. all equipments/material supplied shall be brand new and shall be procured directly from the manufacturers, dealers or authorized agents.

Client shall have access to the manufacturer's premises for stage inspection/final inspection of any item during its design, manufacturing, and assembly and testing. After carrying out the necessary factory tests and routine tests as per IS Standards, a copy of the routine test certificate shall be forwarded along with the call for carrying out the inspection at the manufacturer's works.

Based on the inspection certificate, Client reserves the right to carry out the inspection at a mutually agreed date and/or give inspection waiver. A minimum of two weeks will be needed after receipt of complete shop inspection report and other details to depute our inspector for inspection.

1.0 THE LIST OF APPROVED MANUFACTURES/MAKES

Moulded Case Circuit Breakers	-	Legrand Schneider Electric ABB L&T SIEMENS
Air Circuit Breaker	-	Legrand Schneider Electric ABB L&T SIEMENS
Change Over Switch	-	L&T C&S Areva ABB

Contactors	-	Schneider electric ABB L&T SIEMENS
BUS TRUNKING	-	L&T LEGRAND Schneider Electric
Voltmeter & Ammeter. Digital Multifunction Meters	-	Socomec Schneider Electric L&T
Current Transformer	-	BCH C&S Crompton greaves
Indication Lamp/Push button	-	ABB BCH Siemens L&T
Connector terminal Block	-	Elmex Lupco Phoenix Connect Well
Protection relays	-	ABB L&T Schneider Electric
Cable thimbles and glands	-	Trinity Touch Comet Gripwell Braco
Cable thimbles / lugs	-	Trinity Touch Louts Comet
Capacitors with relay	-	Neptune Epcos ABB L&T Schneider Electric
33 KV Switch gear with	-	Schneider Electric Crompton Greaves Siemens ABB L & T
33 kV /0.415kV Oil Type Transformers With OLTC	-	Crompton Greaves Essner Transformer

		ABB
		Schneider Electric
DG Set	-	Cummins Volvo Penta Caterpiller MTU Perkins by Sterling Gen Set
Sealed Maintenance free Battery	-	Standard Amco Exide
Main LT Panel, Main & Sub Distribution Boards	-	Milestone switchgear Gauri Switchgear Pvt. Ltd Ambit electrical Adlec Advance switchgear
Distribution Boards	-	Schneider Legrand ABB Siemens L&T
MCB/RCCB/RCBO	-	Legrand ABB Schneider L&T
PVC insulated copper conductor Single Core Stranded Wires of 1100 Volt grade/ Fire survival Cable	-	RR Cable Havells Finolex Bonton Polycab Parashield
XLPE insulated PVC sheathed armoured cables of 1.1kv & 33 KV grade as per IS 7098 Part-I & II 1988/1985	-	KEI Havells Polycab Universal
Modular type Switches, Socket etc. (ISI marked)	-	Legrand Hager Schneider Electric
MS Conduit (ISI marked)	-	BEC ROM COM AKG Indeana
Conduit accessories (ISI marked)	-	Trinity Touch

		M-Kay RM Com Noble
Industrial type sockets	-	Legrand Schneider electric Hager
Exhaust Fan/ Ceiling fans	-	Crompton Greaves Orient Havells
Light Fixtures	-	Wipro Philips Crompton Bajaj
Occupancy & Light sensor	-	Philips Hager Bajaj Legrand Honeywell
Surge Protection Device	-	Schneider Electric OBO L &T JMV
Complete Lightning Arrester system	-	OBO Ericko ABB JMV
UPS with battery Bank	-	APC Socomec GE SIEMENS Eaton
24 & 12 port LIU	-	Belden Panduit Siemon Legrand
Fiber patch cords	-	Belden Panduit Siemon Legrand
CAT 6A UTP cables	-	Belden Panduit Siemon

		Legrand
CAT 6A I/O	-	Belden Panduit Siemon Legrand
Jack Panel	-	Belden Panduit Siemon Legrand
UTP patch cords	-	Belden Panduit Siemon Legrand
Face Plate	-	Belden Panduit Siemon Legrand
42 U / 15U wall mount rack	-	APW MTS Rittal Valrac
EPBX and IP Phones	-	Toshiba Polycom Tadiran Legrand
CCTV cameras	-	Bosch Impulse PELCO
NVR with Storage	-	EMC Netapp Impulse
Workstations	-	Dell Lenovo HP
LED Monitor	-	Panasonic LG Samsung

24 port distribution switch For data and voice	-	Cisco Juniper Enterasys
LAN Controller	-	Extreme Juniper Enterasys
Addressable Fire Control Panel, Address monitor modules, control relay modules etc, Addressable Detectors, Hooters, Response indicators, Manual call point etc. . amplifier, speaker.	-	Honeywell Notifier Johnson control Edwards
G.I. Raceway	-	Legrand MK OBO Indeana
Junction Boxes	-	Legrand MK OBO Indeana
Cable Trays	-	Legrand Indeana OBO

HVAC WORK

Section-1: Special conditions of contract and employer's project requirements:

The Supplementary Conditions of Contract & Employer's requirements herein refer to the General Conditionsof the Contract and are intended to elaborate the requirements of the general conditions and shall have precedence over the general conditions.

Generally speaking, the special requirements elaborate the site conditions, scope of works, standards and codes to be adopted, fiscal conditions , mode of measurements etc.

Following documents shall be referred to in the order of precedence given below:

Description of items and notes as given in the bill of materials (B.O.M. / B.O.Q.) read in conjunction with the provided drawings, in this tender document.

Technical specifications of the referred tender document.

Applicable codes and standards as specified herein with amendments / errata / revisions (updated), as the case may be.

In the event of any discrepancy among the documents, the document with the higher order of precedence shall prevail. In the event of any element of specification not being available in any of the referreddocuments, the instruction of the consulting engineer in writing shall be sought by the contractor.

1.1 Chapter-1: The site:

1.1.1 Geographical and weather data

The site is located in Jabalpur, MP,Gurgaon. The chiller plant room is located in the Basement-. The chosen vendor shall supply, co-ordinate with the chiller supplier and assist him to install, test and commission the chiller.The chiller supplier shall hold guarantee for its installation testing, commissioning, and performance. The Contractor/supplier shall comply with all rules and regulations published by the Local codes. . The chosen contractor shall install the air handlers, chilled water risers, cooling towers, pumps, air distribution and all other items as described in the bill of quantities.

Location :Nearest weather station :Jabalpur

Latitude :23.16

Altitude :

Ambient design conditions :

Dry bulb critical (Summer):

Dry bulb temperature :108 Deg F (42.8 Deg C)

Wet bulb temperature :75 Deg F (23.9 Deg C)

Wet bulb critical ***(****Monsoon****):***

Dry bulb temperature :93 Deg F (33.9 Deg C)

Wet bulb temperature :84 Deg F (28.9 Deg C)

Winter heating ***:***

Dry bulb temperature :45 Deg F (7.2 Deg C)

wet bulb temperature :41 Deg F (5.0 Deg C)

Indoor **(**space neutral**)** target temperature **:**

As mentioned in the design data summary.

1.2 Chapter-2: Notes for bidding / cost estimation:

1.2.1 CONTRACTOR'S COSTS ON ALLOWANCES

The Contractor's costs for transport, unloading and handling on the Site, labor, installation costs, overhead, profit and other expenses shall all be included in the itemized rates and no a allowance shall be allowed for any handling of equipment/material i.e. All Allowances shall be included in the Schedule of Unit Prices itemized.

1.2.2 MATERIALS AND SERVICES NOT PARTICULARLY SPECIFIED

If materials or services required by the Contract are not particularly specified in the Specifications included in the Contract Documents, the Work shall be performed in accordance with relevant

and most recent publication of IS Codes and IS Specifications. Where IS Codes and IS Specifications are not available, good engineering practices shall prevail at all times.

1.2.3 CONFLICT BETWEEN BILL OF QUANTITIES, SPECIFICATIONS AND DRAWINGS

In case of conflicts between Bill of Quantities, Specifications and Drawings, the Bill of Quantities shall take precedence over the Specifications and Drawings, in keeping with the general intent of the scope of work in the Contract Documents. In all such cases, the Architect / Consultant will interpret the requirements of the design intent and the Contract Documents and his decision shall be final.

1.2.4 ASSOCIATED CIVIL WORKS

All related Civil works and other works associated with HVAC installation **are not to be included in the scope of this contract** and that **These shall be made available by others (civil contractor) in accordance with the approved shop drawings , and under the supervision of the HVAC contractor.**

How-ever all anti-vibratory mounts etc.for the all equipment shall be provided by the HVAC contractor in accordance with approved shop drawings.

1.2.5 ASSOCIATED ELECTRICAL / PLUMBING WORKS

All associated electrical works listed In the bill of quantities shall form the scope of this contract. All termination of cables, glands, associated electrical earthing work shall be included in the rates of allied items. Plumbing works as described in the bill of quantities shall form the part of this contract.

1.2.6 PERFORMANCE GUARANTEE

Performance of the all equipment as per the intent of the specifications and the schedule of quantity shall squarely be in the purview of the contractor / supplier. For this, if the supplier wishes to have a mutual understanding with the contractor on site, it shall be conveyed to the owners in writing, prior to any installation, testing and commissioning. However, the supplier shall include for the cost of supply, installation, testing and commissioning of the chillers. The supplier shall substantiate the performance of the chiller with the following documents:

Computer generated selection report as per conditions of the BOQ and also as per the conditions mentioned in the NIT. Factory test (if asked for by the owners).

1.2.7 QUIET OPERATION AND VIBRATION ISOLATION

All equipment shall operate under all conditions of load without any sound or Vibration which is objectionable and beyond specified limits as per section "Vibration isolation" and in the opinion of the Owner / Consultant. In case of rotating machinery sound or vibration noticeable outside the room in which it is installed or annoyingly noticeable inside its own room shall be considered objectionable. Such conditions shall be corrected by the Contractor at his own expense.

1.2.8 OPERATING INSTRUCTIONS & MAINTENANCE MANUAL

The Contractor shall submit to the consultant a draft copy of comprehensive operating instructions maintenance schedule and log sheets for all systems and equipment included in this contract. This shall be supplementary to manufacturer's operating and maintenance manuals. Upon approval of the draft, the contractor shall submit four (4) complete bound sets of typewritten operating instructions and maintenance manuals. Training module for familiarizing the client's staff on a periodic basis to be prepared on power point.

1.2.9 MAINTENANCE DURING DEFECTS LIABILITY PERIOD

1.2.9.1 Complaints:

The contractor shall receive calls for any and all problems experienced in the operation of the system under this contract attend to these within 24 hours of receiving the complaints and shall take steps to immediately correct any deficiencies that may exist.

1. 2.9.2 Repairs :

All equipment that require shall be immediately serviced and repaired. Since the period of Mechanical Maintenance runs for one year concurrently with the defects liability period, all replacement part and labor shall be supplied promptly free-of-charge to the Owners.

1.2.9.3 Preventive maintenance:

The contractor shall carry out all preventive maintenance plans for the equipment etc. as per the standards of the industry and good engineering practices.The format shall be mutually agreed upon award of the contract.

1.2.10 **SCOPE OF WORK**

The general character and the scope of works to be carried out under this contract is illustrated in the drawings, schedule of quantities and herein in brevity. The scope of work shall be best understood if read conjunctively of the aforesaid media of elaboration. The contractor shall also make himself aware of the special conditions of contract which may also entail some part of work in form of support services.

However the scope of work (to be read in conjunction and entirety of the drawings, special conditions, SOQ,and herein) shall comprise of installation of the central air conditioning plant comprising of all the items as detailed in the BOQ.

1.2.11 **UPTIME GUARANTEE**

The contractor shall provide an uptime guarantee for the entire system(including the chiller/Pumping system and the basic automation) for 98%.

To safe guard the interests of the client the contractor shall be bound by a clause which enables the client to extend the DLP by a month for every shortfall in the uptime maintenance.

The above mentioned clause shall be subject to the following conditions in favour of the client:

The uptime guarantee for the entire system shall be 98%.

The uptime guarantee and performance shall be recorded and monitored and duly signed by the contractor and the representative of the client every month. For every failure of guaranteed 98% time operations the uptime shall be extended by one month.

There shall be no re-imbursements for the extended tenure of DLP on account of failure of delivery of the guaranteed uptime.

Break-downs shall be attended to in within 12 Hrs. of reporting (in a written format) Service compressor/Compressor motor /Assembly(as the case may be) shall be made available to the client for support within 5 calendar days in case of warranted repairs seeking time beyond 3 days and requires the compressor/motor to be moved to a factory/repair facility.

All consumables and manpower required for maintaining the committed uptime shall be provided by the contractor at his own risk and cost.

1.3 Chapter-3: Instruction to Bidders & Owners / Employers Project Requirements:

1.3.1 All items of work under this contract shall be executed strictly to fulfill the requirements laid down under "Basis **of Design**" in the specifications. Type of equipment, material specification, methods of installation and testing and type of control shall be in accordance with the specifications, approved shop drawings and the relevant Indian Standards, however capacity of each component and their quantities shall be such as to fulfill the above-mentioned requirement.

1.3.2 The unit rate of all equipments or materials shall include cost in RUPEES for equipment and materials including all taxes and duties and also including forwarding, freight, insurance and transport into contractor's store at site, storage–installation, testing, balancing, commissioning and other works required.

1.3.3 For all imported items owner shall arrange import duty Exemption license and open **L/C** in the name of principals, Rates for all imported items shall be quoted in US Dollars. During award of work Owner shall be at liberty to ask for preformed invoice in any convertible foreign currency. Dollar conversion rate shall be at liberty to ask for preformed invoice in any prevalent on the day of issue of **LOI**.

1.3.4 The rate of each item of work included in the schedule of quantities shall, unless expressly stated otherwise, include cost of:

All materials, fixing materials, accessories, appliances tools, plants, equipment, transport, labor and incidentals required in preparation for and in the full and entire execution, testing, balancing, commissioning and completion of work called for in the item and as per Specifications and Drawings,including Wastage on materials and labor.

1.3.5 Loading, transporting, unloading, handling/ double handling, hoisting to all levels, setting, fitting and fixing in position, protecting, disposal of debris and all other labor necessary in and or the full and entire execution and for the job in accordance with the contract documents, good practice and recognize principles.

1.3.6 Liabilities, obligations, whether such requirements are mentioned in the item or not. The specifications and drawings where available, are to be read as complimentary to and part of the Scheduled of Quantities and any work called for in one shall be required for all.

1.3.7 All requirements of Specifications, whether such requirements are mentioned in the item or not. The Specifications and Drawings where available, are to be read as complimentary to and part of the Scheduled of Quantities and any work called for in one shall be taken as required for all.

1.3.8 In the event of conflict between Schedule of Quantities and other documents including the Specifications, the most stringent shall apply. The inter4pretation of the Consultant/ project manager shall be final and binding.

1.3.9 All equipments, quantities and technical data indicated in this Schedule are for the Contractor's guidance only; these are based on the documents prepared by the Consultant. This schedule must be read in conjunction with other documents. The contractor shall be paid for the actual quantity of work executed by him in accordance with the approved Shop Drawings at the contract rates.

1.3.10 The schedule shall be fully priced and the extensions and totals duly checked. The rates for all items shall be filled in **INK** including **NIL** items.

1.3.11 No alteration whatsoever is to be made to the text or quantities of this Schedule unless such alteration is authorized in writing by consultant. Any such alterations, notes or additions shall unless authorized in writing, be disregarded when tender documents are considered.

1.3.12 In the event of an error occurring in the amount of the schedule, as a result of wrong extension of the unit rate and quantity, the unit rate quoted by the tendered shall be regarded as firm and the extensions shall be amended on the basis of rates.

1.3.13 Any error in totaling in the amount column and in carrying forward total shall be corrected. Any error, in description or in quantity, omission of items from this Schedule shall not vitiate this Contract but shall be corrected and deemed to be variation required buy the Consultant/ Project Manager.

1.3.14 Rates have been called for a number of items of works, as alternatives which, for the present do not form part of the total value of tender. However the rates for these items shall be quoted, with due care so that in the event of choice of an alternative item of work, said rate shall form part of the contract any way

1.3.15 The contractor shall procure and bring Materials/ Equipment to the site only on then basis of drawings approved for construction and shop drawings and not on the basis of Schedule of quantities which are provisional only. This also applies to the Contractor's requisition for owner supplied materials.

1.4 Chapter-4: Preamble to the mode of measurement:

1.4.1 All equipment described hereafter, shall be in accordance with the specifications. All equipment shall be selected and installed for the lowest Operating noise level. Supply of various equipment shall include all expenses for correspondence with manufacturers, submission of shop drawings, documents and their approval by the Consulting Engineer, procurement of equipment, transportation, shipping, payment of all taxes and levies, storage, supply of equipment at the point of installation, furnishing all technical literature required, replacement of defective components, and warranty obligations for the individual equipment. Installation of various equipment shall include all material and labor associated with hoisting and lowering of equipment in position, insulation of the components and vibration isolation as required, grouting and anchoring or suspension arrangements and all incidentals associated with the installation as per the specifications and manufacturer's recommendation.

Vibration isolators as specified or as recommended by the manufacturer shall be installed with each component. Performance ratings, power consumption and power data for each component shall be verified at the time of testing and commissioning of the installation,against the data submitted with the tenders.

Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirit, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.

Testing and commissioning shall include furnishing all labor, materials, equipments, instruments, and incidentals necessary for complete testing of each component as per the specifications and manufacturer's recommendations, submission of test results to the Consulting Engineer and obtaining their approval and submission of necessary documents and completion drawings.

All ducts shall be fabricated and installed conforming to the relevant Indian standards, approved shop drawings and the specifications.

Duct installation shall include fabricating and installing the ducts, splitter dampers, turning vanes, and distribution grids within the ducts in position, and providing, installing and making air tight all joints with slips, bonded felt insertions, nuts, bolts and screws as required. In addition multi-louvered manually adjustable dampers shall be provided in various branch ducts as required or shown on drawings for proper balancing of air flows.

All registers and diffusers shall be provided with a soft continuous rubber gaskets between their periphery and the surface on which these have to be mounted.

Registers and diffusers shall be given, at the factory, a rust resistant primer coat and enamel paint finish of approved color. Aftercompletion of the installation, the entire air distribution system shall be tested for air leaks and balanced in accordance with the specifications.

1.4.2 Mode of measurement:

1.4.2.1 Air ducts:

Payment for ducting shall be made on the basis of the external surface area of the ducting including all material and labor for installed duct

The rates per sq. ft. of the external surface shall include flanges, gaskets for joints, bolts and nuts, duct supports and hangers, vibration isolation pads or suspenders, flexible connection, inspection doors, dampers, turning vanes, and any other item which will be required to complete the duct installation except external insulation and acoustic lining.

The external area shall be calculated by measuring the overall width and depth (including the corner joints) in the center of the duct section and overall length of each duct section from flange face in case of duct lengths with uniform cross section. Total area will be arrived at by adding up the areas of all duct sections.

In case of taper pieces average width and depth will be worked out as follows;

W1 = Width of small cross section

W2 = Width of large cross section

D1 = Depth of small cross section

D2 = Depth of large cross section

Average width =W1__+__W2

2

Average Depth = D1__+__D2

2

Width and depth in the case of taper pieces shall be measured at the edge of the collar of the flange for duct sections fitted with angle iron flanges, otherwise at the bottom of the flange where flanges are of duct sheet.

For the circular pieces the diameter of the section mid-way between large and small diameters shall be measured and adopted as the mean diameter for calculating the surface at the taper piece.

For the face length of taper piece shall be the mean of the lengths measured face to face from the centre of the width and depth flanges.

Duct measurements for calculation of area shall be taken before application of insulation.

For the special pieces like bends, branches, and tees etc. same principle of area measurement as for linear lengths shall be adopted except for bends and elbows, the length of which shall be the average of the lengths of inner and outer periphery along with curvature or angle of the piece.

1.4.2.2 Duct Insulation

This item is provided separately for various thickness and shall be paid for on area basis of un–insulated duct. The area of the duct to be insulated shall be measured before application of insulation.

1.4.2.3 Un–insulated Piping

Payment for un–insulated piping shall be made on the basis of linear measurement including all materials and labor for installed pipe. The linear rate per meter / feet for each nominal diameter shall include all pipe fittings, flanges, unions, nominal diameter shall include all pipe fittings, flanges, unions, gaskets for

joints, bolts and nuts, pipe supports and hangers, vibration isolation devices or suspenders flexible connections and any other item required to complete the pipe installation except valves of any kind and strainers. The length of the pipe section with flanges shall be from flangeface to flange face.

For fitting like bends, elbows, branches and tees, etc. Same principle of linear measurement as for pipe sections shall be adopted except for bends, the length of which shall be the average of the lengths of inner and outer periphery alongthe curvature.

1.4.2.4Valves / Strainer

Payment will be made on unit basis.

All quantities indicated in this schedule are for Contractor's guidance only.

1.4.2.5 Grills / Diffusers / Dampers

Minimum area to charged as 0.1 Sq.Mt. as per manufacturer's standard.

1.5 Chapter-5: Employer's project requirements:

1.5.1 Irrespective of the fact that the project is Griha certified or NOT, the owners / employers desires to practice certain requisites to be adopted in terms of the followings, which will be adhered to by the contractor. The main highlights are as follows:

1.5.2 Material handling:The material will be shipped and stored in a manner that it is not exposed to humidity and dust.

1.5.3 Flushing of the building: The HVAC contractor shall flush the building as prescribed in the ASHRAE standards before the beneficial use of the user.

1.5.4 Commissioning Plan: The contractor shall submit the quality assurance plan for the construction period andwill also submit a commissioning plan entailing all commissioning procedures, equipments involved, and the reports to be generated for the testing, adjusting and balancing activities.

1.5.5 Verification of installation: The contractor shall work in conjunction with the validation authority, support the validation team with all that it takes to establish the intent of the commissioning system, train the operators, along with preparation of the operations and maintenance manuals, and shall also submit a commissioning report.

1.5.6 Construction period IAQ management:

The contractor shall develop and implement an IAQ management plan for the construction and pre-occupancy phases of the building as follow:

During construction meet or exceed the recommended Design Approaches of SMACNA guideline for occupied buildings under construction, 1995, chapter-3. Further to that the contractor shall execute a duct pressure testing at site as per the provisions of SMACNA guideline for a low / medium pressure air ducts.

The contractor shall protect stored on –site or installed absorptive materials from moisture damage.

If air handlers are to be used during construction , filtration media with a minimum efficiency reporting value of 8 , as determined by ASHRAE 62.1-1999 at each return air grill.(If construction for interior fit-out is undertaken within a conditioned space)

Replace all filtration media immediately prior to occupancy. Filtration media shall have a minimum efficiency reporting value of 13 , as determined by ASHRAE 62.1-1999 for media installed at the end of construction.

The contractor shall submit a GRIHA letter template, duly signed declaring that the construction IAQ management plan has been developed and implemented, and listing each air filter used during construction and at the end of commissioning. Include the MERV value , manufacturer name and model number.

AND EITHER

Provide 18 photographs – six photographs taken on three different occasions during construction-along with identification of SMACNA approach featured by each photograph.

OR

Declare the five design approaches of SMACNA IAQ guideline for occupied buildings under construction,1995,chapter 3, which were used during building construction

After construction ends and prior to occupancy conduct a minimum two weeks building flush out with new MERV-13 filters at 100 % outside air. After the flush out replace the filter media with new MERV-13 filtration media, except the filters solely processing out side air.

Conduct a baseline IAQ quality testing procedure consistent with the US EPA current protocol for environmental protection.

Submit submittals on GRIHA letter template for the building flush out.

Reduce the quantity of indoor air contaminants.

The contractor shall perform the cooling tower performance as per the provisions of CTI and certify the same.

1.6 Chapter-6 :Specifier's Notes : Basic Mechanical Requirements:

1.6.1 REFERENCES / STANDARDS

National Building Code of India –2016

ANSI : American National Standard institute **(Wherever applicable)**

BIS : Bureau of Indian Standards (This code will supersede in case of any ambiguity or misinterpretation)

ARI : Air conditioning and Refrigeration Institute

ASHRAE : American Society of Heating Refrigeration and Air conditioning Engineers.Fundamentals 2005. Systems & Equipment 2004 Application 2003.

ASME : American Society for Mechanical Engineers

SMACNA / BIS(Modified as per specifier's recommendations) : For Duct construction standards.

UL: Underwriters' Laboratories INC. for fire protection and ratings / testing

Air filters as per ASHRAE Standard 52.1 – 1992

Indoor Air Quality as per ASHRAE Standard 62.1 – 2007

Motors, cabling, wiring and accessories as per BIS codes / IE Rules / IS codes

Recognized / approved manufacturer's standards.

Motors, cabling, wiring and accessories as per BIS codes/ IE Rules / IS codes / ITC Electrical Guidelines

IS :277	Galvanized steel sheet (Plain and corrugated)
IS :325	Three-phase induction motors.
IS :554	Dimensions for pipe threads where pressure light joints are required on the threads.
IS :659	Safety code for air conditioning.
IS :660	Safety code for mechanical refrigeration
IS :694	PVC insulated cable for working voltage up to and including 1100V
IS :778	Copper alloy gate, globe and check valves for water works purposes.
IS :780	Sluice valves for water works purposes. (50 to 300 mm size)
IS :1239 (Part-1)	Mild steel tube, tubular and other wrought steel pipe fittings : Part 1 Mild steel tube.

IS :1239 (Part-1) Mild steel tube, tubulars and other wrought steel pipe fittings : Part 2 Mild steel tubular and other wrought steel pipe fittings.
IS :2147 Degree of protection provided by enclosures for LV switch gears and control gear.
IS :2379 Colour code for the identification of pipelines.
IS :3043 Code of practice for earthing.
IS :3103 Code of practice for industrial Ventilation.
IS :3589 Seamless or electrically welded steel pipes for water, gas and sewage. (168.3 to 2032 mm outside diameter).
IS :3854 Switches for domestic and similar purposes.
IS :4064 (Part-1) Air break switches, air break disconnectors, air break switch disconnectors and fuse-combination units for voltages not exceeding 1000V ac or 1200V dc:
Part 2 Specific requirements for the direct switching of individual motors.
IS :4237 General requirement for switchgear and control gear for voltages not exceeding 1000 volts ac or 1200 volts dc.
IS :4671 Expanded polystyrene for thermal insulation purposes.
IS :4736 Hot-dip zinc coatings on mild steel tubes
IS :4894 Centrifugal Fans
IS :5082 Wrought aluminum and aluminum alloy bars, rods, cubes and sections for electrical purposes.
IS :5312 (Part-1) Specification for Swing check type reflux (non-return) valves : Part 1 Single door pattern.
IS :5424 Rubber mats for electrical purposes.
IS :8183 Bonded mineral wool
IS :8544 (Part-1) Motor starters for voltages not exceeding 1000V : Part 1 Direct on line starters
IS :8544 (Part-2) Motor starters for voltages not exceeding 1000V : Part 2 Star delta starters.
IS :8544 (Part-3/Sec 1) Motor starters for voltages not exceeding 1000V : Part 3 Rheostatic motor starters.
Sec 1 General requirements
IS :8544 (Part-3/Sec 2) Motor starters for voltages not exceeding 1000V : Part 3 Rheostatic motor starters.
Sec 2 Additional requirements for ac rheosatatic motor controllers.
IS :8544 (Part-4) Motor starters for voltages not exceeding 1000V:
Part4 Reduced voltage dc starters: two step autotransformer starters.
IS :8623 (Part-1) Factory built assemblies of switchgear and control gear for voltages up to and including 1000 volt ac and 1200 volt dc.
IS :8623 (Part-2) Factory built assemblies of switchgear and control gear for voltages up to and including 1000 volt ac and 1200 volt dc :
Part 2 Particular requirements for bus bar trunking system.
IS :9224 (Part-2) Low voltage fuses : Part 2 Supplementary requirements for fuses for industrial applications
IS :10221 Code of practice for coating and wrapping of underground mild steel pipelines.
ANSI/AHRI 340/360-2007 Performance Rating of Commercial and industrial Unitary Air-Conditioning Heat Pump with addendum 2 Equipment
AHRI 400 Liquid to Liquid Heat Exchangers (Plate and Frame Type)
AHRI 410-2001 Forced-Circulation Air-Cooling and Air-Heating Coils With Addenda 1,2 and 3
ANSI/AHRI 430-2009 Central Station Air Handling Units
ANSI/AHRI 440-2008 Performance Rating of Room Fan-Coils
AHRI: 550 Standard for centrifugal or rotary screw water chilling packages
AHRI: 575 Standard for method of measuring machinery sound within equipment room.
AMCA: 210 Test Code for Air moving devices
ASHRAE Handbook: Fundamentals
ASHRAE Handbook: Refrigeration
ASHRAE Handbook: HVAC Application
ASHRAE Handbook: HVAC System and Equipment

ASHRAE Standard 62 :	Ventilation for acceptable indoor air quality
ASHRAE Standard 52 :	Gravimetric and dust spot procedures for testing air cleaning devices used in general ventilation for removing particulate matter.
ASHRAE Standard 55 :	Thermal comfort
ANSI/ASHRAE/IESNA Standard 90.1-2009 :	Energy standard for buildings except low rise residential buildings
ASHRAE 150 :	Method of testing the performance of Cool Storage Systems requirements
ANSI/AHRI 900 (I-P)-2010	Performance Rating of Thermal Storage Equipment Used for Cooling
ANSI/AHRI 900 (SI)-2010	Performance Rating of Thermal Storage Equipment Used for Cooling
ASME :Section VIII Div.1	Code for Unfired Pressure Vessels Section VIII (Design; construction, testingand certification of pressure vessels) with 'U' stamping
ANSI :B9.1	Air compressor system (refer for overall general safety requirement, relief device sizing etc.)
ANSI: B31.5	Code for Refrigeration piping
ASME: B31.1	Code for Process piping
BS EN 253:2009	District heating pipes- Pre-insulated bonded pipe systems for directly buried hot water network – pipe assembly of steel service pipe, polyurethane.
CTI	Cooling Technology Institute
ATC-105-00	Acceptance Test Code for Water-Cooling Towers (CTI Std-103 Code Tower Standard Specifications)
ATC-201-96	Standard for Certification of water Cooling Tower Performance (CTI Code Tower Standard Specifications).
ECBC	Energy Conservation Building Code (latest version)
IEC	Relevant section applicable to HT motors and HT starters
ISO :281-1	Rolling Bearing – Dynamic Load Ratings and Ratings Life : Part 1 Calculation methods
ISO 2858, 5199	Specifications for pumps
National Standards	For total system balance
NBC 2005	National Building Code of India 2005
SMACNA	HVAC Duct Construction Standard Metal and flexible
TEMA	Standards of Tubular Exchanger Manufacturer' Association, USA
UL 555	Fire Dampers

Legend:

AMCA Air Movement and Control Association Inc.
ANSI American National Standard Institute
AHRI Air-Conditioning, Heating & Refrigeration Institute, USA
ASHRAE American Society of Heating, Refrigeration and Air-Conditioning Engineers
ASME American Society of Mechanical Engineers
IEC International Electro-technical Commission
IS Indian Standard
SMACNA Sheet Metal and Air-Conditioning Contractor's National Associations, USA
TEMA Tubular Exchanger Manufacturers, Association, USA
UL Underwriters Laboratories, USA

I&C System/Equipment codes & Standards:

- National Electricity Manufacturers Association (NEMA).
- The institute of Electrical and Electronic Engineers (IEEE).
- Instrument Society of America (ISA).
- American National Standards Institute (ANSI)
- Deutsche Industries Norman (DIN)
- International Electro technical Commission (IEC)
- International Electro chemical Commission (IEC)
- International Consultative Committee on Telephone and Telegraphy (CCITT)
- Verin Deutschar Eisecnhuttenleute (VDE)
- Indian standard Institute (IS)
- International standards organization (ISO)
- Bureau of Indian standards (BIS)
- American society of mechanical engineers (ASME)
- Scientific apparatus mfrs. Association (SAMA)

- Noise immunity

- Input normal mode noise rejection 80 dB
- Input common mode noise rejection 75 dB
- For radio frequency inputs, noise immunity shall be tested as per AMA Std. PMC 33.1 1978, Class 2, Bands A, B and C
  - Surge Protection
- Surge Protection shall confirm to :
- IEEE – 472/1974
- ANSI – C37.90A/1982
- BEAMA – 219
  - Standard to be followed for signal/control cables shall be as per IS-8130, 5831, 3975, 1554 latest – editions.

1.6.2 **SUBMITTALS**: To cross check the cooling and heating Load Estimations / Design Data Summary and point out any discrepancy at the time of bidding.

1.6.2.1 Under provisions of sample approval before the commencement of the project.

1.6.2.2 Includes products mentioned in the Approved list of manufacturers as per the mode of approval mentioned in the list.

1.6.2.3 Submit shop drawings and product data grouped to include complete submittals of related Systems products, and accessories in a single submittal.

1.6.2.4 **SHOP DRAWINGS**

Submit a copy of the shop drawings,including :

Actual duct routes after the site survey.

Automatic temperature /Pressure control system.

Inertia pads and foundations for the various equipments.

Fire protection systems (Fire / Smoke dampers: Motorized) (Relief dampers, smoke extract system, pressurization system)

Layout of the AHU / Plant room including dimensions of the room and the foundations and the sizes and all necessary construction details required on site.

Location of the allied equipments and the requirements from other agencies.

Trench locations if any.

Sump location and size.

Sleeve location if any.

Ventilation air / exhaust air locations.

Location of wall mounted equipment (If any)

Any structural inputs.

1.6.2.5 **Brochures**:

Submit manufacturer's product data and brochure including :

Complete description.

Illustrations.

Rating data, accessories, and dimensional data.

Capacities stated in the terms specified.

Performance curves of the fans and pumps.

1.6.3 PROJECT/SITE CONDITIONS

Mechanical layouts indicated on drawings are diagrammatical. Co-ordination (final) shall be required with other trades prior to installation. Install all works as shown on the drawings, unless prevented by project conditions.

Prepare drawings showing proposed rearrangement of work to meet the project conditions, Obtain permission from of architect / consultant before proceeding.

Place anchors, sleeves and supports prior to pouring concrete on installation of masonry works.

Keep roads and site clear of debris and scrap.

1.6.4 Painting and service line identification.

The scope of this section comprises of identification of service for each piece of equipment and allied works.

1.6.4.1VALVE TAGS AND CHARTS

Each valve shall be provided with a tag indicating the service being controlled together with a reference number corresponding with that shown on the valve chart and as fitted drawings. The labels shall be made from 3 ply (Black/White/Black) trifoliate material showing white letter and figures on a black background. Labels to be lied to each valve with chromium plated linked chain.

A wall mounted glass covered plan to the Architect / Engineer shall be provided and displayed in each plant room showing the plant layout with pipe work. Valve diagram and valve schedule indicating size. Service duty etc.

Pipe work and duct work shall be identified by color bands 150 mm. Wide or color triangles of at least 150 mm / side. The bands of triangles shall be applied at termination points. Junction, entries and exits of plant room. Walls and duct. And control point to readily identify the service but spacing shall not exceed 5.0 meters.

1.6.4.2 Pipe Work Service:-

For pipe work service and its insulation the color of the bands shall be company with BS. 1710:1971.

Basic color for pipe line identification:-

Pipe Line Contents	BS 4800 Color Reference	Color
Water	12 D 45	Green
Steam	10 A 03	Grey
Oils	06 C 39	Brown
Gas	08 C 35	Yellow/brown
Air	20 E 51	Blue
Drainage	00 E 53	Black
Electrical	06 E 51	Orange

Color code indicator bands shall be applied as color band over the basic identification color in the various combination as listed below:-

Pipe Duty	**Color Bands to BS. 4800**
Water service	
Cooling	00 E 55
Ventilation/ drinking	18 E 53
Boiler feed	04 D 45/ 00 E 55 / 04 D 45
Condensate	04 D 45/ 14 E 53/ 04 d 45
Chilled	00 D 55/ 14 E 53/ 00 D 45

Pipe Duty	**Color Bands to BS. 4800**
Central heating service	18 E 55/04 d 45 / 18 E 53
Below 100 degree C	04 D 45/ 18 E 53/ 04 D 45

Above 100 degree C

Cold water storage

Tanks	00 E 55/18 E 53/ 00 E 55
Hot water supply	00 E 55/ 04 D 45/00 E 55

Steam service

Drainage and other fluids:	Basic Colour Only

Electrical service: Basic Colour Only

In addition to the color band specified above all pipe work shall be legibly marked with black or white letter to indicate the type service and the direction of flow. Identified as follow:-

High temperature hot water	HTHW
Medium temperature hot water	MTHW
Low temperature hot water	LTHW
Chilled water	CHW
Condenser water	CONDW
Steam	ST
Condensate	CN

Pipe shall have the letter **F** and **R** added to indicate flow and return respectively as well as directional arrows.

1.6.4.3 Duct work service :

For duct work service and its insulation the colour of the triangles shall comply with **BS. 1710:1971**. the size of the symbol will depend on the size of duct and the viewing distance but the minimum size should not be less than **150 mm** length per side. One apex of the triangle shall point of the direction of air flow.

Service	Color	BS. 4800 Color Reference
Conditioned air	Red and Blue	04 E 53/ 18 E 53
Ward air	Yellow	10 E 53
Ventilation air	Green	14 E 53
Exhaust / extract		
Recalculated air	Gray	AA 0 09
Foul air	Brown	06 C 39
Dual duct system hot	Red	04 E 53
Supply air		
Cold supply air	Blue	18 E 53

In addition to the color triangle specified above all duct work shall be legibly marked with black or white letter to indicate the top of service identified as follows:-

Supply air	S
Return air	R
Ventilation air	F
Exhaust air	E

The color banding and triangle shall be manufactured from self adhesive cellulose tape laminated with a layer of transparent ethyl cellulose tape.

1.6.5 **Good Engineering Practices For MVAC Installation Works.**

1.6.5.1 Mechanical noise control: All good engineering practices involved in controlling the noise of equipment within permissible limits shall be adopted by the contractor**.**

Vibration Control: All good engineering practices involved in controlling the vibrations of equipment within permissible limits shall be adopted by the contractor.

Equipment at the best operating parameters and acoustical performance along with the necessary isolation devices for vibration control shall be adopted by the manufacturer and the contractor.

1.6.5.2 **INTENT in general pertaining to this section is as follows**:

The vibration isolators for certain equipments although have been specified and quantified in the BOQ, however, as a precautionary measure, if any additional safeties are required to fulfill the intent of this basic mechanical requirement, then the same shall be provided by the manufacturer/contractor, at no additional cost.

1.6.5.3 Mechanical service shall generally be designed and installed with provisions to contain noise and the transmission of vibration generated by moving plant and equipment schedules to achieve acceptable noise rating specified for occupied areas.

1.6.5.4 In addition to the provision specified in the specification particulars attention must be given to the following detail at time of ordering plant and equipment and their installation:-

1.6.5.5 All moving plant, machinery and apparatus be statically and dynamically balance at manufactures work and certificate issued.

1.6.5.6 The isolation of moving plant. Machinery and apparatus including lines equipment from the building structure.

1.6.5.7 Where duct work and pipe work service pass though walls floor and ceiling or where supported shall be surrounded with a resilient acoustic absorbing material to prevent contact with the structure and minimize the outbreak of noise from plant room.

The reduction of noise breakout from plant room and the section of externally mounted equipment and plant to meet ambient

noise level requirement of the specifications.

1.6.5.8 Electrical conduits and connection to all moving plant and equipment shall be carried out in flexible conduit and cable to prevent the transmission of vibration to the structure and nullify the provision of anti–vibration mountings.

1.6.5.9 All duct connection to fans shall incorporate flexible connections. Except in cases where these are fitted integral within air handing unit.

1.6.5.10 All resilient acoustic absorbing materials shall be non flammable vermin and rot proof and shall not tend to break up or compress sufficiently to transmit vibration or noise from the equipment to the structure.

1.6.5.11 Where practicable silencer shall be built into walls and floor to prevent the flanking of noise the duct work system and their penetrations sealed in the manner previously described.

1.6.5.12 where this is not feasible the exposed surface of the duct work between the silencer and the wall subjected to noise infiltration shall be acoustically clad as specified.

1.6.6 Acoustic and vibration control. - Acoustics Measures For Noise Control And Vibration Control Measures

1.6.6.1 INTENT in general pertaining to this section is as follows:

The vibration isolators for certain equipments although have been specified and quantified in the BOQ, how-ever, as a precautionary measure, if any additional safeties are required to fulfill the intent of this basic mechanical requirement, then the same shall be provided by the manufacturer/contractor, at no additional cost.

1.6.6.2 **STANDARD**

The testing of the all noise control equipment and the method use in measuring the noise rating of air conditioning plant and equipment shall be in accordance with the relevant section of the following British standards unless otherwise stated:

BS 4718 : 1971 Method of test of silencer for air distribution systems.

BS 2750:
Parts 1-9:1980 Laboratory and field measurement of airborne sound insulation of various building element.
Recommendation for field laboratory measurement of airborne and impact sound transmission in building.

BS 3638 :1987 Method of measurement of sound adsorption in a reverberation room.

BS 4773:
Part 2: 1976 Acoustic performance without additional ducting of forced fan convection equipment.

BS 4857:

Part1978 (1983) Acoustic testing and rating of high pressure terminal reheat units.

BS 4954:
Part 2: 1978(1987) Acoustic testing and rating of induction units.

BS 5643:1984 Glossary of Refrigeration, Heating Ventilation and Air Conditioning terms.

1.6.6.3**INTENT in general pertaining to this section is as follows**:

1.6.6.3.1 Mechanical service shall generally be designed and installed with provisions to contain noise and the transmission of vibration generated by moving plant and equipment schedules to achieve acceptable noise rating specified for occupied areas.

1.6.6.3.2 In addition to the provision specified in the specification particulars attention must be given to the following detail at time of ordering plant and equipment and their installation.

1.6.6.3.3 All moving plant, machinery and apparatus be statically and dynamically balance at manufactures work and certificate issued.

1.6.6.3.4 The isolation of moving plant. Machinery and apparatus including lines equipment from the building structure.

1.6.6.3.5 Where duct work and pipe work service pass though walls floor and ceiling or where supported shall be surrounded with a resilient acoustic absorbing material to prevent contact with the structure and minimize the outbreak of noise from plant room.

1.6.6.3.6 The reduction of noise breakout from plant room and the section of externally mounted equipment and plant to meet ambient noise level requirement of the specifications.

1.6.6.3.7 Electrical conduits and connection to all moving plant and equipment shall be carried out in flexible conduit and cable to prevent the transmission of vibration to the structure and nullify the provision of anti – vibration mountings.

1.6.6.3.8 All duct connection to fans shall incorporate flexible connections. Except in cases where these are fitted integral within air handing unit.

1.6.6.3.9 All resilient acoustic absorbing materials shall be non flammable vermin and rot proof and shall not tend to break up or compress sufficiently to transmit vibration or noise from the equipment to the structure.

1.6.6.3.10 where practicable silencer shall be built into walls and floor to prevent the flanking of noise the duct work system and their penetrations sealed in the manner previously described.
Where this is not feasible the exposed surface of the duct–work between the silencer and the wall subjected to noise infiltration shall be acoustically clad as specified.

1.6.7 Preamble of allied works and scope definition (common for all items)

1.6.7.1 Work Included:

Supply, Installation, Testing, Commissioning & Holding Performance responsibility, as per the duty conditions and capacity ratings of various equipment, its accessories (as described here-under and in the schedule of quantities).

1.6.7.2 Approved makes :As per approved list of makes in this section : O.E.M. ONLY (No locally integrated systems acceptable)

1.6.7.3 Related Work and Obligations:

1.6.7.3.1 The general requirements apply to work specified in this section.

1.6.7.3.2 Examine all the other sections of the specification for requirements, which may affect work of this section.

1.6.7.3.3 Co-ordinate works with all other trades affecting, or affected by activities of this section. Co-operate with such other trades to assure the steady progress of all operations under the contract.

1.6.7.4 Submittals for Review: Technical Data, General arrangement drawings, foundation drawings Performance tobe validated by curves with duty point marked (system duty point to be plotted). CFD analysis wherever asked for, location & quantity confirmation , GA /SLD, control sequence etc. and other requirements specifically askedfor in the relevant sections.

1.6.7.5 General Requirements:

1.6.7.5.1 This specification covers requirements for supply, erection, testing and commissioning and holdingresponsibility of performance as desired.

1.6.7.6 Codes And Standards:

1.6.7.6.1 As detailed in the relevant sections.

1.6.7.7 Quality Assurance

The Contractor shall ensure that all materials furnish and installed by him under the contract shall meet the requirements of relevant Indian standards / referred international standards.

1.6.7.8 Guarantee

Manufacturer shall provide guarantee for work under this section. However, such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturer and Contractor may have by other provisions of the contract document.

1.6.7.9 Delivery, Handling and Storage

All equipment and its components shall be carefully transported to site to avoid damage during transit. While on site the same shall be stored in a proper manner to prevent damage from moisture / rusting / mechanical damage.

All equipment and its accessories shall be inspected for the damage, quality and specifications.

SECTION-01: MECHANICAL EQUIPMENT & ACCESSORIES

CHAPTER-02: ELECTRIC CHILLER (SCREW-WATER COOLED)

ASHRAE 90.1 Minimum Energy Efficiency criterion applicable for all options asked for in the BOQ. The intent is to pre-qualify for ASHRAE 90.1), and have the best NPLV (at duty conditions) for optimized building energy performance.

Performance evaluation will be based on annual power consumption based on the energy

model developed for this project.And shall be done on reducing condenser water temperature.

Benchmarking and R.O.I. analysis IKW /TR at full load not more than 0.69 , COP : 5.4 as per ECBC norms,NPLV – not more than 0.4

TYPE	**WATER COOLED SCREW**
STANDARDS	ASHRAE std 15 ; AHRI-550/590-2003 ; AHRI-575-94
Capacity and duty	As per BOQ
Mandatory	Coefficient of performance, NPLV as indicated in BOQ
Type of starter	Closed transition, star delta starter
Submittals for Review	Technical data & AHRI computerized selection General arrangement drawings, nozzle arrangement Part load performance, IPLV, NPLV calculations
General	Factory assembled, run tested, water cooled screw chiller, comprising of single/multiple semi hermetic, single/twin rotor , screw compressors, suction gas cooled motors, unit mounted, weather proof closed transition, VFD / star delta starter, micro processor based chiller control panel interconnected piping and wiring, factory installed water flow switch, including first charge of gas and oil. The chiller shall be suitable for green refrigerant R134 a/ R-514 A All electrical, terminal box, exposed wiring etc to be weather proof. Vendor to submit computerized chiller selection with part load performance. The power ratings to include power required by both compressor and fan Vendor to include low ambient kit if indicated in BOQ.
Compressor	Shall be multiple/single stage, semi hermetic/Open,single/twin rotor. The housing shall be fully accessible so that major wearing parts, like main bearings and thrust bearings are accessible for maintenance or replacement. The compressor casting shall be hydrostatically pressure tested at 10 KG/cm2 for R 134 A. The rotor assembly shall consists of a cast aluminum fully shrouded impeller. The impeller shall be designed for balanced thrust, over speed tested and dynamically balanced for smooth, vibration free operation. The chiller shall be selected so that it is capable of stable operation with constant condenser entering water temperature upto 20% . The suction line shall be insulated with 19 mm thick closed cell insulation. Capacity control will be achieved by use of pre rotation vanes to provide fully modulating control from minimum to maximum load.
Compressor motor	The motor shall be squirrel cage induction, two pole, suction gas cooled motor. The compressor shall be direct driven. Motor shall be of continuous duty, and shall be protected by thermal sensors embedded in three phase, stator windings. The starter should also have external overload relay on all the three phases. Motor shall be suitable for 3 phase,415+/- 10% v,50 c/s A C supply. The maximum speed of the rotor shall be 2975 RPM. Capacity control shall be Step-less: 100% to 20% of full load.
Cabinet	Unit panels, structural elements, control boxes and heavy gauge structural base shall be fabricated of galvanised steel sheet and finished with baked powder coat paint and rendered corrosion and weather proof. All painted surface shall be subject to ASTM B 117 ,1000 hr,5% salt spray test and yield minimum ASTM 1654 rating 6.
Lubrication System	The compressor shall have an independent forced fed lubrication system using submersible positive displacement oil pump. The oil pump shall operate prior to start up, during compressor operation and during coast down. Compressor shall have an auxiliary reservoir to provide lubrication during coast down in the event of power failure. An electric heater should be provided in the sump to maintain oil at high temperature to minimize affinity of refrigerant .The oil cooler shall be water/refrigerant cooled and thermostatically controlled. Oil cooler should be

factory fitted with external oil filters, piping etc. Oil cooler shall be refrigerant/water cooled.

Condenser

Shall be of shell and tube, designed for 150 psig working pressure on the refrigerant side. Shell shall be rolled from carbon steel, with fusion welded seams. Tube sheets shall be of carbon steel, drilled and reamed to accommodate high efficiency, internally a externally enhanced, plain copper tubes. The tubes shall be individually replaceable. The refrigerant side will be designed and tested as per ASME or applicable pressure vessel code of country of origin. Water velocity shall not be more than 3.0 m/sec. Reseating type spring loaded pressure relief valve as per ASHRAE 15 safety code shall be included. However, The HVAC contractor shall verify the working head, considering static suction head of the building and select the DWP accordingly. Condenser shall be single / multi-pass, with water pressure drop not exceeding 6 m wg. ns to be provided onVent & drain connectio the end covers.The pipe connections will be either flanged/ Grooved coupling . If flanged, counter flanges will be provided. Codenser shell to be ASME / GB stamped.

Cooler/Evaporator

Shall be shell and tube, flooded type, designed for 150 psig working pressure on the refrigerant side. The shell shall be fabricated from rolled carbon steel plate with fusion welded seams. The tube sheets shall be of carbon steel, drilled and reamed to accommodate the tubes. Tubes shall be high efficiency, internally and externally enhanced type for better heat transfer. Each tube shall be roller expanded into tube sheets providing a leak proof seal and shall be individually replaceable. The refrigerant side shall be designed and tested in accordance with ASME/ applicable pressure code. Water tube velocity thro the tubes will not exceed 3 m/sec. Aluminum mesh eliminators shall be located above the tube bundle to prevent liquid refrigerant carry over to compressor. The evaporator will have a refrigerant reseating type spring loaded, pressure relief valve sized to meet the requirement of ASHRAE standard 15.Cooler shall be thermally insulated with minimum 32 mm, (mm+13mm19) closed cell, class O insulation to avoid condensation. Water connections will be either flanged/ Grooved coupling. If flanged, counter flanges will be provided. Water Pressure drop not to exceed 5 M wg. Evaporator shell to be ASME / GB stamped.

Micro processor control panel

The chiller shall be controlled by a stand alone micro processor based control panel. The front door shall have suitable provision for LCD backlit display, of all chiller operating data and alarms. The chiller control parameters will primarily monitor and control the operation of chiller. The operating program to be stored in a non volatile memory (EPROM) to eliminate re programming the chiller due to Power failure or battery discharge. Programmed set points shall be retained in lithium battery backed RTC memory for a minimum of 11 years with power retained from the system. The control panel shall have a real time clock to enable programming schedules based on day and time.

The chiller control shall provide following system operating data. There may be minor variations based on OEMs.

Entering and leaving chilled water temperature
Entering and leaving condenser water temperature
Evaporator and condenser saturation temperature
Differential oil pressure
Percent motot current
Evaporator and condenser saturation pressure
Operating hours
Number of compressor starts
Oil temperature
Other parameters

Digital programming of following set points through universal keypad

should be possible

Leaving chilled water temperature

Percent current limit

Pull down demand limiting

Weekly/monthly schedule of start/stop

Remote reset temperature range

Status message indicating feature

System ready to start

System running

System coast down

System cycling shut down-auto re start

The text displayed within system details and status shall be preferably color coded to indicate severity. Apart from above details, the chiller control panel should also provide information of all safety and cyclic shut down for analysis and required corrective action .All sensors and transducers shall be factory supplied, installed, piped and wired. The control panel shall have the facility to store the historical data of last 20/40 faults and shut down to plan corrective action.

The chiller micro panel shall be BMS compatible. It should be possible to interface the chiller panel onto a BMS system. Any interface card if required should be included.BMS compatibility should be on open protocol. A fused connection through a transformer in the compressor shall provide individual over current protection for all controls. The control panel shall be enclosed in a NEMA 1 enclosure and suitable for indoor duty

SECTION-01: EQUIPMENT AND ACCESSORIES (MECHANICAL PROCESS)

CHAPTER-03: VARIABLE REFRIGERANT VOLUME (VRV / VRF) SYSTEMS : INVERTER TYPE HEAT PUMPS

1.	Scope Responsibility of	:	Supply, Installation, Testing, Commissioning & Holding Performance the system as per duty conditions & capacity ratings
2.	Type	:	Inverter type VRV / VRF systems.
3.	Capacity & Duty Parameters	:	As per BOQ / Schedule of Quantities
4.	Mandatory Requirements	:	Refer detailed specification & BOQ
5.	Scope and	:	The scope of this section comprises the supply, erection testing commissioning of Variable Refrigerant Volume/ flow System conforming to these specifications and in accordance with the requirements of Drawing and Schedule of Quantities.
6.	Type of one /	:	Units shall be air cooled, variable refrigerant volume heat pump, consisting multiple outdoor unit and single / multiple indoor units all connected in single refrigerant Piping circuit. Each indoor units shall be capable to cool/heat independently as per the requirement of the rooms. The systems will operate either on cooling or heating duty. The indoor units on any circuit can be of different type and also controlled individually. Following type of indoor units (Depending upon the type specified in the drawings and the BOQ) shall be connected to the system: Ceiling mounted cassette type, Multi flow-standard Ceiling mounted cassette type, Multi flow-compact Ceiling mounted Low static, Duct type Ceiling mounted high static Duct type Ceiling suspended, exposed type High Wall mounted type Floor standing type Floor standing Duct type (Air Handling Units) Compressor installed in outdoor unit shall be equipped with all inverter type.. The system shall be capable of changing the speed of inverter compressor by inverter controller to follow variations in cooling/heating load. The VRV/VRF system shall be suitable for green refrigerant R-410a. Outdoor unit shall be suitable for mix match connection of all type of indoor units. The refrigerant piping between indoor units and outdoor unit shall be extended up to 150m with maximum 50m level difference between outdoor and indoor unit with oil traps. Outdoor unit shall be factory assembled, tested and outdoor unit shall be charged with first charge of refrigerant before delivering at site.
7.OUTDOOR UNIT		:	The outdoor unit shall be factory assembled, weather proof casing, constructed from heavy gauge galvanized steel panels and powder coated. The unit should be completely factory wired tested with all necessary controls.

All outdoor units shall have herrmetically sealed scroll/twin rotary compressors, DC inverter driven, and shall be able to operate even in case one of compressor is out of order.

Outdoor unit should also be provided with duty cycling and starting sequence changing facility for multiple inverter compressor and multiple outdoor units working in one system.

The outdoor unit shall be modular in design and should be allowed for side by side installation the unit shall be provided with its own microprocessor control panel with provision for integration with Building management system using BACNET/MODBUS-Protocol. The outdoor units should have anti-corrosion paint free steel plate for easy mounting of unit. The outdoor unit should be fitted with low noise, aero spiral design fan with grill for spiral discharge airflow to reduce pressure loss and should be fitted with DC fan motor to better efficiency. The unit should also be capable to deliver 55 Pa external static pressure to meet long exhaust duct connection requirement.

All outdoor units must be equipped with night time quite operation feature. The condensing unit shall be designed to operate safely when connected to multiple fan coil units.

The Noise level shall not be more than 65 dbA at anechoic chamber, measured horizontally 1m away and 1.5m above ground level.

The outdoor units shall be suitable for three phase, 415 V, 50c/s AC Supply. Each outdoor units shall be provided with suitable capacity MCB/MCCB in water proof enclosure. All power & control wiring between multiple outdoor unit connected to a single circuit with adequate rating MCB/MCCB shall be done by HVAC contractor.

8. Compressor of inverter : The compressor shall be highly efficient scroll / twin rotary type and capable control & capable of working on 415+/- 10% volts. It shall change the speed in accordance to the variation in cooling /heating load requirement: All outdoor units shall have multiple steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated stock. For oil recovery, every compressor shall have oil separator for stable operation. Forced lubrication may also be employed for better oil management. Oil heater shall be provided in the compressor casing

9. Heat Exchanger bonded to anti-corrosion : The heat exchanger shall be constructed with copper tubes mechanically aluminum fins to form a cross fin coil. The aluminum fins shall be covered by resin film. The unit should be with bye-pass heat exchanger type for good efficiency of condenser. The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical discharge. Each fan shall have a safety guard.

10. Refrigerant valves at : The refrigerant circuit shall include liquid & gas shut-off valves and a solenoid **c**ondenser end.All necessary safety devices shall be provided to ensure the safely operation of the system.

11. Safety Devices : All necessary safety devices shall be provided to ensure safe operation of the system.

Following safety devices shall be part of outdoor unit; high pressure switch, fuse, fan drive overload protector, fusible plug, over load relay, overload protection for inverter Anti-corrosion treatment

Outdoor units should be designed with anti-corrosion specifications as detailed below for use in area, which are subject to salt damage and atmospheric pollution

The portions of machines like side panel, outer panel, bottom frame, which are exposed to corrosive atmosphere, should be of alloyed hot-dip zinc coated steel plate, coated with corrosion protection powder polyester resin coating on both inner and outer surfaces in thickness of 64micron or more.

Finned coil protection net should have coating of resin coating containing ultraviolet ray absorbent. Fan and its fan protective net should be with weather resistant polypropylene resin.

The copper pipe–aluminum fin shall be with special acrylic resin coated. And internal supports, frame, control box shall also be hot-dip zinc coated steel plate and with rust preventive powder coating of 64mcron or more on inner and outer surfaces.

All screws, bolt used in outdoor unit shall be with SUS410, Zinc-nickel alloy plating, zinc chrome acid film treatment and rust inhibitor coating.

When running power and control wires parallel to each other, either run them in separate conduits or maintain a suitable distance between them.

All control wiring shall be two core, shielded wire (outdoor to outdoor, indoor to indoor, outdoor to indoor) to prevent noise.

12. Oil Recovery System : Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigeration piping lengths.

13. INDOOR UNIT : This section deals with supply, installation, testing, commissioning of various type of indoor units confirming to general specification and suitable for the duty selected. The type, capacity and size of indoor units shall be as specified in detailed Bill of Quantities.

While all indoor units shall be suitable for single phase, 220 V,50 c/s AC supply, or as mentioned in BOQ, all outdoor units shall be suitable for three phase, 415 V, 50 c/s Ac supply.

Indoor units shall be either ceiling mounted cassette type, or ceiling mounted ductable type or floor standing type or wall mounted type or other as specified in BOQ. Each unit shall have electronic expansion valve to control refrigerant flow rate respond to load variations of the room. The address of the indoor unit shall be set automatically in case of individual and group control. In case of centralized control, it shall be set by liquid crystal remote controller. The fan shall be dual suction, aerodynamically designed turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having supported from housing. The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/mechanically expanded for minimum thermal contact resistance with fins. Each coils shall be factory tested at 21kg/sqm air pressure under water. Unit shall have cleanable type filter fixed to an integrally moulded plastic frame. The filter shall be slide away type and neatly inserted. Each indoor unit shall have computerized PID control for maintaining design room temperature. Each unit shall be provided with microprocessor thermostat for cooling or cooling and heating. Each unit shall be cable of being controlled by wired/LCD type remote controller. The remote controller shall memorize the latest malfunction code for easy maintenance

The controller shall have self-diagnostic features for easy and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flap individually as per requirement.

13.1 Ceiling Mounted : The unit shall be ceiling mounted type. The unit shall include pre-filter, fan section. The Cassette Type housing of the unit shall be powder coated galvanized steel. The body shall be light in Unit weight shall be ableto suspend from four corners. The fan shall be aerodynamically (MULTI FLOW TYPE) designed diffuser turbo fan type. Unit shall have an external attractive panel for supply and return air. Unit shall have four-way supply air grilles on sides and return air grille in center.Each unit shall have high lift drain pump, fresh air intake provision (if specified). Low gas detection system and very low operating sound. All the indoor units regardless of their difference in capacity should have same decorative panel

size for harmonious aesthetic point of view. It should have provision of connecting branch ducts.

13.2 Ceiling Mounted Ductable Type Unit : Unit shall be suitable for ceiling mounted type. The unit shall include pre-filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.
The unit shall have high static fan for Ductable arrangement.

13.3 Ceiling Suspended Unit : Unit shall be suitable for ceiling suspended arrangement below false ceiling. The unit include pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

13.4 High Wall Mounted unit : The units shall be wall-mounted type. The unit includes pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.Unit shall have an attractive external casing for supply and return air.

13.5 Floor Standing Type : Unit shall be suitable for floor standing arrangement. The unit include pre filter, section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

14. Centralized Type system.The (Touch Screen type give complete control of VRV air-conditioning Equipment, It should have ease of use for Controller (Option the user through its T touch screen, icon display and color LCD display. It shall be able to control up to 64 groups of indoor units with the following functions :-

a) Starting/stopping of Air conditoners as a zone or group or individual unit.
b) Temperature settling for each indoor unit or zone.
c) Switching between temperature control modes, switching of fan speed and direction of airflow, enabling/disabling of individual remote controller operation.
d) Monitoring of operation status such as operation mode & temperature setting of individual indoor units, maintenance information, trouble shooting information.
e) Display of air conditioner operation history.
i. Daily management automation through yearly schedule function with possibility of various schedules.
ii. The controller shall have wide screen user friendly color LCD display and can be wired by a non polar 2 wire transmission cable to a distance of 1 km. away from indoor unit. The Control cable shall be as per OEM standard, but shall have minimum two core, 1.5 sq mm.

15. Refrigerant Piping: All refrigerant piping for the air conditioning system shall be constructed from soft seamless up to 19.1mm and hard drawn copper refrigerant pipes for above 19.1 mmwith copper fittings and copper-soldered for copper joints & silver-soldered for copper to other material joints. The refrigerant piping arrangements shall be in accordance with good practice within the air-conditioning industry, and are to include charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits. Refrigerant pipe fitting while include Y/Refnet joints and headers as per OEM design for correct distribution of refrigerant.

All joints in copper piping shall be sweat joints using low temperature brazing and or silver solder. Before jointing any copper pipe or fittings, its interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints.Subsequently, it shall be thoroughly blown out using nitrogen.

After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of PSI for 350 High side & 150PSI forlow side. Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum if 700mm hg and held for 24 hours.

The air-conditioning system supplier shall design pipe sizes and erect proper interconnections of the complete refrigerant circuit.

The thickness of copper piping shall not be less than mentioned below:

Pipe Size in mm (OD)	Wall Thickness in mm
54.1	1.5
41.3	1.3
34.9	1.3
28.6	1.2
25.4	1.2
22.2	1.0
19.1	1.0
15.9	1.0
12.7	0.8
9.5	0.8
6.4	0.8

The suction line pipe size and the liquid line pipe size shall be selected according to the manufacturers specified outside diameter. All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets and supports which shall be fixed to the building structure by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.

16. PIPE INSULATION

16.1 Refrigerant Pipe strainer : Entire liquid and suction refrigerant lines including all fittings, valves and bodies, etc. shall be insulated with 19mm /13 mm thick elastomeric, class O, nitrile rubber as specified in BOQ. For outdoor duty, if exposed to sun, to protect from degradation from UV rays, the insulation shall be covered with 7 miles thick glass cloth & two coats of UV coating of approved shade & colour.

16.2 Drain Pipe Elastomeric : Drain pipes carrying condensate water shall be insulated with 6 mm thick insulation nitrile. For proper drainage of condensate, U Trap shall be provided in the

		drain piping (wherever required). All pipe supports shall be of pre fabricated & pre painted slotted angle supports, properly installed with clamps etc.
17.	Aqua Shower for Outdoor unit (if indicated in BOQ) :	Unit shall be equipped with Solenoid valve, strainer and pressure reducing valve. It Should Be compatible with High Water pressure. It should have constant water pressure adjusting for control of VRV system and optimum spraying control.It should realize optimum spraying time and water volume base on the pressure on the pressure on the high pressure side of the outdoor unit. It should be automatically controlled by the micro-computer, having spray temperature ranging from 30C -50C. Operating range for water pressure should be 0.12- 0.7 MPa. It should reduce the power consumption by reducing the workload of compressor by reducing condensation pressure. It should not require any extra installation space to prevent short circuits.
18.	Selection large variance Guidelines :	Selection and design guidelines are laid out in the appended sheets. Due to In the product specifications (CFM/TR, diversity , Outdoor unit sizing etc.) amongst various manufacturers,vendor is advised to refer the equipment selection sheet, and the notes therein.

CHAPTER- 04 : RE-CIRCULATORY PUMPS : WATER DUTY:FIXED SPEED CONDENSER WATER PUMP AND PRIMARY

CHILLED WATER PUMP

1.	Scope Responsibility of the	:	Supply, Installation, Testing, Commissioning & Holding Performance system.
2.	Acceptable Manufactures	:	As per Approved list of makes.
3.	Submittals for Review	:	As per Approved list of makes. Technical Data. General Arrangement Drawings Performance curves with duty point marked
4.	Standards	:	ISO 2858, DIN 24255,IS 1520 ; EN773. IS 325, IS 12615
5.	Capacity and duty Parameters	:	As per BOQ, Schedule of quantities
6.	Mandatory Requirements	:	Pump efficiency shall not be less than 75%. Motor shall be energy efficient IE-2 HVAC contractor to ensure that casing design pressure is adequate considering static suction and working head. Shall be as per Hydraulic institute standard
7,	Type		
7.1	**Vertical inline pumps**		
7.1.1	General which	:	Shall be single stage, single or double suction type, with pump characteristics Provide rising heads to shut off. Provide long coupled type VIL units, with rigid spacer type coupling.
7.1.2	Casing Ductile Iron with	:	Cast Iron with PN10 flanges for working pressure 16 bar (232 PSI) and PN25 flanges for working pressures to 25 bar (375 PSI). Suction and discharge connections shall be flanged and the same size and shall be drilled and tapped for seal flush and gauge connections.
7.1.3	Impeller required impeller width.	:	Bronze, fully enclosed type. Dynamically balanced. Two-plane balancing is where installed impeller diameter is less than 6 times the
7.1.4	Shaft	:	Provide Stainless Steel pump shaft.
7.1.5	Coupling designed to be	:	Rigid spacer type of high tensile aluminum alloy. Coupling to be easilyremoved on site to reveal a space between the pump and motor shafts sufficient to remove all mechanical seal components for servicing and to be replaced without disturbing the pump or motor.
7.1.6	Shaft seal secondary seal	:	Shall be Stainless Steel multi-spring outside balanced type with Viton carbon rotating face and silicon carbide stationary seat. Provide 316 stainless steel gland plates. Provide factory installed flush line with manual vent. All split coupled pumps shall be provided with a lower seal chamber

throttle bushing to ensure seals maintain positively cooling and lubrication Seal flush line accessories, if required to improve seal chamber cleanliness: Supply in the flush line to the mechanical seal a 50 micron cartridge filter and sight flow indicator, to suit the working pressure encountered. If Pressures exceed 21m/70ft/30 psig/200kPa, a maintenance-free sediment separator, with sight flow indicator can be used.

7.1.7 Installation : The pump with motor shall be installed on a rigid concrete foundation.
The pump base frame should be grouted on the foundation with bolts.
The foundation should be isolated from floor slab with vibration isolation ribbed rubber pads in multiple layers with GI sheet in between. Pump motor alignment should be done using dial indicator.

All pumps shall be installed with the following ancillary items of equipment.

a. Inlet and outlet butterfly isolating valves
b. Inlet and outlet pressure gauges and thermometers
c. Drain cocks
d. Inlet and outlet flexible connections
e. Inlet and outlet pressure test points
f. Pressure differential sensor tappings on inlet and outlet connections
g. Inlet strainer or suction diffuser
h. Outlet triple duty valve or combination of Circuit Balancing Valve, check valve and isolating valve.

BMS INTERFACES

1. All electrical connections shall be fully drip proof and fully earthed to a dedicated earth connection point. The BMS and electrical interfaces shall provide the following information.
   a. Motor run hours
   b. Discharge Pressure
   c. Pump Speed
   d. Pump Status – ON/OFF/AUTO/Trip
2. All the foregoing equipment shall be contained with an IP55 casing 1000m above the plant room floor.

SECTION-01 : EQUIPMENT & ACCESSORIES (MECHANICAL PROCESS) (RE-CIRCULATORY PUMPS : WATER DUTY)

CHAPTER-05: VARIABLE SPEED PUMPING SYSTEM –SECONDARY CHILLED WATER PUMPING SYSTEM

1.	Scope Responsibility of	:	Supply, Installation, Testing, Commissioning & Holding Performance the system. The variable pumping system shall be complete with pump, motor, VFDs for each pump, microprocessor based programmable logic controller, pressure transmitters/ sensors & multi core shielded cable in hard MS conduit between DPT and Controller or sensorless pump operation.
2.	Acceptable Manufactures	:	As per Approved list of makes.
3.	Submittals for Review	:	Technical Data & sequence of operation General Arrangement Drawings, Performance curves with duty point marked
4.	Capacity and duty Parameters	:	As per BOQ, Schedule of quantities
5.	Standards	:	ISO 2858, EN 773, Hydraulic Institute, IS 325,IS 12615
6.	Mandatory Requirements	:	Pump efficiency shall not be less than 80%. Motor shall be energy efficient IE-2 HVAC contractor to ensure that casing design pressure is adequate considering static suction and working head. Shall be as per hydraulic institute standard.
7.	General mounted VFDs	:	The variable pumping system shall be complete with pump, motor, motor for each pump, microprocessor based programmable logic controller, pressure sensorless controls & multi core shielded cable in hard MS conduit between DPT and controller or sensorless pump operation..
7.1	Type inline Split	:	**Single stage, centrifugal,** volute casing, Bronze impeller fitted, Vertical coupled, Long coupled type. Pumps shall have stable head vs flow characteristics. It should be a rising curve. Shut off head shall not be less than10 to 12% of operating head. Volute shall have gauge tapping at the suction and discharge nozzles. Pump should be selected for best efficiency and not at end of curve. Pump should be supplied with 4 pole motor. Pumps working in parallel, should be identical & motor should be rated for Non overloading through out its capacity range.
7.2	Casing	:	Shall be of close grain cast iron. The design casing pressure shall be 12-20 kg/cmSq or as noted in BOQ. The casing shall be hydro-tested at works. at 1.5 times the casing design pressure. The casing shall be complete with case wear ring. The suction and discharge connections shall be flanged Type. Flanges to be drilled to ANSI rating of either class 125 or 150 as per pump casing design pressure.
7.3	Impeller horizontal split	:	Impeller shall be radial flow,closed type single suction for end suction. For

Case it will be double suction. The impeller shall be of cast BRONZE. Entire rotating assembly including impeller and coupling should be dynamically balanced as per ISO 1940 /ANSI/HI 1.1-1.5 grade G 6.3 balance quality.

7.4 Shaft : Shaft shall be of high tensile steel accurately machined, supported by anti friction grease

Sleeve lubricated bearings. Shaft shall be protected by replaceable stainless steel / bronze sleeve.

7.5 Shaft seal : Shall be Stainless Steel multi-spring outside balanced type with Viton secondary seal,

carbon rotating face and silicon carbide stationary seat. Provide 316 stainless steel gland plates. Provide factory installed flush line with manual vent.

7.6 Coupling : Pump/Motor coupling shall be flexible type. For End suction pumps it should also be spacer

type. The coupling shall be complete with coupling guard.

7.7 Common base : Shall be rigid, heavy M S factory fabricated, duly painted after two coats of primer. Frame

Base frame shall be factory supplied.

7.8 Accessories : Pumps shall be fitted with air vent valve, grease lubricators, drain plugs and water seal

connection. The pump motor & base frame shall be finish painted after

primer coat. Painted

after primer coat. Shop coating of paint that have become marred during shipment or erection should be repainted after wire brushing, spot priming of the affected areas.

7.9 Motor : TEFC, Squirrel cage induction,S1 Continuous duty class F insulation, temperature limited to

class B, Energy efficient IE-2 (as per IS 12615), foot mounted B3 construction, design ambient 50 deg C, Degree of protection IP55. Motor should be suitable to work with variable speed drive. Motor shall be 4 pole, suitable for working on 3ph, 415+10%v, 50+3% AC supply. Motor rating shall be at least 125% of rated BKW. The pumps shall be factory manufactured, assembled and hydrostatically tested as per Hydraulic institute /ISO 9906

8. Variable : Shall be of variable frequency, variable voltage type suitable for variable torque frequency drive pumping application. The VFD shall be of sensor-less vector control pulse width

modulation type, microprocessor based design. The VFD shall convert incoming three phase AC power into a variable frequency and voltage for controlling speed of motor.

10. Approvals : The VFD should have UL, CUL and C-Tick approvals. The VFD shall be tested as per UL 508C and listed for 100 KA. It shall confirm to European Union Electro magnetic compatibility directive .

11. RFI/EMI filters : The VFD shall comply to EMC directive IEC 61800-3/2004 C2, on both conducted and radiated emission. Necessary Harmonic filters, like in built non saturating type DC link harmonic filter on both DC rails/DC reactors which matches the correct inductance with load, so that it suppress and reduces effect of harmonics on the power line and add protection from AC transients. The drive shall be housed in an IP 55 enclosure suitable for indoor / outdoor use.

The drive should be suitable for continuous operation at 40 C,95% humidity non condensing, rated at 100 M altitude.

The drive should be suitable for three phase, 415V, 50 HZ AC supply, with a voltage range of380-480 volts. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute. The VFD shall have a

soft start capability, so that starting current is never more than full load amps. Also the drive shall be starting into a coasting load forward or reverse upto full speed and de accelerate to safety tripping or component damage.

The VFD shall be capable of running the system at programmed lower speed at a lower frequency in case of a phase loss. It should also be capable of sensing a loss of load(broken belt/coupling) and provide signal for the same. The drive shall have 0.98 displacement power factor, and full load efficiency of minimum 96%.

12. Pump logic signals to : PID controllers shall be provided in the drive, allowing pressure or flow be connected to VFD for a close loop control. The VFD shall have 250mA/24v DC auxiliary power and capable of powering a transmitter supplied by others. Active harmonic distortion shall be as per manufacturer's standards

The PID set point shall be adjustable from VFD keypad, analog input or communication bus. There shall be real time clock having battery back up with minimum 10 years life span. The clock shall be programmable for various actions which can be pre decided with time function.

VFD should have following minimum built in protections -over voltage, under voltage, VFD over temperature, Earth fault, Over current, short circuit, motor stall thermistor fail etc. The following user adjustable parameters shall be provided in the VFD acceleration time, deceleration time, minimum frequency, maximum frequency.

The VFD shall be complete with hot plug able local control panel with alpha numeric/graphic display of frequency, voltage, current, KWHr, running hours, active power, RPM, mode etc

Standard EIA 485(RS 485) communication port and compatibility with BMS over METASYS N2/MODBUS RTU protocols is required.THD should be less then 5%.

12.1 Dedicated Pump Logic Controller will be marked as : DPLC has been approved by major international bodies like U/L and CE as minimum.

12.2 Analog Input time and keep on processing compared to the set point, which will be fed by the user, in DPLC. : DPLC will continuously scan the incoming signal from DPT`s all the processing the output. Output will be the most deviated one

12.3 Two Additional Analog Inputs : DPLC should have provision for two additional analog inputs for:

a Taking input signal from Flow sensor (if provided by BMS contractor). This will help the system to protect the pumps against End Of Curve condition.

b. Taking the input from any external sensor (e.g. return temperature sensor, supply temperature sensor, ambient temperature sensor etc). This input can be used to influence the system externally. DPLC should have provision to influence the main signal upto 8 steps.

12.4 Set Point should have a : DPLC can be set for separate "set points" as per real time clock. DPLC min of 7 alternate set points to be activated by external digital inputs.

If a lower differential pressure is acceptable during certain periods, for instance after normal working hours or weekends, the set point can be lowered to minimize power consumption.

DPLC should have night set back facility to enable the system to run at lower set point during night time.
DPLC should use digital inputs to switch between set points automatically at any point of time.

12.5 Automatic cascade control of pump : DPLC will start other pumps, which are available for operation, whenever system is not able to meet the demand for chilled water. Once demand is met then all the pumps will cut out with changeover, except for one pump. At least one pump will run at minimum 25% speed if DP value is satisfied.

12.6 Automatic Sequence Change : DPLC will have automatic changeover facility based on:

a. Fault – When any pump/motor/VFD/starter fails.
b. Operation – While running/cascading.
c. Time – As per the time set in the DPLC (daily or weekly).

To ensure equal number of hours run by each pump and to control the number of starts (to avoid hunting) on each pump, the system will alternate the sequence of the pumps used each time the system starts.
Additionally, should the demand not allow the pump set to completely shut down over a 24 hour period; the DPLC will stop the pumps that are running and start the pump/pumps with the lowest number of operating hours.

12.7 Auto Testing : DPLC will start the pumps, which have not been cut-in because of lower load, for 2 seconds each day, to ensure that all the rotating elements do not bind. DPLC should have an option to set the same on 24 hrs / 48 hrs / weekly basis.

12.8 Friction Loss Compensation : It is possible to allow for the friction loss component of the system, calculated at full flow and set as a percentage of the set point. A linear approximation of system resistance curve is therefore allowed for, and differential pressure must automatically increase as system flow and subsequent frictional losses increase. As such power consumption will get reduced because of this.

12,9 Displays : Through the monitor keypad, all variable parameters are adjustable, current status of settings and measured values to be displayed on the minimum 320 pixels X 240 pixels VGA display with backlight
Individual menus are available for monitoring individual pumps, settings, alarms and ON/OFF functions.

12.10 Pump Status : Running Hours of each pump
Actual pump status, (running, not available, standby, fault)

12.11 Zone Status : This menu is the main operating menu where all the setting and operating parameters can be viewed e.g.

i. Current operating set point
ii. Measured values in the system
iii. Operating capacity in terms of total output
iv. Mode of operation for the zone
v. Clock programs (relating to set point differential pressure value)
vi. Standby pumps (if any)
vii. Pump change over time
viii. Friction loss compensation

ix. System response times

12.12 Setting Menu : In this menu all parameters for the operation of the pump set can be adjusted as required

* Set points (up to 7)
* On/Off function (used to prevent unnecessary cycling at low demands)
* Displayed differential pressure units (Meter, Bar, PSI, mBar, kPa)
* Real time clock programming for any time of the day, week, or weekend)
* Friction loss compensation

12.13 Alarm : The alarm menu to display all faults / warnings that occur during operation, logging the time and date of when the fault occurred and when it was corrected, or whether it is still an actual fault, and up to 24 faults to be maintained as history in the controller.

Examples of faults
* Mains failure
* VFD fault
* Analogue input (differential pressure transducer) fault
* High discharge pressure fault
* Low discharge pressure fault
* Motor thermal overload fault

1.13 Communication features : Communication protocol MODBUS/bacnet will be provided to display the system values in BMS such as an option:

a. VFD speed.
b. DP value(s).
c. Current drawn by each pump.
d. Power consumed by each pump.

BMS contractor will bring his RS – 485 (MODBUS/BACNET) link directly to this DPLC communication port. Port and register addresses of the various data shall be provided. A potential free contact for remote start/stop shall be provided.

The following minimum safe guard against hydraulic conditions shall be included-

Pump flow surges, system hunting and End of curve protection

Pump controllers shall be capable of receiving multiple analog input signals from zone differential pressure transmitters as per system requirement. Pump controller shall select the analog signal that has deviated most from its set point. The selected signal will then be used as the process input value for hydraulic stabilization function. Controller shall be capable of controlling four or more pumps as per BOQ. Pump controller shall be capable of sensorless control / control through DPT.

13. Sensor / transmitter **:** Pump controller shall be capable of accepting an additional input signal from a flow sensor for end of curve protection. The controller shall have program function to accept the pump curve data for optimizing the system performance in terms of energy consumption.

Hydraulic stabilization program shall utilize a proportional integral control function. Controller shall be self prompting and all alarm messages shall be

displayed in plain English. The operator interface shall have multi fault recall memory of at least last 10 faults, alarm indications and soft touch membrane key pad switches.

The display screen should display actual pump status including current status of settings and measured values. The following communication features shall be provided on the BMS-Remote start/stop of the BMS thro potential free contact, Individual pump start /stop/trip status.

The following communication features shall be provided to BMS via RS 485 port utilizing MODBUS protocol- individual analog input, individual pump/VFD on/off status, system percent reference, system start/stop command/system operating mode/individual pump KW/ operating hours/individual pump running speed.

Differential pressure transmitter shall be field mounted and shall transmit an isolated 4-20 Ma DC signal indicative of process variable to the pump logic controller. DPT shall have stainless steel wetted parts with required process connection. It shall be protected against protected against radio frequency interference and shall have water tight NEMA 4 enclosure capable of withstanding 14 bar static pressure. Accuracy shall be within 0.25% of full span

14 Sequence of Operation dump/AFD set, one : The system shall consist of a pump logic controller, one duty

standby pump with duty-standby with manual and automatic alteration and pump staging (whenever applicable).

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 is in the LOCAL position and start command is given via operator interface the pumping system shall operate automatically.

Sensors / transmitters shall be provided as indicated on the plans.

Each sensor/transmitter shall send a 4-20 mA signal to the pump logic controller, indicative of process variable condition.

The 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 pump logic controller shall continuously scan and compare each process variable to its individual set point and control to the least satisfied zone.

Of the set points cannot be satisfied by the designed lead pump, the pump logic controller shall initiate a timed sequence of operation to stage a lag pump (whenever applicable).

The lag pump shall accelerate resulting in the lead pump(s) decelerating until they equalize in speed.

In the event of a AFD fault, the pump logic controller automatically initiates a time sequence of events to start the retardant pump / AFD set in the variable speed mode. The retardant variable speed system shall be started through a pump logic controller.

Upon AFD fault(s) the pump controller shall display an alarm condition through a plain English massage.

AFD fault indication shall be continuously displayed on the operator interface of the pump until the fault has been corrected and the controller has been manually reset.

In the event of the failure of a zone sensor/transmitter, its process variable signal shall be removed from the scan/ compare programme .Alternate zone sensor / transmitters if available shall remain in the scan /compare programme for control.

Upon sensor failure a plain English warning message shall be displayed on the operator interface of the pump logic controller.

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, a user selectable number of AFD's shall maintain a user adjustable speed, reset shall be automatic upon correction of the zone failure.

15. Technical Information : Tenders shall include the following and shall be specific to this project. With tender

System summary sheet.
Sequence of operation.
Shop drawings indicating dimensions, required clearances and location and size of each field connection.
Power and control wiring diagrams.
System profile analysis including variable speed pump curves and system curve. The analysis shall also include pump, motor and Adjustable Frequency Drive (AFD) efficiencies, job specific load profile, staging points, horse power and kilowatt/hour consumption.
Pump data sheets.

16. Quality Assurance : The pumping package shall be assembled by the pump manufacturer. An assembler of

pumping systems not actively engaged in the design and construction of centrifugal pumps shall not be considered a pump manufacturer. The manufacturer shall assume "Unit Responsibility" for the complete pumping package. Unit responsibility shall be defined as responsibility for interface and successful operation of all system components supplied by the pumping system manufacturer.

All functions of the variable speed pump control system shall be tested at the factory prior to delivery. This test shall be conducted with motors connected to AFD output and it shall test all inputs, outputs and programme execution specific to this application.

Tenderer shall comply with all sections of this specification relating to packaged pumping systems. Any deviations from these specifications shall be clearly defined in writing at time of bid. If no exceptions are taken at time of bid, the supplier shall be bound by these specifications.

SECTION 01 : EQUIPMENT & ACCESSORIES (MECHANICAL PROCESS)

CHAPTER-06 : COOLING TOWER (CTI APPROVED)

1.	Scope	:	Supply, Installation, Testing, Commissioning & Holding Performance Responsibility of the system.
2.	Acceptable Manufacturers	:	As per Approved list of makes .
3.	Submittals for Review	:	Technical Data. General Arrangement Drawings Foundation Drawing Performance rating & Heat Balance calculation.
4.	Capacity & duty Parameters	:	As per BOQ, Schedule of quantities
5.	STANDARD	:	CTI Approved , as per CTI STD-201(11)
6.	Mandatory Requirements multiple fans to be provided.	:	TEAO Fan motor shall be energy efficient IE-2 Axial flow fans shall be Energy efficient with low RPM and noise.
7.	Type	:	Vertical, counter flow/cross flow Induced/Forced draft tower manufactured from Fibre glass reinforced plastic with cold water basin suitable for OUTDOOR installation.
7.1	Casing Panels	:	Casing panels shall be made out of FRP, with smooth internal finish, adequately reinforced to withstand high wind velocity. The FRP panels should be self extinguishing and should not propagate fire.
7.2	Cold water basin	:	Cold water basin shall be deep FRP sump with suitably sized baffle at outlet to prevent vortex. For large towers, a non-cavitating water sump to be provided complete with suction strainer screen. The basin shall be complete with water outlet connections for Inlet, Outlet, make up, drain, overflow and drain. The pipe nozzles shall be of galvanized pipes with flanges.
7.3	Hot water ensure	:	Gravity flow, comprising of PVC headers, branches and nozzles to uniform water distribution distribution at the top of the fill to achieve proper wetting of entire fill surface.
7.4	Fills	:	High efficiency, UV stabilized, Self Extinguishing type, rigid FILM PVC fills, cross fluted design, corrosion proof, arranged in square/rectangular/ honeycomb form to provide excellent heat transfer with very low resistance to air flow. The fill spacing should be such that fouling with water scale is minimum. The fills should be able to withstand maximum continuous flow at 48 deg C. The fill pack should be located above air inlet so that the same can be replaced.
7.5	Drift eliminator	:	To reduce water droplet carry over, multipass PVC drift eliminators should also

be provided. These eliminators should also be UV stabilized and of Self extinguishing quality.

7.6 Hardware : While all hard ware in contact with water shall be of stainless steel, all other supporting structure shall be hot dip galvanized.

7.7 Fan : Fan shall be of propeller type with multiple aerofoil blades. The blades shall have variable pitch and shall be of Cast aluminum alloy. The fan shall be statically balanced. The fan shall be direct driven. The fan selected shall be of low 475/600/720 RPM (based on manufacturer's standards) and low noise, as specified in the BOQ

The fan motor assembly shall be adequately supported on a rugged steel base providing a vibration free support..

A galvanized wire guard with FRP cowl shall be provided on the discharge of fan. While for induced draft tower, the fan will be located on top, for forced draft tower, the fans shall be located at air entry blowing air thro the fill pack. Fan tip speed should not be more than 4500MPM.

7.8 Fan Motor : The motor shall have CE marking. Design ambient shall be 50 degC.. Motor shall be TEAO IE3 type. Motor to be suitable for 3 PH,415+10%V,50+5 HZ AC supply Motor to be suitable for operating with variable speed drive.

Each motor to be provided with electrical power isolator near the tower.

7.9 Air inlet : For counter flow induced draft tower- Galvanized wire guard all around. For Crossflow induced draft -air inlet louvers on two sides.

7.10 Ladder : **Hot dip galvanizing iron** ladder for accessibility of fan and motor.

8. Manufacturers : Factory test certificate required on confirmation of all rated and duty parameters.
test certificate Trailing is the format on which the technical submittal shall be made

9. Installation : The cooling tower should be located as per approved drawing. There should be free space around cooling tower for air entry and maintenance access.

10. Testing at site : Capacity of cooling tower shall be computed from the measurement of water flow, incoming and outgoing water temperature. The approach can be checked measuring the ambient WBT.

11. Measurement at : cooling tower performance will be tested at side and reported in the following formats :-
Site

Hot Water temperature (T-1)	**Deg C**	**Deg F**	Other parameters to be established:
Cold Water temperature (T-2)	**Deg C**	**Deg F**	Air flow calculations
Wet Bulb temp.	**Deg C**	**Deg F**	
Range of cooling tower design	**Deg C**	**Deg F**	Approach
Approach	**Deg C**	**Deg F**	
Diameter of fan	**Mm**		Range
Diameter of fan hood	**Mm**		
Avg air velocity at exit	**m/sec**		Drift losses

Density of water	**Kg/CuM**		Evaporation loss
Density of air	**Kg/CuM**		
Specific heat capacity of water	**kJ/kgK**		
Air mass flow rate of fan	**Kg/Hr**		
Water mass flow rate	**Kg/Hr**		
Ratio of water mass flow rate to air mass flow rate	**Absolute value**		
Enthalpy pick up of water	**kCal / kG of dry air**		
Heat Balance equation	**To be established by manufacturer.**	**(Air side and water side)**	

SECTION-01: EQUIPMENT AND ACCESSORIES (MECHANICAL PROCESS)

CHAPTER-07: AIR HANDLING AND TEMPERING UNITS.

1. Scope : Supply, Installation, Testing, Commissioning & Holding Performance Responsibility of the system.

2. Acceptable Manufactures : As per approved list of makes

3. Submittals for Review : Technical data
General arrangement drawing

4. Capacity and Duty parameters : As per BOQ / Schedule of quantities

5. Mandatory Requirements : Fan efficiency shall not be less than 70 %.
Motor shall be energy efficient , IE-2
Noise level at 1.0m distance less than 70 db(A)
Factory test certificates for casing, thermal break, leakage, coil performance
Ports with suitable arrangement to measure pressure drop across Micro vee & HEPA filters.
The cooling & Heating coils shall be AHRI certified.
The AHU should confirm to EN 1886 for thermal & mechanical strength of the casing.
The AHU fan should be AMCA certified.

6. Type : Shall be Floor / ceiling Mounted (Horizontal or Vertical Type)
Double tier /Single Tier, Double skin, Draw through over pre filter, coil & fine filter (combination filter frame)

7. Housing and The casing semi knocked down : The housing & casing of air handling unit shall be of double skin construction. unit shall be so made that it can be delivered at site in total/

conditions depending upon the requirements. The main framework shall be of extruded aluminum hollow structural sections & with thermal break profile

All the framework shall be assembled using mechanical joints to make a sturdy & strong framework for various sections.

Double skin panels shall be 25mm thick made of 0.8 mm pre-laminated & pre-painted with PVC guard GSS sheet on outside & 0.8mm GSS sheet inside with PUF insulation of density not less than 40 Kg/CuM injected in between by injection moulding machine. These panels shall be bolted from inside/ screwed from outside on to the framework with soft rubber gasket in between to make the joints airtight. The gaskets shall be inserted within the groove in extruded aluminum profile of the framework. The corners of the panels shall be coved. Suitable access doors to be provided with nylon handles, aluminum die-cast powder coated hinges & latches to be provided for access to various panels for maintenance purpose. The entire housing shall be mounted on galvanized steel channel framework made of GI sheet "GI sheet not less than 2mm" for AHU capacity less than 10000 CFM. For capacity higher than 10000 CFM the thickness of GI sheet shall be 3mm.

8. Panel Thickness And profile Outdoor

Application : 43 mm with thermal break and mixing box.

Indoor application ducted return : 25 mm with thermal break profile (with mixing box).

Outdoor TFA : 43 mm with thermal break **(Outdoor air treatment unit OR OATU).**

Outer Skin : 0.80 mm pre-painted / pre-coated GSS.
Inner skin : 0.80 mm plain GSS.
Density of PUF : 40 Kg/m^3
Joint/Corners : Pressure die cast aluminum/Engineering plastics
Base skid, Entire unit shall be supported on a rolled form GSS channel.
Screws -electroplated self tapping steel screws protected by PVC caps
Captive rubber gaskets within groove of extrusion between panel and frame.
Access doors required in mixing box/fan/filter sections for maintenance
Hinges -Die cast Aluminum, powder coated, Nylon handles

8. Casing leakage 0.8 test : As per DW 143 Class B (AHU casing shall not have air leakage more than liters/sec/m2 of surface area at 1000 Pa

9. Condensate drain closed cell pan : 20 G SS of adequate size and slope thermally insulated with 13 mm elastomeric Class O insulation.
For stack coils, provide intermediate SS drain tray with drip pipe.

10. Fan Type : Double inlet double width, Backward /Forward curved, centrifugal, non overloading Fan

outlet velocity 550 MPM Max. Casing/scroll -galvanized steel sheet of thickness not less than 1.6mm, 200 gsm, skin passed, zero spangled, chromated.Impeller shall be of Mild steel, Shaft shall be of carbon steel, extended on both sides, with anti corrosion varnish, Statically and dynamically balanced to ISO 1940. Fan impeller shall be mounted on a solid steel shaft statically and dynamically balanced. Shaft shall be supported to the housing with angle iron frame and pillow block heavy duty ball bearing. Fan housing shall be made of die-formed side sheets with streamlined inlets and guide vanes to ensure smooth air-flow into the fans. Fan housing and TEFC Fan motor shall be mounted within the fan section on a common extruded Aluminum base mounted inside the air handling unit on anti-vibration mounts. Fire retarding

double canvas flexible connection shall be provided between fan outlet and AHU casing. The operation of the fan shall be quiet.

Fan performance shall be certified for AMCA 210 , 300 certified for Air & Sound

Fan selection should not be done at unstable zone.

11. Drive & drive set : Multiple V belts (2/3), fixed pitch cast iron taper lock pulleys. Belts shall be oil-resistant type

12. Motor : TEFC, Squirrel cage induction,S1 continuous duty
Class F insulation, Temperature rise limited to class B
IE-2
Design ambient 50,IP 55 enclosure, Horizontal foot mounted B3
Suitable for operation on 3 PH,415+/-10%,50+3% AC supply
Motor should be suitable to operate with Variable Frequency drive.

Selected motor rating should be minimum 115% of operating fan BKW and drive losses. Motor shall be of four pole. Motor shall have CE marking.

13. Cooling/ Heating coil : The coil shall be seamless solid drawn copper tube.
The depth of coil shall be as such to suit the requirements viz. re-circulated air application or 100% fresh air applications & the bypass factor required shall be specified in the tender specifications. The coil shall be 4 row or 6 row (3+3 row, spacing of atleast 400mm in between coils) deep for normal re-circulated air application & 8 row (4 + 4 row, spacing of atleast 400mm in between coils) deep for outdoor application. In case of 8 or a 6 row deep coil it shall be made with a spacing of 400mm between the two coils, access door & independent drain pan.

U bends shall be of copper, jointed to the tubes by brazing soft soldering shall not be used.

Each section of coil shall be fitted with flow & return headers to feed all the passes of the coil properly. The headers shall be of heavy class MS & shall be complete with water in/out connections. Vent plugs on top & drain at the bottom. The coil shall be designed to provide water velocity between 0.6 to 1.6 m/s in the tubes.

The fins shall be of Aluminum. The minimum thickness of the fins shall be 0.15mm nominal. The no. of fins shall not be less than 4.7 per cm length of coil. Fins may be of either spiral or plate type. The tubes shall be mechanically expanded to ensure proper thermal contact between fins & tubes. The fins shall be evenly spaced & upright. The fins bent during installation shall be properly combed & realigned.

Shut off & regulating valves at the inlet & outlet of water shall be provided . In case of DX coils solenoid valves & expansion valves shall be provided at the inlet of coil.

Finned, multi-circuited, multi-row, self draining with air vent. Galvanized steel sheet
Tube material-Copper,12.5/15 mm OD tube,& 0.50 mm thick minimum
Fin material - Aluminum,0.15 mm, Sine wave ripple-edge with collars,4-5 fins/cm

For coastal / corrosive environment areas for corrosion protection aluminum fins to be hydrophilic type, besides providing relevant anti-corrosive treatment (blue finning etc).
Tube expansion-Mechanical
Coil face velocity-2.54 m/sec or as noted in BOQ
MS header with adapter
Maximum water pressure drop 4 m WG
Coil test pressure at works 21 Kg/cm^2 pneumatic under water
Performance- Coil to be selected using AHRI 410 certified software

14. Filters at Air Handling Unit : The air used an air-conditioning systems must be filtered to maintain a clean atmosphere in the conditioned space. The concentration of contaminants in the air and the degree of cleanliness required in the conditioned space will determine the type of filter or filters that must be used. All filters shall be UL certified.

14.1 Pre-Filters (as mentioned in AHU schedule) : 50mm thick, multi-pleat
Flange type Or Box type
Frame -Anodized Aluminum
Synthetic non woven media supported between HDPE & Aluminum mesh
Sealing shall be with ductile epoxy .Filter shall be washable and performance standard -MERV 8 as per ASHRAE 52.2, G4 as per EN 779, EU 4 as per Eurovent, average arrestance 90% down to 10 microns
Maximum initial air pressure drop 4 mm WG
Filter face velocity 2.54 m/sec, or as noted in BOQ
Flange filter should be with rubber gasket.

14.2 Fine Filters (as mentioned in AHU schedule) : 300mm thick, bag Type, Flange or Box type
Frame - Anodized Aluminum
Synthetic non woven media on one side &Aluminium wire mesh on the other side with separator combs supported by hot melt glue separators performance standard- MERV-13 as per ASHRAE 52.2, F7 as per EN779 , EU 7 as per Eurovent, Average arrestance 99% down to 5 microns partical size as per EU-7 standards
Sealing shall be with ductile epoxy/ PU
Filter shall be washable type.
Maximum initial air pressure drop 8 mm WG
Filter face velocity 2.54 m/sec, or as noted in BOQ

14.3 HEPA-Filters (as mentioned in AHU schedule) : 300mm thick, Flange or Box type
Frame - Anodized Aluminum
Filters shall have efficiency of 99.9% upto 0.3 micron particle size s per EU 13 standard & are required for applications like operation theatre, micro-labs etc. these are also provided in the AHU after fan section or at terminal point and always must be backed by fine filters & pre filters. These filters after they become dirty, can not be reused and have to be thrown away.

15. Mixing box : Construction details shall be same as that of casing. Mixing box shall be complete with manual low leakagedamper, aluminum aerofoil opposed blade fresh & return air dampers. Mixing box shall also have open-able access door.

16. Safety Features : The fan access door shall be equipped with micro-switch interlock with fan motor enabling switching OFF the fan motor automatically in the event of door opening. Wire guard for fan section access door shall be provided.

17. Accessories : Marine light in fan section & mixing box
Limit switch interlocked with fan motor,
Double wall Sight glass in fan section
Extruded aluminum common base frame for fan and motor
Spring/rubber in shear vibration isolators for fan and motor
Fire and moisture resistant double flexible canvass

Canopy for out door type air handler units
Fan and Motor base shall be electrically earthed.

18. Manufacturers : Factory test certificate as provided by OEM, confirming the rated duty Parameters of fan, Test certificate motor, filters from OEM and other tests carried out by AHU manufacturer like leak test of coil and casing.

19. Testing at site : Air quantity shall be measured, through measurement of filter face velocity and filter area.
Cooling coil capacity shall be worked out from measurement of air entry and leaving WB across coil and knowing the enthalpy from psychometric chart.

20. Installation : Air handling units to be installed on unit base skid, supported on concrete/PCC /Pedestals foundation with vibration isolation pads (one at bottom of pedestal & 2 nos. sandwiched with 22G G.I. Sheet in between rubber pads above pedestal) spaced correctly, providing a rigid and level surface. The height of foundation should be adequate to accommodate the drain trap.

Chilled water inlet pipe connection to coil should be at the lower nozzle at air leaving side, providing, counter flow heat exchange between air & water.

21. Items to be provided with : The following accessories need to be provided with each AHU, as itemized separately in schedule of quantities and BOQ and as shown in piping schematic.

AHU Insulated butterfly valve at inlet and outlet, manual balancing at outlet, Y strainer at inlet, 2 way motorized control valve at outlet & pressure and temperature gauges at inlet and outlet.

CHAPTER-08: VARIABLE SPEED DRIVES FOR FANS

1.	Scope	:	Supply, Installation, Testing, Commissioning & Holding Performance Responsibility of the system.
2.	Acceptable Manufactures	:	As per approved list of makes
3.	Submittals for Review	:	Technical data General arrangement drawing
4.	Capacity and Duty parameters	:	As per BOQ / Schedule of quantities
5.	STANDARD	:	UL 508,CUL,IEC 61800-3:2004 IP -55 rating
6.	General	:	This section describes the type of Variable Frequency Drive (VFD) for fan speed control. The drive shall not be general purpose product, but a dedicated HVAC design. VFD shall be of variable voltage and variable frequency type, suitable mounting for variable torque application (fans).
7.	Submittals for Review	:	Technical data General arrangement drawing Performance curves & selection
8.	Mandatory Displacement Requirement	:	Efficiency of Variable frequency drive - Minimum 96% at full load power factor-0.98.
9.	Compliance magnetic approvals Further, the VFD shall	:	The VFD should have UL,CUL,C-Tick approvals and confirm to Electro compatibility directive. The VFD should have CE marking. comply to EMC directive as per IEC 61800-3: 2004,category C2, on both conducted and radiated emission. Necessary Harmonic filters in built non saturating type DC links on both DC rails/DC reactors with matching inductance with load so that it reduces effect of harmonics and adds protection from AC transients. The drive shall be tested as per UL 508 and as per UL 508 and listed for 100 KA. Harmonic distortion shall be restricted to 5%. Suitable filters will be supplied with all VFDs
10.	General voltage description duty	:	The drive should be suitable for three phase 415V,50 HZ, AC supply, with a range of380-480 V.The overload rating of drive should be 110% of its normal The VFD shall convert 380 – 440 V, 3 phase, 50 Hertz utility power supply to an adjustable output voltage and frequency. The VFD shall continue to deliver full motor output voltage even if the supply is at (380 – 10%). The voltage to frequency ratio shall be suitable for fan control. It should not be possible to set a constant V/F ratio to prevent damage to connected equipment and to optimize energy usage. The VFD shall work in conjunction with any I.E.C. standard design motor and shall not require the motor to be derated or cause the motor temperature to rise above the class `B' rise expected on normal mains operation. The VFD shall be capable of controlling parallel motors of mixed ratings and allow disconnection of any machine whilst running without causing

tripping. The VFD shall be capable of running with no motor connected for service functions.

The VFD shall be fully tested at the manufacturer's works. The test certificates shall be submitted.

The VFD shall be of sufficient capacity to provide a quality wave form so as to achieve full output of the motor, without causing additional heat rise. The VFD shall have following features:

a) Minimum efficiency @ 100% load - above 96%
@ 20% load - 92%

b) Rated input voltage 380V ± 10%, 3 phase, 48-62 ± 1% HZ

c) Working ambient temperature range – 10C to +40C, humidity to 95% RH.

d) Output frequency range – 0 to 1000 HZ.

e) Output voltage range 0 to full mains input voltage, 3 phase even at (-) 10% of full mains voltage input.

f) Connection of oversized motors within the current rating of the VFD shall be allowed.

g) Output torque should be limited to 1.05 x F.L.T. to prevent damage to connected plant.

h) The VFD shall accept 3 analog inputs of either 0-10V; 4-20 MA as well as resistive inputs as a control signal.

- The VFD shall provide two output relays to provide signals including – ready, run, tripped and be programmable for other selected information. Two analogue outputs of 4/20 MA or 24 V.D.C. shall be programmable to transmit speed or 25 other parameters to the B.M.S.
- The VFD shall log and display "Kwhr's consumed" and "Hours Run" by the motor without additional instrumentation.
- The VFD shall provide 4 skip frequencies of adjustable band width to overcome mechanical or air resonance.

The VFD shall be capable of running the system at programmed lower speed at a lower frequency, in case of a phase loss. It should also be capable of sensing a loss of load (broken belt) and provide signal for the same.

PID controllers shall be provided in the drive, allowing pressure or flow signals to be connected to VFD for a close loop control. The VFD shall be capable of powering a sensor cum transmitter supplied by others. The PID set point should be adjustable from VFD keypad, analog input or communication bus.

11. Programmable Real time which can Clock : The drive shall have a real time clock having a battery back up of minimum 10 years life span. The clock shall be programmable for various actions be pre decided with time function

12. Motor Protection : The VFD should have following minimum built in protections -over voltage, under voltage, VFD over temperature, Earth fault, over current ,short circuit motor stall etc.

The following user adjustable parameters shall be provided in the VFD-acceleration time, deceleration time, minimum frequency, maximum frequency. The drive shall be complete with hot pluggable local control panel with alpha numeric/graphical display of frequency, voltage, current, KWHr, running hours, active power, RPM ,etc.

The VFD shall be selected based on full load current of the motor considering the selected motors synchronous speed. The maximum permissible power cable length between the drive and motor without effect of cable heating should be 90 M.

13. VFD Construction : The F.C. shall contain as standard within its enclosure D.C. Link filtering with both features inductive and capacitive elements to control the main borne harmonics. The document `

Electrical Supply Industry Recommendation G5/3, limits for harmonic currents in the U.K.' shall be used for the basis of calculation of Total Harmonic Distortion (THD) for the point of common coupling. The VFD manufacturer shall provide THD figures for the total connected load. Restrict all distortions to 5%

The HVAC contractor shall collect the details of supply transformer rating, impedances, \ etc. from the Client to feed to the VFD.

The VFD shall comply with Electromagnetic compatibility complying with IEC 61800:3:2004 Category C1 for 50 m.

The drive shall be capable of automatically reconnecting to a spinning fan, forward or reverse running, without tripping, following mains interruption for on transfer from bypass running.

The VFD design shall comprise a diode input bridge, fixed voltage D.C. link section with both inductors and capacitors to form a filter and inverting bridge comprising I.G.B.T's (Insulated Gate Bipolar Transistors) and output inductors in the motor lines. All equipment must be housed within the VFD enclosure.

The inverting bridge shall be controlled by a 32 bit processor and A.S.I.Cs (Application Specific Integrated Circuits) to produce a V.V.C. (Voltage Vector Controlled) P.W.M. waveform naturally resulting in full motor voltage and sinusoidal current of mains supply quality in the motor circuit. Other forms of current source or 8 pulse converters are not accepted.

The current limit feature shall be sufficiently fast to allow the VFD to survive a continuous short circuit on the output terminals without damage to any drive components.

The VFD shall protect itself against input transients to loss of mains phase (3 phase measurement); loss of motor phase (3 phase measurement); grounding of any output phase or loss of speed reference (runs at last setting/preset speed/close down-programmable).

The VFD shall use overriding frequency fold back control techniques to prevent damage in the event of excessive load during either running or starting.

The VFD shall model the motor in its software to predict motor overheating without the use of thermisters in the motor. When overheat is predicted, an alarm or automatic shutdown shall be initiated.

The VFD shall exhibit near unity fundamental power factor at all loads and speeds and should not require the addition of A.C. reactors for power factor improvement, harmonic control or prevention of zero voltage notching.

The output circuit shall be of such a design, as to allow unlimited switching of the motor circuit, at any load/speed without causing damage to the I.G.B.T. output stage and without needing auxiliary control switching.

VFD from 1.1 to 90 KW rating shall have self adjusting modulation frequency control from 4.0 KHZ to 10 KHZ. The control form shall be such as to allow the VFD to deliver full output at all times without de-rating, by optimizing the switching frequency dependent on the output frequency.

Full galvanic isolation between power and control components shall be incorporated to ensure compliance with protective extra low voltage to prevent damage to B.M.S. interface.

The design shall include a full 4 term independent PID control (proportional integral derivable) as standard to provide closed loop control direct from a single transmitter without the need for external signal conditioning.

The VFD shall not exhibit an inrush current when a `start' signal is given and current must not exceed 105% at any time to prevent damage to connected equipment.

The VFD design shall be suitable for either local or remote control, selectable.

The VFD design shall include a motor preheat circuit to prevent condensation forming in the motor during shutdown periods.

The VFD shall not be damaged if it is energized with a `start' signal without a motor connected.

The VFD shall also have the following protections / features:

Heat sink over temperature protection.
Under voltage protection.
Over voltage protection.

Graphic Alpha-numeric display with all information displayed in clear language i.e. "Motor Tripped – Earth Fault".
Display to be in selectable language.
VFD "On" light.
VFD "Tripped" light.
Selectable display from 2 readouts including output current, voltage, frequency, speed, power, torque, motor temp %, inverter temp. %.
Raise and lower speed push buttons in local mode.
4 independently adjustable ramps – 2 acceleration, 2 deceleration with the range 0-3800 seconds, for use in normal/fire operation.

The design technology and operator keypad shall be common through the whole series of drives offered.

14. Design Ambient **:** The drive shall be housed in an IP 54 enclosure for indoor duty. For outdoor duty, VFD shall have IP 55 duty. The drive should be suitable for continuous duty at 40C, 95% non condensing humidity, rated at 100 M altitude.

15. BMS compatibility **:** VFD should be able to provide following inputs/outputs-6 nos Digital input,3 nos

relay output,2 nos analog input,2 nos analog output

Standard EIA 485 (R S 485) communication port and capability with BMS over METASYS N2/MODBUS RTU protocols is required

SECTION-01: EQUIPMENT AND ACCESSORIES (MECHANICAL PROCESS)
(VENTILATION, SMOKE PILL & LIFE SAFETY PRESSURIZATION)

CHAPTER-11: AXIAL / VANE AXIAL FAN

1.	Scope	:	Supply, Installation, Testing, Commissioning & Holding Performance Responsibility of the system as per duty conditions & capacity ratings.
2.	Acceptable	:	As per Approved list of makes . O.E.M only
3.	Submittals for Review	:	Technical Data General Arrangement Drawings Foundation drawing Performance to be validated by curves with duty point marked (system duty point to be plotted).
4.	Capacity and Duty parameters	:	As per BOQ / Schedule of quantities
5.	STANDARD	:	IS 12615/325 ; AMCA-210 &300 ,ISO 5801/BS 848 part 1; ASHRAE standard 51,DIN 24663 ; DIN45635,BS EN 12101-3,UL 705,ISO 21927-36.
6.	Related work & Obligations	:	The general requirements apply to work specified in this section. Examine all the other sections of the specification for requirements, which may affect work of this section. Co-ordinate works with all other trades affecting, or affected by activities of this section. Co-operate with such other trades to assure the steady progress of all operations under the contract.
7.	Mandatory EFF-2 (As Requirement	:	Fan motor shall be energy efficient IE-2/EFF 1,(as per IS 12615) OR IE-1 / mentioned in BOQ) Axial flow fans shall be Energy efficient as per ASHRAE 90.1, Minimum energy efficiency for fan motors Fan outlet velocity shall not be more than 13 M/s for pollution ventilation fan and 17 m/s for smoke extraction fans
8.	General	:	Fan efficiency shall not be less than 65 % for tube axial and 70% for Vane axial. Fan shall be licensed to bear the AMCA Air & Sound certified rating seal. The test standard shall be AMCA 210 & AMCA 300.Alternatively, the fan performance shall be tested as per ISO 5801/ DIN 24663 and sound testing as per DIN 45635. Fan selection should not be done at the extreme pitch angle and at stall zone.

9. Mounting : Wall mounted/Duct mounted

10. Fan Casing : Casing shall be tubular, made from heavy gauge galvanized steel with zinc coating of minimum 200 gm/Sqm, long casing, complete with foot mounting saddles and protection wire guard. spangle, skin passed and chromated. Running clearance between blade tips and casing shall not exceed 1% of impeller diameter. The casing should have an external terminal box duly wired .

In case of VANE AXIAL ,fan casing should also be provided with special designed integral straightening vanes to reduce turbulence, provide low noise, high efficiency.

11. Hub & Impeller : The hub shall be of cast aluminum alloy. The blades shall be aerofoil, variable die cast aluminum, grade LM2. Impellers shall be secured to the drive shaft by a pitch key and keyway..The fan assembly shall be dynamically balanced to ISO 1940 and AMCA 204 to balancing quality of GR 6.3 minimum. The fan impeller shall be of adjustable pitch type to obtain desired pitch angle. The fan impeller shall be statically and dynamically balanced. The selection of the fan shall be on the most efficient part of the fan performance curve.
The impeller shall be X RAY tested.

12. Type of drive : Direct drive.

13. Motor : Motor shall be TEFC, Squirrel cage induction, continuous duty (S1),energy efficient Class F insulation, temperature rise limited to class B, Design ambient 50 C. for normal duty
Motor shall be TEFC, Squirrel cage induction, continuous duty (S1),energy efficient IE-2,Class H insulation, temperature rise limited to 250 DegC, Design ambient 50 C. for exhaust & smoke spill duty

Motor shall be TEFC, Squirrel cage induction, continuous duty (S1),energy efficient IE-2
Class F insulation, temperature rise limited to class B, Design ambient 50 C. for pressurization duty

Motor shall be Horizontal foot mounted,B3 construction, with degree of protection as IP 55. Motor shall be suitable for 3 phase, 415 +10%v,50+5% AC. Fan motor base shall be properly secured, locked and sealed to the fan housing.

14. Accessories : Inlet & outlet bell mouth cone OR square flanges on either side OR bird screen of heavy metal wire gauge (16G) with round flange on either side as specified in the BOQ.

Additionally, smoke and heat exhaust fans are required to be in compliance with the requirement of class B performance as defined in BS 7346 Part 2/BS EN 12101-3 .

15. Quality Assurance: The Contractor shall ensure that all materials furnish and installed by him under the contract shall meet the requirements of relevant Indian standards / referred international standards.

16. Manufacturers test: Factory test certificate confirming all rated and duty parameters and type test

certificate report in case ofsmoke spill.

17. Delivery, handling section. However, andstorage liabilities which : The contractor shall provide guarantee for work under this such guarantee shall be in addition to and not in lieu of all other manufacturer and Contractor may have by other provisions of the contract document.

18. Installation : Fan& its components shall be carefully transported to site to avoid damage during transit. While on site the same shall be stored in a proper manner to prevent damage from moisture / rusting / mechanical damage.

Fan and its accessories shall be inspected for the damage, quality and specifications

19. Duct Connection: The fan should be installed as per approved drawing. The fan should not be grouted directly on wall . For mounting within ducts provide fire resistant flexible canvass on both ends vibration. Also in such case either motor or fan impeller cannot be accessed. The fan should be fixed on a structural steel frame grouted on wall. For mounting within ducts provide fire resistant flexible canvass on both ends to arrest vibration. The fan may be suspended from ceiling using proper structural frame work. For installation on roof raise the level of fan from roof level so that accidental flooding level on roof is lower than the level of fan.
To suspend the fan from slab spring type vibration isolators are to be used between the slab & the hanging support. Adequate sized fully threaded GI rods depending on the weight of fan with nuts & washers to be used.

Factory Fabricated Round to square duct piece made of out of GI sheet of thickness not less than 18G to facilitate connection at site
OR
Factory fabricated square/Rectangular flange piece made out of GI sheet of thickness not less than 18G to facilitate connection at site around the periphery of fan.

(Duct Connection to fans shall be as per site connection : Whether round to square or square flanges to be used shall be as per site condition.)

SECTION-01: EQUIPMENT AND ACCESSORIES (MECHANICAL PROCESS)

CHAPTER-12 : VENTILATION FAN SECTION, PROPELLER FANS, INLINE FANS

1.	Scope	:	Supply, Installation, Testing, Commissioning & Holding Performance Responsibility of the system as per duty conditions & capacity ratings.
2.	Acceptable Manufactures	:	As per Approved list of makes . O.E.M only
3.	Submittals for Review	:	Technical Data General Arrangement Drawings Foundation drawing Performance to be validated by curves with duty point marked (system duty point to be plotted).
4.	Capacity and Duty parameters	:	As per BOQ / Schedule of quantities
5.	STANDARD	:	IS 12615/325 ; AMCA-210 &300 ; ASHRAE 52.2,EN 779,Eurovent.
6.	Related work & Obligations	:	The general requirements apply to work specified in this section. Examine all the other sections of the specification for requirements, which may affect work of this section. Co-ordinate works with all other trades affecting, or affected by activities of this section. Co-operate with such other trades to assure the steady progress of all operations under the contract.
7.	Mandatory Requirements	:	Fan motor shall be energy efficient IE-2 Fan efficiency shall be between 65% to 70 %.
8.	General	:	Double skin fan section for duty specified, Floor mounted / ceiling suspended
9.	Casing	:	Aluminum hollow profile framework
9.1	Panel thickness & profile	:	25mm thick
9.2	Outer skin	:	0.63 mm pre-painted / pre-coated GSS.
9.3	Inner skin	:	0.63 mm plain GSS.
9.4	Density of PUF	:	40 Kg/m^3
9.5	Joints / corners	:	Pressure die cast aluminum/Engineering plastics.
9.6	Base skid	:	Entire unit shall be supported on a rolled form GSS channel.
9.7	Screws	:	Electroplated self tapping steel screws protected by PVC caps. Captive rubber gaskets within groove of extrusion between panel and frame. Access doors required in fan section for maintenance. Hinges -Die cast Aluminum, powder coated, Nylon handles.
10.	Fan Type	:	Double inlet double width, Backward curved, centrifugal, non overloading.

11. Fan Outlet Velocity : 610 MPM Max.

Casing/scroll -galvanized steel sheet.
Impeller - Mild steel, epoxy powder coated.
Shaft - carbon steel, extended on both sides.
Statically and dynamically balanced to ISO 1940,AMCA 204 GR 6.3 minimum.
Drive- multiple V belts, cast iron, fixed pitch, taper lock pulley.
AMCA 210, 300 certified for Air & sound .
Fan selection should not be done at unstable zone.

12. Motor : TEFC, Squirrel cage induction,S1 continuous duty
Class F insulation, Temperature rise limited to class B
IE-2/EFF-1 confirming to IS 12615
Design ambient 50,IP 55 enclosure, Horizontal foot mounted.
Suitable for operation on 3 PH,415+/-10%,50+3% AC supply
Motor should be suitable to operate with Variable Frequency drive and should be 4 pole, with synchronous speed 1500 RPM. Selected motor rating should be at least 115% of operating fan BKW and drive losses. Motor shall have CE marking.

13. Pre-filters : Pre-filters are required for supply air fan sections only.
50mm thick, multi-pleat, Flanged / Box type Frame -Anodized Aluminum Synthetic non woven media supported between HDPE & Aluminum mesh.
Sealing shall be with ductile epoxy .Filter shall be washable performance standard -MERV 8 as per ASHRAE 52.2, G4 as per EN 779, EU 4 as per Eurovent, average arrestance 90% down to 10 microns.
Maximum initial air pressure drop 4 mm WG
Filter face velocity 2.54 m/sec, or as noted in BOQ
Flange filter should be with rubber gasket

14. Quality Assurance by : The Contractor shall ensure that all materials furnish and installed him under the contract shall meet the requirements of relevant Indian standards / referred international standards.

15. Guarantee : Manufacturer shall provide guarantee for work under this section. However, such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturer and Contractor may have by other provisions of the contract document.

16. Installation : The fan section shall be mounted on concrete/PCC pedestals .There should be space all around the unit for maintenance. The unit location should be as per approved drawings. Fans shall have adequate rating electrical isolator near the fan.

18. Delivery, Handling storage : The equipment & its components shall be carefully transported to site to avoid damage during transit. While on site the same shall be stored in a proper manner to prevent damage from moisture / rusting / mechanical damage.

19. Manufacturers test certificate : Factory test report confirming all rated and duty parameters, reports of fan, motor andfilters if applicable from OEM.

20. Test at site : Computation of air flow rate by measurement of filter face velocity and knowing

filter face area. Verifying power drawn by measurement of current drawn by tong tester.

12.1 PROPELLER FAN : Propeller fans shall be direct-drive, three or four blade type, mounted on a steel fixed plate

with orifice ring.

12.1.1 Mounting Plate : Shall be of steel construction, square with streamlined venturi inlet (reversed for supply

applications) coated with epoxy paint finish. The mounting plate shall be of standard size, constructed of 2 to 18 gauge sheet steel depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

12.1.2 Fan Blades Shall be constructed of aluminum or steel. Fan hub shall be of heavy duty welded steel

construction with blades bolted to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the factory.

12.1.3 Shaft Shall be of steel, accurately ground and shall be of ample size for the load transmitted.

The shaft shall not pass through first critical speed through the full range of specified fan speeds.

12.1.4 Motor Shall be standard . Motors shall be suitable for either horizontal or vertical services.

12.1.5 Accessories The following accessories shall be provided with the propeller fans as per the application

and as required by engineer.

i) Wire guard on the fan inlet side and bird screen at the fan outlet.

- Gravity operated/fixed louvered shutter, built into a steel frame to be provided at the fan outlet.
- Speed Redulator

12.2 Roof Extractors : Roof mounted direct driven fans for exhaust shall be complete with motor drive, housing

with rain protection cowl and bird screen, goose neck for exhaust as per following specifications.

12.2.1 Housing Shall be constructed of 18 gauge heavy MS steel sheet spray galvanized. The housing

shall have an adjustable flange to facilitate installation and shall be especially adopted to receive fan, motor and drive. The driven units motors shall be installed in ventilated water proof housing along one edge for easy access to motor and drive, for inspection and maintenance. The entire assembly shall be weather proof and raised from the roof terrace sufficiently to prevent down flow of rain water accumulated on terrace. 18 gauge aluminum steel mesh bird screen of 8 mm sieves shall be provided on all discharge cowls around the outlet areas.

12.2.2 Rotor Impeller blade shall be of airfoil section fixed pitch type designed for maximum efficiency,

minimum turbulence and quiet operation. Fan shall be statically and dynamically balanced.

12.2.3 Motor Fan motor shall be squired cage induction, totally enclosed fan cooled motor, suitable for

415 +/- 8%, 50Hz., 3 phase, Motor RPM shall not exceed 1500 RPM. It shall be designed for quiet operation. Bearing shall be designed for vertical mounting. Motor name plate horsepower shall be such that the motor shall not be overloaded in the entire range of rated speed. Motor and fan assembly shall be easily removable.

Each fan shall be equipped with a rattle free back draft damper to prevent air from re-entering the fan when fan is not in operation, thus sealing completely in closed position. Damper shall be rattle proof under all conditions.

12.3 Inline Fan : Inline fan shall be complete with centrifugal impeller, casing, direct driven motor and

vibration isolators. Direction of discharge, and rotation position shall be as per the job requirement and shall be marked on the fan assembly. In case of lower ceiling heights the unit shall be with swing out motor type fans.

12.3.1 Housing construction with Shall be constructed of hot rolled GSS sheets in double skin/single skin

FRP corners.

Housing metal parts shall be either spot welded or screwed or mounted together with rivets. Indication showing rotation arrow and make, model number and duty conditions of the fan shall be available on the housing.

12.3.2 Fan Wheel balanced. Shall be backward curved type. Fan wheel shall be statically and dynamically

12.3.3 Bearings at Shall be completely maintenance free and can be used in any mounting position,

maximum indicated temperature. The bearing lubricant shall be suitable for low temperature applications. The life expectancy at maximum indicated temperature shall be minimum 40,000 hours operation.

12.3.4 Fan motor squirrel Shall be suitable for 415 $\pm$ 10% volts, 50 cycles, 3 phase/1 phase power supply,

cage, totally enclosed fan cooled motor (IP-44/IP-55), provided with class B or F insulation. Motor shall be with built-in thermal contact which will open and break the power supply at critical high temperature point.

12.3.5 Drive Shall direct driven.

12.3.6 Accessories application The following accessories shall be provided with the Inline fans as per the

and as required by engineer.

i) Wire guard on the fan inlet side and bird screen at the fan outlet.

- Gravity operated/fixed louvered shutter, built into a steel frame to be provided at the fan outlet.
- Speed Redulator

CHAPTER-14: AIR – WASHER

1	Scope:	Supply, Installation, Testing, Commissioning & Holding Performance Responsibility of the system.
2	Acceptable Manufactures:	As per Approved list of makes .
3	Capacity and duty parameters	As per BOQ, Schedule of quantities
4	STANDARD	IS 12615/325 AMCA-210 &300
5	Type Mounting	Single Tier, Double skin, Draw through ,air and water cross flow Floor Mounted
6	Submittals for review	Technical Data General Arrangement Drawings Performance curves and selection
7	Mandatory Requirements	Fan efficiency shall be between65–70.% (PROVIDE BEST EFFICIENCY IN THE AVAILABLE RANGE) Motor shall be energy efficient , IE-2 . Saturation efficiency of wetted media 90%
8	Casing	Double skin, pressure injected CFC free PUF Panels mounted on a extruded Aluminum hollow profile framework .Panel thickness and profile -43 mm PUF)outdoor/(25 mm PUF)indoors .(Outer skin -0.80 mm pre-painted / pre-coated GSS .Inner skin -0.80 mm plain GSS .Density of PUF -40 Kg/m3, Joint/Corners -pressure die cast aluminum/Engineering plastics .Base skid shall be GSS channel below fan section and MS angle frame below sump .Screws - electroplated self tapping steel screws protected by pvc caps captive rubber gaskets within groove of extrusion between panel and frame .Access doors required in fan section for maintenance .Hinges -Die cast Aluminum, powder coated, & Nylon handles.
9	Water Sump	Water sump below the pad section shall be fabricated out of 18 G stainless steel argon welded, complete with make up, quick fill, overflow and drain connection .The tank should be at least 300 mm deep .A brass float valve shall be provided for make up connection .Necessary bleed off connection with valve to be provided .
10	Fan Type	Double inlet double width, Backward curved, centrifugal, non overloading
10.1	Fan outlet velocity	610 MPM Max.
10.2	Casing/scroll	Galvanized steel sheet, with drain plug in scroll with minimum thickness of sheet as per manufacturer's standard,200 gsm, zero spangle
10.3	Impeller	Mild steel, epoxy powder coated carbon steel, extended on both sides
10.4	Shaft	Statically and dynamically balanced to ISO 1940,AMCA 204 Gr6.3 Multiple V belt, fixed pitch, cast iron, taper lock pulleys. AMCA 210 & 300 for Air & Sound
10.5	Drive	TEFC, Squirrel cage induction,S1 continuous duty Class F insulation, Temperature rise limited to class B Energy efficient IE-2 Design ambient 50,IP 55 enclosure, Horizontal foot mounted B3 Suitable for operation on 3 PH,415-/+10%,50-/+3 %AC supply 4 pole, synchronous speed 1500 RPM.
11	Wet Deck	Evaporative cooling pads shall be minimum 200 mm deep, with saturation of 90%efficiency at 2.54 m/sec face velocity .The pads should be cross corrugated/fluted cellulose acetate paper glued together and treated with anti rot rigidifying and wetting resins making it algae resistant .The flute design

		should direct water at entering face making it self cleaning .The pad should also act as a drift eliminator. The wet section shall be complete with PVC/FRP water distribution header and perforated pipes .The paper media shall be encased on two sides with 16 G GSS panels welded/bolted to water sump.
12	Pre filters	50mm thick, 7 layers 30 micron Aluminum wire mesh filter .encased in a frame .The filter face velocity should not be more than 2.54 m/sec .
13	Pump, connecting pipe and valves	Water circulating pumps shall be monobloc,)1w+1s.(The capacity and head should be adequate for the duty .The pump should be suitable for 3 ph,415+10%v,50+3 %ac supply .The pump casing shall be CI with impeller of Bronze .The pump shall be connected with water sump and distribution system with GI pipes, valves and strainer .For outdoor duty the pump should be weather proof.
14	Accessories	Marine light in fan section Limit switch interlocked with fan motor, Safety Wire guard Double wall Sight glass in fan section Extruded aluminum common base frame for fan and motor Spring/rubber in shear vibration isolators for fan and motor Fire and moisture resistant double flexible canvass Canopy for out door units Fan and Motor base shall be electrically earthed. Supply air outlet should be GSS flanged. Fan and Motor base shall be electrically earthed. Supply air outlet should be GSS flanged. Fan and Motor base shall be electrically earthed. Supply air outlet should be GSS flanged.
15	Manufacturers test certificate	Factory test certificate confirming all rated parameters and test certificate of Fan, pump, motor, filters and wetted media.
16	Testing at site	Measurement of face velocity on pre filter and computation of air quantity, knowing filter face area .Measurement of operating fan RPM using tachometer/stroboscope and current drawn using tong tester.
17	Installation	Air washer concrete foundation to be made considering water sump .The pedestals should be rigid and level .The unit should be mounted on the foundation .It should be high enough to provide positive suction to water pump .Adequate space should be provided all around for access and maintenance.

SECTION-01 : EQUIPMENT AND ACCESSORIES (MECHANICAL PROCESS)

CHAPTER-15: AIR – SCRUBBER (Dry Type with Adsorber)

a) Scope of Responsibility : Supply, Installation, Testing, Commissioning & Holding Performance

The system

b) Acceptable : As per List of approved makes

c) Capacity & Duty Parameters : As per BOQ

d) Standards : ASHRAE 90.1 Minimum Energy Efficiency criterion

e) Type : Floor / Ceiling Mounted as specified in BOQ

f) Housing/Casing construction .The : The housing/casing of the Air Scrubber Unit shall be double skin

frame work shall be Extruded Aluminum hollow section .The entire frame shall be assembled using PVC corner to make a sturdy, strong and self-supporting frame work for various sections)25±2(mm thick Double Skin Panels shall be made of 0.60mm pre-painted sheet on outer side and 0.60mm Galvanized sheet inside with 40kgs/cub mtr density, fire retardant P.U . insulation injected in between .This panel shall be screwed on to the aluminum frame work with soft rubber Gasket in between to make the joints air tight.

Frame work for each section shall be jointed together with soft rubber gasket in between to make the joints air tight .Suitable air tight access door to various sections for maintenance .The entire fan section housing shall be mounted on rolled formed GSS Channel frame work.

g) Motor and Drive : Fan motors shall be 415±10 %Volts, 50 cycles, 3 phase, squirrel-cage, totally enclosed

fan cooled with IP-55 protection .Motor shall be especially designed for quiet operation and motor speed shall be between 2Pole to 6 Pole .Motor shall be Energy Efficient with class IE3 & VFD compatible type.

h) Fan : The fan shall be **AMCA certified** backward curved Direct Driven CENTRIFUGAL SISW

Fan with integrated factory fitted VFD .The wheel shall be fabricated from heavy gauge steel .The fan impeller shall be mounted directly on motor shaft . The fan shall be selected for a low noise level .The impeller shall be statically and dynamically balanced .Fan impeller with motor shall be mounted on a common extruded aluminum /M.S .Epoxy coated base mounted inside the air handling housing on anti-vibration mounts .The fan inlet shall be connected to casing with the help on fire retardant fabric acting as flexible connection for anti-vibration

i) Technical parameters : The unit shall provide efficiency of 85 %or better for single pass .Multiple units can be joined together for increased volume .The system shall be suitable to connect to fan section with average velocity of 500 FPM across air cleaner.

j) ESP Unit Housing corrosion . : Housing shall be of heavy gauge construction to protect against rust and

Each section shall include single door access, located one side of the unit . The access door shall be mounted on steel hinges and secured with adjustable, gasket sealed lever latches allowing for component access and removal .All doors shall be gasketed to prevent air and water leakage .Doors to charged high voltage components shall be equipped with electrical interlocks, for interconnection into the primary power supply, to prevent

access when the components are energized .The housing shall be furnished completely assembled with bottom drain pan under ESP section for ease of shipment and installation .

k) Electrostatic : The electronic air cleaner shall be cylindrical honeycomb structure electric filter cells Precipitator Module rated at not less than 85 %efficiency for dry particulate .Module must equip with high

voltage solid state transformer with epoxy resin encapsulation, driven by half bridge switching converter .Multiple protection functions such as electrostatic discharge protection, power over-loading protection and transformer over-heated protection, making it safe and reliable.

l) Power supplies : Power supplies shall be 100 %solid state, operate on 200 to 240 VAC, 50 HZ, 1 Phase

input and provide a dual high voltage output of (+)14 KVDC for the ionizer and (+)6.0 to 6.5 KVDC for the collector .A regulated output of 20-50 MA shall be supplied to maintain the specified collection efficiency .Integrally mounted electrical interlocks shall be provided to prevent access to the high voltage components without first interrupting the primary input power .The power supply shall operate over a temperature range of -32 degrees F to 140 degrees F, be self-protecting and accommodate an LED light indicating the performance status of the ionizing/collecting cell .High voltage output leads shall be sealed and a bleed resistor incorporated to remove stored electrical charge where the power supply)s (are de-energized .Module of capacity above 3000 CFM shall be equipped with invariable current output function to maintain the specified collection efficiency.

m) System Controls : Programmable Logic Controller)PLC (shall be housed in enclosure and must be

installed indoors or other means of weather protection .Terminals shall be provided to interconnect the system fan by contactor .ESP will be start only after running of system fan.

n) **Activated Carbon :** The unit shall be fitted with activated carbon filter to absorb smell of kitchen exhaust .**Filter** The filter shall be at least 20mm thick and have carbon activated granules for absorption

of smell.

14.1 Scope : Supply, Installation, Testing, Commissioning & Holding Performance Responsibility

14.2 Acceptable Manufacturer : As per approved list of manufacturers

14.3 Submittals for : Technical Data Sheet
General arrangement drawings

14.4 Standard : IS 12615/325 ; AMCA-210 &300

14.5 Capacity & Duty Parameters : As per BOQ , schedule of quantities

14.6 Mandatory : Fan efficiency shall not be less than 75 .%
Motor shall be energy efficient, IE-2

o) Fan Type : Single inlet, Backward curved, SISW centrifugal,non overloading type
outlet velocity 610 MPM Max.

15.1 Casing / Scroll : Galvanized steel sheet, with drain plug in scroll,200 gsm, zero spangle

15.2 Impeller : Mild steel, epoxy powder coated

15.3 Shaft : Carbon steel, extended on both sides Statically and dynamically balanced to ISO 1940,AMCA 204 Gr 6.4

15.4 Drive : Multiple V belt, fixed pitch, cast iron, taper lock pulleys OR Direct drive

15.5 Motor : TEFC, Squirrel cage induction,S1 continuous duty
Class F insulation, Temperature rise limited to class B
Energy efficient IE3
Design ambient 50,IP 55 enclosure, Horizontal foot mounted B3
Suitable for operation on 3 PH,415-/+10%,50-/+3 %AC supply 4 pole, synchronous speed 1500 RPM .Selected motor rating should be at least 115 %of operating 115 %of fan BKW and drive losses .Motor shall have CE marking.

p) Accessories : Marine light in fan section
Limit switch interlocked with fan motor,
Wire guard
Double wall Sight glass in fan section
Extruded aluminum common base frame for fan and motor
Spring/rubber in shear vibration isolators for fan and motor
Fire and moisture resistant double flexible canvass
Canopy for out door units

SECTION-01 : EQUIPMENT AND ACCESSORIES (MECHANICAL PROCESS)

CHAPTER-16: ENTHALPY RECOVERY UNIT

1.	Scope	:	Supply, Installation, Testing, Commissioning & Holding Performance Responsibility of the system as per duty conditions & capacity ratings.
2.	Acceptable Manufactures	:	As per Approved list of makes . O.E.M only
3.	Submittals for Review	:	Technical Data General Arrangement Drawings Foundation drawing
4.	Capacity and Duty parameters	:	As per BOQ / Schedule of quantities
5.	Scope Units	:	The scope of this section comprises of the supply of double-skin "ERW AHU conforming to the following specifications .The manufacturer or their principals shall have at least 10 years of designing and manufacturing experience directly in the product i.e. enthalpy recovery devices, with a two tier, two air stream unit design in India.The heat recovery wheel and box should be from the same manufacturer. The manufacturer of the wheel should have manufacturing units in India.
6.	Type comprising	:	The ERW AHU units shall be two stream units in double skin construction, of supply air section, return air section and Heat Recovery Section. The supply air section shall include the following sections if defined in the Bill Of Quantities: Cooling/Heating Section, Microvee filter section, Mixing Box Section, Sound Attenuator Section, Damper Section, Humidifier Section, Inspection Section. Option shall be available for Digital Air Flow Measurement, Pressure Transmitter and Filter Cleaning Alarm if required in the Bill of Quantities.
7.	Capacity mentioned in	:	The ERW AHU units shall be of such capacities and static pressures as the Bill of Quantities.
8	Casing profile box	:	The units shall be made of extruded Aluminium Thermal profile frames. The size shall be of minimum 46 mm for capacities upto 22000 CMH, such that it provides the required mechanical strength and rigidity. The unit should be devoid of any welded construction and should be of cabinet type. All the frames should be assembled using pressure die cast aluminium joints/corners to make a self-supporting frame. The Casing leakage shall be in accordance with relevant EUROVENT standard that is CLASS B. The panels shall be of double skin construction with both inner and outer steel sheets being minimum 0.8mm thick pre coated & plasticized. 46 mm thick fire retardant, fibre glass insulation shall be sandwiched between the sheets. The fibre glass density shall be 48 kg/m^3. Materials emitting toxic gases like PUF shall not be used for insulation. The Inspection and access panels shall be hinged type. The hinges shall be casted, powder coated Zinc alloy. Flushed Locks and Handles shall be of galvanized steel. Other panels will be screwed on to the frame with sealant and soft rubber gasket thus making the joints air tight. All screws used for panel fixing shall be covered with PVC caps.

Special hollow gaskets and seals shall be used on inspection doors and to create separation between the airstreams to ensure negligible air leakage and mixing

The entire casing shall be mounted on electro galvanized channel frame work with level screws. Condensate drain pan shall be fabricated from 18 g GSS/SS construction. fire resistance Class of A-30

a) Supply Air Section : The supply air section shall comprise of the following:

9.1 Fan Section : The fan shall be centrifugal backward curved, double inlet double width type. The

impeller and the fan casing shall be made of hot galvanized sheet steel. The impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy duty ball bearing. The impeller shall be statically and dynamically balanced. The fan shall be selected such that unit noise level is less than 65 db. Fan housing and motor shall be mounted on a common galvanized steel or aluminium block base which can be drawn out from side for ease of maintenance. A quarter pin lock arrangement between the slide and guide pin lock arrangement between Fan and TFA outlet should be provided.

9.2 Motor & Drive : Fan motor shall be squirrel cage, totally enclosed fan cooled with IP – 55 protection. &

energy efficient IE-2 and suitable for 415 V, 3 phase

Motor shall be designed for quiet operation. Drive shall be provided through belt – drive arrangement. Belts will be of oil resistant type.

9.3 Filter Section **:** The filter section shall be normally designed for deep folded disposable synthetic

prefilters for Class EU3.The filter elements shall be mounted on rails and shall be easily pulled out for replacement. The rails shall be provided with efficient gaskets to minimize the risk of leakage .If mentioned in the Bill Of Quantities the section shall be designed to include filters upto class EU 8.

9.4 Mixing Section : The casing for mixing shall be as described in 8.0. The mixing section shall have built in

dampers made up of aluminium profiles with leakage Class III. The damper blades shall be controlled with plastic gear wheels and silicone gaskets shall be provided between the blades. Inspection hatch shall be provided.

9.5 Damper Section : Damper section shall contain a built in damper of aluminium profile with leakage class III.

The damper blades shall be connected with plastic gear wheels with a gasket of silicon rubber to produce tightness between the blades.

9.6 Cooling Coil Section:: The cooling coil section shall be available in two options as below, and shall be selected

based on the details mentioned in the Bill Of Quantities.
Upto 8 row deep - long
Upto 4 row deep - short

The cooling coil section shall be suitable for both DX and chilled water type. Drain pan made out of 18g GSS/SS shall be provided.

9.7 Heating Section : The heating section shall be suitable for both hot water coil (2 row deep) .

9.8 Inspection Section : The Inspection section shall be for inspection of other functional sections. It shall be

available in two options; long and short version and shall be selected as defined in the Bill of Quantities.

9.9 Humidifier Section : The humidifier section shall have evaporative cooling pads for humidification .The pads shall have minimum efficiency of 85 %.

9.10 Return Air section : The return air section shall comprise of above sections.

9.11 Heat Recovery : The Heat Recovery section shall include enthalpy wheels and shall have minimum Section recovery of 75 % of total heat, i.e both sensible and latent (each being 75 %). The recovery of sensible and latent shall be equal .Necessary computerized selection of the wheel should be provided alongwith the bid to justify the same. The wheel shall be made of pure aluminium foil coated with molecular sieve desiccant "Ecosorb 300 "with pore diameter of 3oA.The cross contamination between the two air streams shall be nil and leakage less than 0.04%. The vertical and radial run of the wheel shall be less than 1 mm per meter of **diameter. The wheels shall have non contact labyrinth seals for effective sealing between the two air streams.**

Detailed specification for the wheel shall be as per 9.11.1 i.e. "HEAT RECOVERY WHEEL"

9.11.1 Heat Recvery : Rotor/wheel matrix shall : - Wheel Specifications

The substrate: The substrate or wheel matrix should be only of pure aluminum foil so as to allow.

a) Quick and efficient uptake of thermal energy.
b) Sufficient mass for optimum heat transfer
c) Maximum sensible heat recovery at a relatively low rotational speed of 20 to 25 rpm.

Nonmetallic substrates made from paper, plastic, synthetic or glass fibre media, will therefore, not be acceptable.

The substrate shall not be made from any material which is combustible or supports combustion like synthetic fibrous media.

The wheel has to be certified as per DIN EN ISO 846 with 0% fungal and bacterial growth at 95% Relative humidity and above.

Fire rating : NFPA - 90A certification with 0% for Flame spread classification should be confirmed by manufacturer.

Pressure drop : The pressure drop across the rotary heat exchanger shall not exceed 0.1 inch for every 100 FPM face velocity, or part thereof, for the minimum stated / required latent recoveries / efficiencies

NECESSARY SOFTWARE SELECTION OF THE WHEEL HAS TO BE ENCLOSED TO JUSTIFY THE PRESSURE DROP AND EFFICIENCY CALCULATIONS.

Descicant Wheel : The desiccant should be water molecule selective and non-migratory.The desiccant should be molecular sieve 3Å , so as to keep the cross contamination to absolute minimum and also ensure the exclusion of contaminants from the air streams, while transferring the water vapour molecules.

The desiccant, of sufficient mass which should not be less than 5 kg per 1000 cfm of air should be coated with non masking porous binder adhesive on the aluminum substrate so as to allow quick and easy uptake and release of water vapour. A confirmation has to be provided by manufacturer of wheel to this effect. A matrix with desiccants impregnated in non metallic substrates, such as synthetic fibre, glass fibre, etc. will not be accepted.

The rotor/wheel matrix shall have <u>equal</u> sensible and latent recovery.

The weight of desiccant coating and the mass of aluminum foil shall be in a ratio so as to ensure equal recovery of both sensible and latent heat over the operating range. Accordingly, a rotor matrix which has an etched or oxidised surface to make a desiccant on a metal foil and results in insufficient latent recovery and hence unequal recovery, or a rotor matrix made from desiccant integrated in synthetic fibre matrix which result in insufficient sensible recovery, high rotation speed, and unequal recovery, will not be accepted.

Rotor : With optimum heat and mass through matrix formed by desiccant, of sufficient mass,

coated on an aluminum foil, the rotor should rotate at lower than 20 to 25 RPM, thereby also ensuring long life of belts and reduced wear and tear of seals.

The rotor shall be made of alternate flat and corrugated aluminum foil of uniform width.

The rotor honeycomb matrix foil should be so wound and adhered as to make a structurally very strong and rigid media which shall not get cracked, deformed etc. due to change of temperature or humidity.

The rotor having a diameter upto 2800 mm shall have spoken to reinforce the matrix. From 2000 mm diameter upwards, the option of a special wing structure, to prevent the rotors from wobbling or deforming due to the successive pressure differentials, will be available.

Sectioned wheels, with pie segments, capable of being assembled in the field, shall be available as an option, above 2000 mm in diameter.

The surface of the wheel/rotor should be highly polished to ensure that the vertical run out does not exceed ± 1 mm for every 1 metre diameter, thereby ensuring, negligible leakage, if labyrinth non contact seals are provided, and minimal drag, if contact wiper seals are provided.

The radial run out also shall not exceed ± 1 mm for every 1 meter diameter, thereby minimising the leakage/drag on the radial seals, and minimise the fluctuation in the tension of the drive belt.

The number of wraps (of alternative corrugated and flat foil) for every inch of rotor radii shall be very consistent so as to ensure uniform air flow and performance over the entire face in the air stream. Flute height and pitch will be consistent to a very tight tolerance to ensure uniform pressure drop and uniform airflows across the rotor face.

The rotor shall be a non clogging aluminum media, having a multitude of narrow aluminum foil channels, thus ensuring a laminar flow, and will allow particles upto 800 microns to pass through it.

The media shall be cleanable with compressed air, or low pressure steam or light detergent, without degrading the latent recovery.

Cassette / casing : The recovery wheel cassette/casing shall be manufactured from tubular / sheet metal

structure to provide a self supporting rigid structure, complete with access panels, purge sector, rotor, bearings, seals, drive mechanism complete with belt.

The rotor/wheel should have a field adjustable purge mechanism to provide definite separation of airflow minimising the carryover of bacteria, dust and other pollutants, from the exhaust air to the supply air. It shall be possible, with proper adjustment, to limit cross contamination to less than 0.04% of that of the exhaust air concentration.

The face and radial seals shall be four (4) pass non contact labyrinth seals / brush seals for effective sealing between the two air streams, and also for a minimum wear and tear ensuring long life of the seals.

SECTION-02: PIPE WORKS AND ACCESSORIES

CHAPTER-01: MECHANICAL PROCESS

1. PIPING WORKS : Refrigerant, Condenser, chilled & condensate applications.

1.1	Scope	:	Supply, Installation, Testing, Commissioning & Holding Performance Responsibility for the piping work, comprising of copper (hard or soft) , carbon steel pipes) for chilled water/hot water(ater, condensate drain pipes of Galvanized steel / UPVC / Composite pipes (as the case may be).
1.2	Acceptable Manufacturer	:	As per Approved list of makes
1.3	Submittals for Review	:	Technical Data SCHEMATIC CHILLED/CONDENSER WATER DIAGRAM, REFRIGERANT PIPING Pressure drop calculations
1.4	STANDARD	:	IS 1239-2004 Pt 1 &2, ; IS 3589-2001 ; IS 6392,BS 10; ,as Indicated
1.5	General description and sizes arrangement.	:	Supply, laying and jointing of pipes with fittings, flanges, valves, pipe strainer, complete with, structurally stable, supporting The scope shall include, finish painting of pipe after primer coating, with service identification. Pipe size, shall be as required for the duty and as shown in approved schematic drawing. The HVAC contractor shall be responsible for providing noiseless, balanced circulation of water flow. Pipe sizing shall be in relation to available pump head.
1.6	Pipe sizing Basis	:	**Closed system Maximum velocity Maximum pressure drop,WG** Occupied areas 1.2 m/sec 1.21 m/30m Main/sub branch 2.4 m/sec 1.21m/30m Open system 2.4 m/sec 1.21m/30m
1.7	Material specification Chilled/Condenser/Hot	:	Pipe size upto 150 mm dia MS,ERW, Heavy class, IS 1239,part 1 200 mm dia -350 mm dia MS,ERW,6.00 mm thick IS 3589,Gr Fe 330 400 mm dia-600 mm dia MS,ERW/SAW, IS 3589,Gr 7.00 mm thick Fe 330 650 mm dia -900 mm dia MS,ERW/SAW,IS 3589 Gr 8.00 mm thick Fe 330
1.8	Pipe Fitting weldable	:	Upto 150 mm dia ERW, Heavy class , IS 1239 Part 1 Factory fabricated & IS 4736 200 mm dia and above Site fabricated, from pipe IS 3589

Material Mitre/segmented bends

Tee-off connections reducers, bends (upto 150mm dia) shall be ready made factory fabricated MS 'C' Class fitings. 200mm & above shall be site fabricated of the same material & thickness of pipe. Drilling and tapping of the walls of the main pipe shall not be restored to. Site fabricated fittings are allowed only in case of non-availability and prior permission has to be taken for the same.

1.9 Condensate Drain malleable ,screwed IS : Galvanized steel class 150, (medium class) 1239 PART3 ; ASTM-A-G.I.198

Galvanized steel pipes for drain, shall be joined with pipe threads. Where, pipes are to be threaded, die cut, right hand ,full depth taper threads. Apply, a thin coat of lubricant to male threads only.

Where pipe is to be threaded, die cut right hand, pipe stand, clean cut full depth, taper threads. Make threaded joints so that they will be leakproof without caulking.
Apply a thin coat of lubricant to male threads only.

HDPE/ UPVC : HDPE pipes (if mentioned in BOQ) shall be at atleast 25mm ID, as per IS 4984 -1995 / IS 14333 - 1996
Shall be as per BOQ & shall have a min. density of 6Kg/m3

1.10 Pipe flanges : Shall be SLIP ON/PLATE type, with raised face, confirming to BS 10,Table E/F,or IS 6392

The flange pressure rating, shall be same as the maximum working pressure of the system ie,PN 10 or PN16 as indicated in BOQ for valves. The connection to control valve and equipment shall be flanged for ease of service. Supply of flange shall include bolts, nuts, washer and gasket.

Common	Table D Dimensions (PN-10)					Table E Dimensions (PN-16)				
Flange Size Designation (Nominal bore of Pipe)	Overall dia. Of Flange (mm)	Flange Thickness (mm	Bolt circle Dia. PCD(mm)	No. Of Bolts	Diameter of Bolts(mm)	Overall dia. Of Flange (mm)	Flange Thickness(mm)	Bolt circle Dia. PCD(mm)	No. Of Bolts	Diameter of Bolts(mm)
12	95	5	67	4	13	95	6	67	4	13
20	102	5	73	4	13	102	6	73	4	13
25	114	5	83	4	13	114	7	83	4	13
32	121	6	87	4	13	121	8	94	4	13
40	133	6	98	4	13	133	9	98	4	13
50	152	8	114	4	16	152	10	114	4	16
65	165	10	127	4	16	165	10	127	4	16
80	184	10	146	4	16	184	11	146	4	16
100	216	10	178	4	16	216	13	178	8	16
125	254	13	210	8	16	254	14	210	8	16
150	279	13	235	8	16	279	17	235	8	19
200	337	13	292	8	16	337	19	292	8	19
250	406	16	356	8	19	406	22	356	12	19

300	457	19	406	12	19	457	25	406	12	22
350	527	22	470	12	22	527	29	470	12	22
400	578	22	521	12	22	578	32	521	12	22
450	641	25	584	12	22	641	35	584	16	22
500	705	29	641	16	22	705	38	641	16	22
550	762	29	699	16	25	762	45	699	16	25
600	826	32	756	16	25	826	48	756	16	29

2. Welding process **:** Piping joints shall be, manually arc welded ,**using Rectifier only**. For pipe dia above

350 mm dia,10% of the joints shall be radio graphed.

Pipe shall be machine cut with ends square. Where, pipe wall thickness exceeds 4.76 mm, the ends of pipe and fittings shall be chamfered/ beveled using a grinding tool. Provide 4-5 mm gap between two piping members to be welded to maintain alignment and weld metal penetration. Circumferential butt or fillet welded joint shall be made using manual arc welding. **Only RECTIFIERS shall be used.** Separate, abutting ends of joints before welding, to permit complete fusion. Tack in two or more points, before complete welding to maintain alignment. All scale, welding flux and oxides shall be removed using chisel and hammer and weld joints shall then be coated with red oxide primer to avoid rusting.

Oxy acytelene welding process is NOT acceptable.

GTAW (Gas tungsten arc welding) process shall be used for the following:

a) On butt welds in carbon steels, in sizes less than 40 mm NB in all passes for 300 class and higher.

b) On butt weld in alloy steels for the root passes in all sizes.

c) On butt weld in stainless steel for root passes in all sizes.

SMAW (Shielded metal arc welding) process shall be used for the followings:

a) On butt welds in carbon steels, in sizes more than 50 mm NB for the filler pass.

b) On butt weld in low alloy steels for the filler passes in all sizes.

c) On butt weld in stainless steel for filler passes in all sizes.

For carbon steel piping, in sizes 40 mm and smaller, where butt welding is required, the entire butt welding including root pass may be carried out by SMAW process in 150 class piping systems except for steam tracers.

Welding consumables are to be provided by the contractor in his cost estimates for the piping works.

2.1 Weld-o-lets **:** Scribe and cut openings in main pipes for welded branches accurately taking care

And thread-o-lets to remove all plugs and cuttings from main pipe.

Full weld fillet welds for full depth of fillet, with additional beads to form well rounded connection as recommended by weld-o-let manufacturer.

Cut openings into pipes for welded connections accurately to give matched intersections.

Make welded fittings of same material with same pressure and temperature ratings as pipe with which they are used.

Make flanged connections to control valves, pump suction and specialties with BIS standard welding neck flanges. All other flange connections may be made with slip-on flanges provided they are seal welded on inside.

Fuse all fillet welds for flanges or fittings into pipe and plate for minimum distance of 1½ times pipe wall thickness and depth weld on 11/4 times pipe wall thickness.

3. Installation : Run/route pipes in straight lines and square with the building. Piping shall be properly

(for details refer supported on floor mounted stands, clamps or supported on trapeze hangers mechanical suspended from slab as indicated in drawings. The HVAC contractor shall adequately installation design all the brackets, saddle clamps, hangers for the dynamic operating load, and guidelines be responsible for their structural integrity. Bull heading shall be avoided. All piping should preferably run at same level except where it crosses. Piping layout should address accessibility of valves and equipment.

3.1 Pipe support : Refer mechanical installation guidelines(section-2, chapter-3)
spacing

3.2 Contractors shop : Design drawings to indicate, the size and location of pipes. The contractor subsequent drawings drawings to award of work, shall prepare detailed shop drawing showing, plan and

sections, detail of valves, strainer, air vents ,drain points and equipment, pipe supports and pipe levels in coordination with other services.

3.3 Service pipe : Refer mechanical installation guidelines. (section-2, chapter-3)
pressure testing

4. Pre-insulated : Where ever specified, the chilled water piping shall be of pre insulated type, as

Pipes per specs mentioned here in. The pre insulated pipe shall comprise of a carrier

steel pipe, insulated with pressure injected, CFC free, PUF insulationwith densitynot less than 40 Kg/CuM within a jacket covering. Material, type and wall thickness of carrier pipe shall be, as specified earlier. The pipe insulation shall be polyurethane foam having density of 36 kg/cum minimum, 90% minimum closed cell content, minimum compressive strength of 2.8 kg/sqcm and thermal conductivity of 0.017 W/mk confirming to IS-12346. Unless otherwise specified else where, minimum pipe insulation thickness shall be as under:

Pipe diameter,mm		**Insulation thickness,mm**
upto 100		30
125	to	600 50
650	and	above 75

However the exact thickness could vary marginally based on OD of steel pipe and ID of jacket pipe. HDPE Insulation jacket- Burried pipe-The outer protective jacket shall be seamless, extruded, black, UV resistant High density, polyethylene (HDPE).The HDPE pipe shall have PN 2.5 rating, PE 80 type.The HDPE pipe shall confirm to IS 4894.HDPE jacketing shall be used for under ground burried pipe,where pipes are backfilled with soil. The minimum thickness of HDPE jacket shall be under:

Jacket OD,mm	**Minimum thickness,mm**
upto 300	3
351 and above	5

Over ground piping-The outer protective jacket shall be spirally wound, LFQ, Galvanized steel/Aluminum sheet as per BOQ.The galvanized sheet shall be confirming to IS 277,with Zinc coating of 120 gm/sqm.The aluminum sheet should confirm to IS 737.Minimum sheet thickness shall be as under

Jacket OD,mm Aluminum	GSS
Less than 250 24 G	26 G
above 250 22 G	26 G

Pre insulated pipes shall be factory made. Each pipe shall have 150 mm exposed on either side to facilitate welding at site. Field joint insulation shall consist of PUF poured manually, in a site fabricated GSS jacket. All fittings will be also done at site. For buried piping, the field joints shall be lastly covered with some cold/heat shrinkable tapes.

5. **Grooved Coupling (Where-ever specified) For any to-suit size / exceptional situations, / prior approvals shall be sought** Carbon **for fabricating welded joints.** : Grooved coupling Grooved Piping System for IPS Steel through 12"(DN300)

American Society for Testing Materials (ASTM)

ASTM A-53 – Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

ASTM A-183 – Carbon Steel Track Bolts and Nuts

ASTM A-234 – Standard Specification For Piping Fittings or Wrought Steel and Alloy Steel.

ASTM A-449 – Quenched and Tempered Steel Bolts and Studs

ASTM A-536 – Ductile Iron Castings

ASTM F-1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications

ASME B16.9 – Factory Made Wrought Butt Welded Fittings

ASME B31.9 – Building Services Piping

AWWA C-606 – Grooved and Shouldered Joints

6. Quality Assurance**:** All grooved components (including couplings, fittings, valves and accessories) to be supplied by one manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

7. Submittals **:** Grooved coupling products shall be shown on drawings and product submittals and shall be specifically identified with the applicable Grooved coupling series or style designation, in compliance with the codes mentioned above.

8. Material **:** Carbon Steel,A-53B/A-106B-Roll or cut grooved-ends as appropriate to Pipe/Groovedmaterial wall thickness, pressures, size and method of joining. Pipe ends to be (Standard/Lightwall) grooved in accordance with Grooved coupling current listed standards conforming to ANSI/AWWA C-606.

9. Grooved Couplings **:** Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45

MechanicalGaskets shall be pressure-responsive synthetic rubber, grade tosuit the intended for service, conforming to ASTM D-2000. (Gaskets used for potablewaterapplications shall be UL classified in accordance with ANSI/NSF-61 for potablewater service.) MechanicalSteel PipeCoupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa) as provided standard Grooved coupling.

Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13. Grooved coupling Style 07 (Zero-Flex®).

Flexible Type: Use in locations where vibration attenuation and stress relief are required.

Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three Couplings shall be placed in close proximity to the vibration source. Grooved coupling Style 75 or 77.

10. Flange Adapters : For use with grooved end pipe and fittings, for mating to ANSI Class 125 / 150 flanges. Grooved coupling Style 741

11. Grooved coupling : Bolted Branch Outlet:Branch reductions on 2"(DN50) through 8"(DN200) header piping.Bolted End Fittings branch outlets shall be manufactured from ductile iron conforming to ASTM A-536, Grade 65-45-12, with synthetic rubber gasket, and heat treated carbon steel zinc plated bolts and nuts conforming to physical properties of ASTM A-183. Grooved coupling Style 920 / 920N.
Strapless Outlet: 1/2"(DN15) or 3/4"(DN20) NPT outlet on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa). Grooved coupling Style 923.
Strapless Thermometer Outlet: To accommodate industrial glass bulb thermometers with standard 1-1/4"-18 NEF 2B extra fine thread and 6" (152mm) nominal bulb length on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa).

12. Sleeves : Pipe sleeves,50 mm larger than pipe shall be provided where pipes pass thro wall. The annular space shall be filled with mineral wool/fiberglass and filled with mastics to provide leak proof joint

SECTION-02: PIPE WORKS AND ACCESSORIES

CHAPTER-02: PIPE WORKS ACCESSORIES SPECIFICS.

1. Temperature gauges minimum 100 with sockets : If indicated in BOQ, temperature gauge shall be dial type, with mm dial.

The gauge shall be Bi Metal type, for horizontal/vertical execution with casing of cast aluminum. The stem and connection are non ferrous. Connection shall be 12.5 mm BSP. Temperature gauges shall be installed in proper thermo wells. These gauges shall be installed at inlet and outlet of chiller and Floor mounted air handling units.

Of mercury in steel direct mounting type having a straight rigid bottom-entry stem suitable for use with the specified pockets.Of a range suitable for the service which it is measuring.
Marked in Deg C with 100 mm diameter dial.

Fitted with an engraving label identifying the instrument and service measured.
Installed in a readily serviceable and visible location.

2. Pressure gauges : If indicated in BOQ, pressure gauge shall be installed at inlet and outlet water nozzle of chiller, pumps, floor mounted Air handling units and heat exchanger. Pressure gauge shall not be less than 100 mm dia. Casing shall be of pressed steel, having stove enamel black finish. Bourdon, movement and block shall be non ferrous. Accuracy shall be +/- 2%. connection 10mm BSP, Range 0-10 kg/Sqcm. Pressure gauge shall be complete with isolating brass globe wall of matching size. Care should be taken to protect gauge during pressure test of piping system.

In accordance with BS EN 837-1
Manufactured from 316L SS
Direct mounting Bourdon type.
150 mm diameter dials
Provided with adjustable pointer which shall be set to indicate the normal working pressure at the point in the system.
Fitted with an engraving label identifying the instrument and service measured.
Gauge cosk shall be ball valves and lever handles to suit the connection on the specified pressure gauges.
Connected via a gauge cock and siphon tube.

Calibrated in Bars and meters from Zero to between 150% and 200 % of the working pressure. Complete with casings and dials or the same style and finish of the temperature gauges.

3. Binder test points : Installed on the inlet and discharge connections of all pumps, coils ,

heat exchanger, boiler, chiller, cooling tower.
Installed adjacent to each port of each control valve.

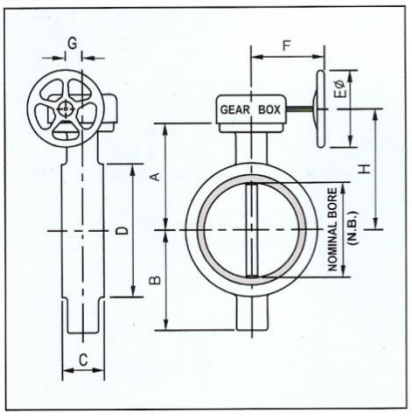
4. Butterfly valves : Shall be provided at cooler, condenser, cooling tower and coil inlet/outlet as per BOQ Duty- two position isolation.
Standard BS 5155/IS 13095/API 609.
TYPE - WAFER design (50 mm to 600 mm), Flanged (above 600 mm).

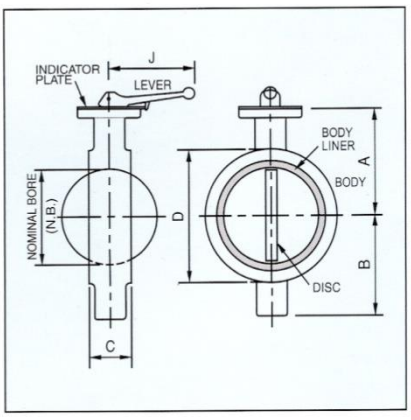
Body-Cast Iron, Concentric (upto 600 mm).
Disc-Epoxy coated, Ductile Iron.
Liner-Integrally moulded, EPDM/Black nitrile.
Stem-Stainless steel SS 410. : SINGLE PIECE
Pressure rating - PN 10 or PN 16 as per BOQ.
Flow control lever with intermediate locking arrangement (upto 200 mm) Gear driven (250 mm and above) End connection-Suitable for fitment between Slip on/Plate flange drilled to BS 10/IS 6392.

4.1 Submittals acceptance : Refer below table for further details and compliance. Intent

forms (IAF) to be filled on this basis, and further, all technical submittals to be referred to the IAF.

Installation Dimensions





Valve NB		A	B	C	D	E	F	G	H	I	Approx. Gr. Wt. Kg.
50	(2")	113	68	43	97	-	-	-	-	237	3.5
65	(2.5")	121	74	46	11	-	-	-	-	237	4.0

					0						
80	(3")	128	81	46	129	-	-	-	-	237	4.5
100	(4")	146	96	52	161	-	-	-	-	237	6.2
125	(5")	158	114	56	188	-	-	-	-	237	7.7
150	(6")	174	132	56	212	-	-	-	-	300/350	9.0
200	(8")	198	165	60	269	-	-	-	-	400/500	14.0
250	(10")	245	215	68	320	300	175	61	283	-	30.0
300	(12")	275	240	78	370	300	175	61	313	-	44.0
350	(14")	305	265	92/78*	436	300	175	61	343	-	50.0
400	(16")	335	295	102	487	450	265	117	408	-	72.0
450	(18")	386	325	114	539	450	265	117	459	-	95.0
500	(20")	416	360	127	592	450	265	117	489	-	120.0
600	(24")	506	435	154	695	450	265	117	579	-	210.0

5. Dual plate check valve :

Duty-shall be provided at all pump discharge to prevent back flow.
Type-Wafer type spring loaded dual plate check valve
Standard-API 594
Pressure rating-PN 16
Type-Wafer Type
Body-Cast Iron
Disc-SG Iron IS 1685/CA-15(SS410)
Hinge/Stop pin-SS-304
Spring-SS 316
Seat-Buna N/EPDM
End connections Suitable for fitment between BS10/IS 6392 flange.

6. Manual balancing valve :

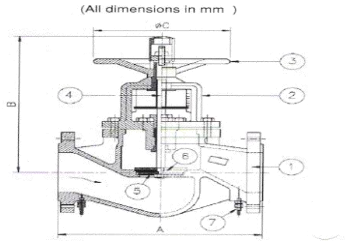
Shall be provided at outlet of cooler, condenser coil , as per drawing/BOQ for water balancing.
Standard-BS 7351
Type-Double regulating, variable orifice, tight shut off, Non rising spindle
Pressure rating-PN10/PN 16 as per BOQ
Seat-Brass
Seat Seal Teflon, Spindle Brass , Hand Wheel-Polyamide/Nylon, Digital display ,lockable, tamper proof, Ends-Screwed, Test cock of Brass required for differential pressure measurement
Body/Bonnet-Cast Iron-(above 65 mm dia)
Disc-stainless steel,SS-410
Stem-stainless steel ,SS 410
Seat/Stem seal EPDM/Nitrile
Ends-Flanged,Drilled to IS 6392/BS 10 pipe flange
Hand wheel-Cast Iron, micrometer scale. Spindle should be lockable with a screw at a pre determined point.
MS,electro plated nipples required. The nipples shall be long enough to protrude out of pipe insulation. Measurement of flow rate and

water balancing should be possible using a computerised balancing instrument. This is a pre requisite. Published K values should be available for various wheel turns. All balancing valves to be tagged both in the drawing and at site with the same Tag No. The contractor to submit a water balancing report, as generated by water balancing instrument with valve identification Tag Nos and ensure that the chilled water flow rates to various terminals is as per design.

Micro–meter scale in the wheel should allow fine settings upto $1/10^{th}$ of a hand wheel turn. The spindle should be lockable with a lock screw, allowing the limiting maximum opening of valve, to pre–determined position, while still allowing to use as shut–off valve.

The spindle shall be non–rising type, and its movement should be lockable/tamper proof type.

6.1 Submittal/ compliance : Refer below table for further details and compliance.



Nominal Size	DN mm (Inch)	080 (3")	100 (4")	125 (5")	150 (6")	200 (8")	250 (10")	300 (12")
L	mm	310	350	400	480	600	730	850
ØD	mm	200	220	250	285	340	405	460
H	mm	290	410	450	490	590	760	820
ØC	mm	175	225	225	300	400	480	480
Stroke	mm	32	40	49	57	69	80	96
Hand wheel Turns		8	10	12.25	14.25	11.25	10	12
Weight	Kg.	22.5	38	55	76	119	220	315

7. Pressure Independent, in Balancing two way differential pressure modulating for AHU, : These valves should be installed at outlet of AHU,FCU as indicated /BOQdrawing, Dynamic balancing will ensure constant across two way temperature control valve irrespective of system pressure.

The flow ON/OFF for FCUrate will vary only as per setting based on temperature. Flow setting as per design should be possible at site. The control valve shall be two way, modulating, capable of accepting analog input signal of 0-10/2-10 V DC/4-20 mA from either stand alone room thermostat or BMS system. Valve shall have provision to pre set maximum flow rate to enable flow limitation. For FCUS, actuator shall be TWO POSITION,ON/OFF

type, suitable for 220 V. The AHU/FCU valves should be so wired, when AHU/FCU is OFF, valve should in closed position. Contractor to select the minimum differential pressure in consideration with available pump head. should ensure that selected valve differential pressure is adequate for selected pump.
Pressure rating- As indicated in BOQ
Fluid Temperature -20 deg C to 120 deg C
Body-Forged Brass (upto 40mm), screwed end ,Ductile Iron Wafer type,50 mm and above.
Internals-Stainless steel
Binders Test plugs for differential pressure measurement required
Electric Actuator, suitable for 24 V AC supply. HVAC contractor to provide transformer.
Control input-Analog,0-10/2-10 V DC/4-20 Ma or ON/OFF for FCU.

8. Ball valve set, with and without strainer provide : Inlet to Fan coil unit shall be connected with Ball valve with strainer. Outlet shall have Ball valve without strainer. The ball valve shall isolation and tight shut off. The strainer basket should be removable for cleaning and shall be of brass/stainless steel. The valve body shall be die cast from brass/bronze. The ball shall be chrome plated brass/SS. The seat shall be of Teflon. The valve shall be of full bore design with quarter turn stainless steel handle. One side shall have either 20/25 mm BSPF threads, while other end shall be with flare connection

9. Bronze Gate valve shall be of bronze. : Body shall be of bronze, confirming to IS 778.The internals The spindle should be non rising, inside screw. Valve should be of PN 16 pressure rating.

10. Suction Diffuser/Guide suction : Suction diffuser shall be installed at the inlet of each pump. The guide shall be with built in strainer and flow straightener. The strainer shall be of stainless steel with cast iron guide vanes. A fine mesh strainer should also be provided which should only be removed after short running of the system. The end connections shall be flanged. A blow down plug shall be provided at the bottom to remove the welding slag/debris. The suction diffuser pressure rating shall be as indicated in BOQ.

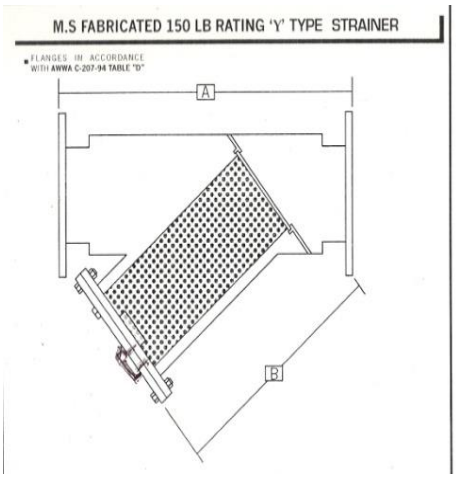
Suction diffuser shall be an angle pattern flow straightening fitting equipped with a combination diffuser-strainer-orifice cylinder, flow straightening vanes, start-up strainer and adjustable support foot. The combination diffuser-strainer-orifice cylinder shall be designed to withstand pressure differential equal to the system pump shutoff head (maximum 175 psig) and shall have a free area equal to five times the cross section area of the pump suction opening. The length of the flow straightening vanes shall be no less than 2½ times the diameter of the system pump suction connection.

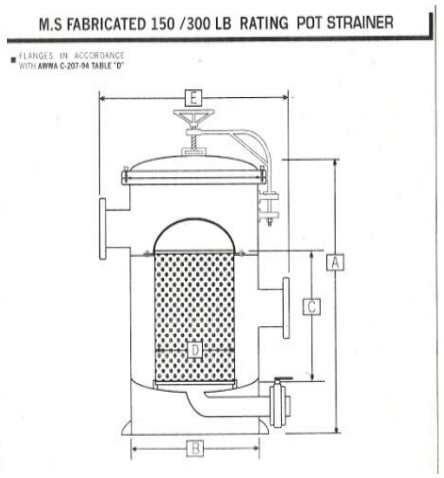
The flow straightening fitting shall be of ductile iron construction with grooved system and pump connections. The fitting shall have a stainless steel combination diffuser-strainer orifice cylinder with 3/16" diameter perforations to protect the system pump, and full length flow straightening vanes shall provide non-turbulent flow to the suction side of the system pump. The start-up strainer shall be of 16 mesh bronze, and the support foot (supplied by others) shall eliminate pipe strain at the flow fitting/pump connection. All internal components shall be replaceable.

11. Y Strainer : Body shall be Y type, fabricated from close grain cast iron or M S, C class

pipe with flanged ends.The screen shall be 20G,SS-304 with 3 mm perforation. The strainer design shall be capable of providing minimum four times free screen area as compared to pipe area. The pressure rating shall be suitable for system working pressure, PN 10/PN 16 as per BOQ. Strainer shall have blow out plug and a permanent magnet to attract all welding burrs etc. The cover shall be bolted. Strainers shall be installed at inlet of each pump and AHU as indicated in BOQ. For 150 mm dia and above,the blow out plug shall have 15 mm nipple connected with a valve to facilitate draining of upstream water before removing screen.

11.1 Submittal / compliance : Refer below table for further details and compliance.





LINE SIZE (NB)	25	50	65	80	100	125	150	200	250	300
"A" Strainer body length	225	260	375	380	425	525	600	750	800	850
"B" Basket length	150	180	230	230	300	340	380	475	525	575

12. Pot Strainer : Pot strainer shall be of simplex type, fabricated out of MS sheet confirming to IS 226.

Thickness of sheet & sizes shall be as per table below, chamfered pipe with flanges shall be provided at the inlet / outlet connections of the Automatic back wash strainer. Butterfly valves shall be provided at the inlet / outlet connections. The Automatic back wash strainer body shall have two separate chambers properly sealed to avoid mixing of filtered and unfiltered water. A powerful magnet shall be provided in the body to arrest MS particles.

Filter Element : Wedge type groove to have more surface area for better cleaning & shall be removed after
flushing the system and before commissioning.

Inner filter shall be made out of 01mm thick non-magnetic stainless steel having 03mm perforation (40 mesh) gr. SS-304 properly reinforced to avoid damage of the element.

Refer below table for further details and compliance.

Pipe size	Pot Dia	Pot HT	Element Dia	Element HT	MS Plate Thickness
50	300	400	200	240	6
80	350	450	250	250	6

100	450	500	300	280	6
125	500	600	330	340	8
150	540	700	360	390	8
200	610	815	400	470	8
250	800	955	550	510	8
300	1000	1105	750	580	12
350	1190	1300	895	678	12
400	1350	1500	1020	785	12
450	1518	1700	1060	890	12
500	1690	1800	1100	900	12
600	2000	2200	1500	1160	12

13. Ball valve : The valve shall be of full bore. Body shall be of brass. Ball shall be of Nickel / chrome plated brass, machined to micro finish with PTFE rings, PVC grip steel handle. Pressure rating of valves shall be as mentioned in BOQ. Ends shall be screwed.

14. Flexible connector: Flexible connectors shall be provided at each pump, condenser, cooler nozzle as shown in the drawing or as indicated in BOQ to reduce transmission of vibrations .The flexible connections shall have neoprene rubber coating, resistant to oil, heat and atmospheric weather conditions. The flexible pipe connector shall be of single, unfilled arch design. The tube shall be leak proof, abrasion resistant with seamless lining of rubber and suitable for working at 70 deg C with a pressure rating as mentioned in BOQ.The unit shall be complete with integral rubber flanges on both sides with split metal retaining rings and control rod. The flange drilling shall be as per BS 10 Table 10,Table F,IS 6392 Table 17.

15. Automatic : Differential pressure controllers suitable for chilled water applications shall be differential proportional self-acting control valves that stabilise the differential pressure pressure across hydronic circuits or directly across modulating control valves.

Controller (if mentioned in BOQ) The proportional band must be sufficient to obtain stable control. This means that the proportional band must be 40 to 50% of the set point chosen.

Each differential pressure controller shall be coupled with a measuring valve for pressure transmission. It should allow for the measurement of the stabilised differential pressure and the water flow rate. The differential pressure controller and its measuring valve should be provided with measuring nipples and a shut-off function.

Pressure measuring nipples must be integral with the body and with leak-tight shutoff when not in use.The differential pressure setting must be adjustable externally with an Allen key, without disassembling the valve or stopping the plant. The relationship between the design set point and the setting in number of turns with the Allen key is given in a table. This design set point corresponds to a valve opening of 70 %.

SECTION-02: PIPE WORKS AND ACCESSORIES

CHAPTER-03: MECHANICAL INSTALLATION GUIDELINES

1. Pipe works anchoring and hanging /supporting :

Supports and anchors must only be fitted to structural members or substrate fixings which are capable of carrying the design loads including the influence of expansion. If there is any doubt, then structural engineer should be consulted. Prior approval of drawings.

Supports and fixings, whether standard patterns or purpose- made, shall be appropriate in style and material to the pipe and the structure to which fixed, with due regard to application.

Where swinging pipe hangers are used, they shall be able to move freely for the full distance necessary. The support rod shall not be less than 300 mm long and shall be clear of the full thickness of any insulation (if applicable). Hemispherical washers shall be used on swinging hangers.

Sliding supports to accommodate linear movements shall be faced with PTFE (polytetrafluoroethylene) / equivalent lining material permanently attached. Rollers shall be avoided. Pipes should be clamped with U-shaped clamps with nuts & washers made with rods of specified thickness, with a spacer gasket, between the rod and the pipe, securing the saddle. The saddle shall be of high density PUF material, formed suitable for the pipe diameter.

Horizontal steel pipe-works shall be supported not exceeding those mentioned in table – 1 of this section. Additional pipe supports to half the spacing as prescribed by the table1 shall be provided on horizontal low level runs, where they might be used as foot rests (up-stand). Additional pipe supports may be required on larger sizes to limit the point load imposed on the structure. All horizontal pipe works would be structurally isolated and supported as per table-1 of this section.

Table-1

Pipe dia. NB (mm)	Spacing (C/C) Maximum (M)	Suspension Rod Dia. (mm)	MS structural support	
			Dimension (mm)	Type
20-32	1.5	8	25*25*3	Angle
40-50	2.4	10	25*25*3	Angle
65-80	2.4	12	50*50*5	Angle
100-150	2.4	12	40*75*40*5	Channel
200-250	2.4	16	50*75*50*5	Channel
300-450	2.4	Floor support	As per structural engineer	Channel / Box section
500 and above	2.4	Floor support		Channel /Box section

Vertical steel pipe-works shall be supported at the base of the riser and guided at intervals. Branches from a riser pipe shall not be used as a means of support from the riser pipe.

Table-2

Pipe dia. NB (mm)	Spacing (C/C) Maximum (M)	MS structural support	
		Dimension (mm)	Type
20-32	1.5	40*40*5	Angle
40-50	2.4	40*40*5	Angle
65-80	3	50*50*5	Angle
100-150	3	40*75*40 *5	Channel
200-250	3	50*100*5 0*5	Channel
300-450	3	As per structural engineer	Channel
500 and above	3		Channel

Pipe supports shall be of fully threaded GI rods, of diameter suitable for the dynamic loading it is subjected to. Vibration isolation pads shall be provided below floor supports.

The above spacing shown is maximum and should not be exceeded. Pipes in plant room should normally be floor supported. For pipes running together, floor supports with horizontal channels supported on vertical square hollow pipe columns shall be planned. Adequate head room should be provided below the steel support member. Piping load shall not be transferred on the equipment. Pipe hangers shall be fixed on walls and ceiling slab by means of a 10 mm MS plate and multiple dash fasteners. Vertical risers shall be parallel to wall and shall be straight and plumb. Risers passing from floor to floor shall be supported on each floor by clamps attached to pipe and isolated with a 12mm thick vibration isolation rubber pad/any other resilient material. Where pipes pass thro terrace, pipe riser shall also have a suitable concrete pad at the lowest point. Vertical risers shall be provided with a dirt leg at the bottom with a removable cap to assist flushing and cleaning. Insulated piping shall be supported in a manner so as not to put undue pressure on the insulation. Fully threaded U-Clamps of adequate size & thickness depending on pipe size shall be provided between pipe & support. At least 2mm thick Fire retardant gasket to be provided on top side where the clamp & pipe are in contact with each other. Pipe sleeves,50 mm larger than the finished (insulated) pipe shall be provided where pipes pass thro wall. The annular space shall be filled with mineral wool/fiberglass and filled with mastics to provide leak proof joint. Split retaining rings shall be provided on either side to finish the opening. All piping work shall be carried out in a manner so that it causes minimum disturbance to existing services, building, roads and structure. The entire piping work shall be organized in consultation with other agencies.

Necessary coordination needs to be done at contractors end to plan work schedule to minimize interferences. HVAC contractor to carefully examine the cut outs provided in floor slab, retaining wall as per design NIT drawing and ascertain the same meets his requirement. The piping layout and supports should be executed in a manner that the issue of pipe expansion/contraction is addressed. Future tap offs shall have an isolation valve with blind flange. Branch or Tee connection shall be thro reducing tees. Otherwise, ferrule welded to main pipe shall be used. Drilling and taking a tapping shall not be acceptable. Where reducers are to be made in a

horizontal pipe, eccentric reducer shall be used for drainage. Also eccentric reducers should be used in pump suction connection to avoid air binding. Flanged inspection pieces 1.5 m long, shall be provided at 30 m centers as shown in drawing to facilitate inspection and cleaning.

a) Movement at bellows must be guided axially with NO lateral movement.

b) Axial bellows must NOT be used in freely suspended pipelines.

c) Axial bellows demand that the structure is capable of withstanding the high loads imposed by the anchors and guides. Thus, sensitivity to this concern should be checked.

d) The effect of the bellows operating forces on press fit, mechanically grooved and proprietary joints should be verified with the manufacturers.

e) Oval shaped plates of the thickness of pipe to be welded at the dead end of pipes.

2. Venting arrangements : Air venting and collecting points shall be provided at the top of risers and where necessary, at other high points. Main headers should also have a air purge point. These accessories have been quantified in the bill of materials, and need to be installed with respect to site conditions, using fair judgment, especially on some awkward bends/ tap-offs etc.

To minimize trapped air pockets during filling, consideration should be given, where space allows, to stagger the positions of flow and return connections off vertical riser.

3. Draining arrangements Grading Pipes for drainage : Drain points and dirt pockets shall be provided at the bottom of the risers and where necessary at other low points.

Draining low points on condenser, cooling water mains and risers, shall be by main size dirt pockets (at foot of risers, pockets not less than 25 mm diameter). Positioned at the point of rise or drop; terminating with a tail pipe and a bronze gland cock with hose union in an accessible position. Drain cocks shall be 15mm, 20 mm or 25 mm , whichever is closest to the main size. Slope will not be less than ¼" per 10' for any drain pertaining to HVAC system. All condensate drain pipes will be installed with care for ease of maintenance and operations. Drains shall be piped through equal size G.I. pipe to the nearest drain or floor waste or as shown on the drawings. Piping shall be pitched towards drain points.

4. Protection : Physical and corrosion protection is must. Where mild steel pipe-work is exposed to weather or located in damp conditions etc., then a protective coat of suitable paint should normally be applied to avoid rusting.

5. Connections to Equipment : All equipment that needs to be maintained, removed etc for repair, maintenance or replacement should have a method with suitable fittings to allow disconnection of pipe work. The type of fitting will depend on the size and material type: i.e. unions for threaded joints or counter flanges to match the flange of the equipment, grooved couplings etc. The source of disconnection should be suitably positioned to ensure after disconnection , there is space for removal of the isolated item of the plant.

7. System Flushing : The entire piping system shall be thoroughly flushed number of times.

The water should be drained periodically drained out from all remote low ends ,to ensure all ends are properly flushed. Keep flushing for at least until clean water drains out from the piping

system at all low points. Adequate ,number of bypass connection with valves should be planned to protect coils, condenser and cooler tubes and control valves from welding slags and debris. Clean Y strainer and pot strainer after system flushing. The system should be then filled with water.

8. Filling the system : Ensure all valves are in their normal duty conditions, and air purge systems are functional. Fill rate should be gradual and slow, using a temporary / permanent connection (in closed loop systems where closed vessel expansion tanks are installed) through a tank. If chemical dosing system is installed, then, the system should be activated immediately once the system is purged and full, to avoid any bacterial contamination of the water.

9. Hydro pressure testing : Test with water in accordance with the Uniform Mechanical Code (IAPMO UMC)

Prior to field joint / pipe length jacketing / back-filling (for under ground systems), all pipe joints would be pressure tested in accordance with the applicable ASME B31 piping code. Prior to pressure testing, all anchors , concrete anchor blocks and thrust blocks and any other piping system thrust restraint devices must be in place and secured

Provide vents at high points to release trapped air while filling system.

Provide drains at low points for complete removal of test liquid.

Drain system if there is a potential for freezing, i.e., no heat in building, coil in outside air stream, or other similar situations.

If leaks are found, they shall be eliminated by tightening, repair, or replacement, as appropriate and test repeated until no leakage is found.

Where repairs or additions are made to piping system following the pressure test, the affected piping shall be tested. Minor repairs and additions are not required to be pressure tested, provided that the work is inspected and connections are tested with a noncorrosive leak-detecting fluid or other leak-detecting methods approved by the authority having jurisdiction. Testing will not be required in cases where it does not include addition to, replacement, alteration or relocation of, any piping, or in any cases where piping is set up temporarily for exhibition purposes.

Hydrostatic pressure testing is to be carried in the following way:

After all service pipes are joined, and before field joint / pipe length insulation, connect pipe testcaps at the ends of the pie run. Use a pressure gauge (5 Bar), sized properly and close to the test pressure.

Set all valves so that the section of the piping to be tested can be pressurized.

Fill the service pipe with water.

Vent the service pipe of all trapped air.

Slowly pressurize the service pipe to the test pressure (typically 2.5 times the system design pressure).

CAUTION: Under no circumstances should the system be pressure tested at a pressure greater than the maximum pressure rating of any component in the system.

Maintain the pressure for 24 hours, allowing for corrections due to temperature changes.
All leaks and defects in joints need to be rectified and retested.
Insulation of pipes shall be done only after successful pressure testing of the system.

10. Pipe Loops : **Pipe loops shall be:-**

a. Fabricated from similar material to the pipe in which they are installed.
b. Fabricated from a single length of pipe with pulled bends. No joints or fittings shall be permitted.
c. Finished with a straight length of pipe no less than 15 x the diameter of the pipe.
d. Rated to the same pressure as the main pipework.
e. Unless particularly specified otherwise bellows shall be:
f. Fabricated from stainless steel.
g. Installed strictly in accordance with the manufacturers recommendations.
h. Installed with 50% cold pull which shall be witnessed by the Engineer.
i. Pipelines shall not be pulled up for cold draw until the anchor points are rigid and firm.
j. Rated to the same pressure as the main pipework.

NOTE : GENERAL DETAIL DRAWING FOR INSTALLATION OF PIPES TO BE SUBMITTED & APPROVED PRIOR TO INSTALLATION

SECTION-02: PIPE WORKS AND ACCESSORIES

CHAPTER-04: MECHANICAL PROCESS & INSTALLATION GUIDELINES DX SYSTEM (REFRIGERANT / COPPER PIPES)

1. Scope : Supply, Installation, Testing , Commissioning & holding performance responsibility for the piping work, comprising of soft / hard drawn copper tubes.

2. Acceptable manufacturers : As per List of approved makes.

3. Submittal for review : Schematic diagrams, Pressure drop Calculations, CV Calculations

4. General and pipe sizes : Supply, laying and jointing of pipes with fittings, flanges, valves, strainers complete with supporting arrangement. The scope of work shall include, finish painting of pipe with service identification. Pipe size shall be as required for the duty and as shown in approved schematic diagram. The HVAC contractor shall be responsible for providing noiseless, balanced circulation of refrigerant flow. Pipe sizing shall be in relation to the length of the piping from Indoor unit to outdoor unit taking into consideration all bends, loops etc. for calculating final pressure drop.

REFRIGERANT PIPING

Copper Tubing: ASTM B280, Type ACR hard drawn [or annealed].
Fittings: ASME B16.22 wrought copper.
Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480°F.

UNIONS, FLANGES, AND COUPLINGS

2 inches and Smaller: Copper Pipe: Bronze, soldered joints.
2-1/2 inches and Larger: Copper Piping: Bronze, flanged joints.
Gaskets: 1/16 inch thick preformed neoprene.
Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

5. Piping & fitting Materials : Hard/Soft drawn copper tubes (BS 2871 Tables W & Y), supplied in straight lengths or coil is most common type used in commercial pipe-work. Pipe & pipe fittings should be mutually compatible and suitable for the application intended and that they are suitable for use on copper pipe-work.

6. Jointing Methods : Copper piping shall be normally assembled with capillary, compression, flanged, push fit, brazed or press fit joints. However brazed joints are widely accepted. While brazing of joints/pipes flux should be used with brazing media (Copper when it is copper to copper OR Silver when it is copper to some other material)

7. Pipe Sleeves : There shall be no pipeline joints within the thickness of walls or floors. Pipe-work shall not be embedded in the structure unless specifically identified as part of the design. Where pipes pass through walls or floors a pipe sleeve shall be built in, comprising a length of tube, of the same material as the pipeline, or other equivalent proprietary purpose made sleeve. The sleeve shall be sufficient in length for the sleeve to finish not less than 3mm nor more than 12mm clear of the finished wall or floor. The sleeve should be of internal diameter at least 25mm greater than the OD of the insulation passing through. Apply 12mm deep cold mastic seal to both ends within sleeve.

8. PREPARATION

Ream pipe and tube ends. Remove burrs.
Remove scale and dirt on inside and outside before assembly.

Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

9. INSTALLATION – Above ground piping system Refrigeration conducting :

Install refrigerant piping in accordance with ASME B31.5, Piping. Where more than one piping system material is specified, provide compatible system components and joints. Use non-dielectric connections when joining dissimilar metals in systems.

Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves or equipment.

Provide flexible connectors at or near equipment where piping configuration does not absorb vibration.

Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

Route piping parallel to building structure and maintain gradient.

Install piping to conserve building space, and not interfere with use of space.

Group piping whenever practical at common elevations.

Sleeve pipe passing through partitions, walls and floors. Provide UL/FM approved through penetration fire stop system when penetrating a fire rated barrier (i.e., wall, floors, etc.).

Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

Provide access where valves and fittings are not exposed.

Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 1/2 inch in 10 feet in direction of flow.

Flood refrigerant piping system with nitrogen when brazing.

Install valves with stems upright or horizontal, not inverted.

Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

Fully charge completed system with refrigerant after testing.

Comply with ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.

Support piping in accordance with Section 22 0529, Hangers and Supports for Plumbing Piping and Equipment.

Sleeve pipe penetration and caulk in accordance with Section 22 0548, Vibration and Seismic Control for Plumbing Piping and Equipment.

Pressure test piping in accordance with Section 22 0813, Testing Piping Systems.

Insulate piping in accordance with Section 22 0713, Plumbing and HVAC Insulation.

Label piping in accordance with Section 22 0554, Identification for Plumbing, HVAC, and Fire Piping and Equipment.

10. Installation :

Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

Install refrigerant service valves in suction and discharge lines of compressor.

Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

Install refrigerant charging valve in liquid line between receiver shut-off valve and expansion valve.

Install solenoid valves upstream from each expansion valve. Install solenoid valves in horizontal lines with coil at top and provide electrical connection to solenoid valves.
Install thermostatic expansion valves as close as possible to distributors on evaporators and locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
Install pressure relief valves on ASME receivers. Install relief valve discharge piping to terminate outdoors.

Install strainer upstream of each automatic valve and install shut-off valves on each of strainer. Install filter dryers in liquid line between compressor and thermostatic expansion valve or in the suction line of the compressor.

11. Supports & Fixing : Supports and fixing whether standard patterns or purpose -made, shall

be appropriate in style and material to the pipe and to the structure to which fixed, with due regard to application. Pipes shall be laid in supports with proper clamps. Wherever bare pipes are in contact with supports additional gaskets are to be provided in between pipe & support to avoid metal to metal contact. Pipe supports shall be arranged as near as possible to joints and changes in direction. The pipe work shall be normally be supported at intervals not exceeding as mentioned in the following Table. However additional pipe supports may be required as per site conditions.

Pipe Size mm	Maximum Support interval	
	Horizontal (M)	Vertical (M)
15	1.8	2.0
22-28	2.0	2.5
35-42	2.5	3.0
54	2.7	3.0
67-108	3.0	3.7
133-159	3.6	4.2

12. Flushing of the system : After installation of pipes & fittings, the system should be thoroughly flushed with nitrogen before pressure testing.

13. Pressure testing : The system under test should be charged with nitrogen to 350 PSI. &

check for any leaks. If Leak is observed in brazed or screwed threads, which involves removal of nitrogen from the system & then again repair the leak. After repair of leak it must be again charged with nitrogen at 350 PSI & the system must be left for a minimum of 24 hrs. to observe for any pressure drop. If there is no pressure drop after 24 hrs., the system should be prepared for Vacuuming followed by Refrigerant charging.

14. Insulation of copper pipes : The pipes after pressure testing should be insulated as per below details:
With 9mm thick closed cell elastomeric insulation in tubing form for pipes not exposed to atmosphere.

With 13mm thick closed cell elastomeric insulation in tubing form for pipes exposed to atmosphere followed by Jacketing with fire proof compound and As per Specification laid in Section -4, Chapter -4.

15. Drain Piping : Drain Piping Shall be 25mm ID either UPVC or HDPE as mentioned in the BOQ.

HDPE pipes shall be as per BOQ & shall be at least 25mm ID, as per IS 4984 -1995 / IS 14333 – 1996

UPVC shall be as per BOQ & shall have a min. density of 6Kg/m3 & shall be at least 25mm ID

Proper U-loop & TEE- Connection to be provided near the drain outlet from the equipment & the gradient of drain pipe shall be towards the designated drain point for smooth & gravity flow.

16. Vacuuming & Refrigerant Charging : After insulation of pipes is done, Vacuuming of the Circuit should be done with a high capacity vacuum pump. Prior to vacuuming ensure that the nitrogen filled in the circuit is completely blown out. The 1st vacuuming should be done for at least 2-3 hrs. depending on the length of the piping. Vacuum the circuit till the pressure reaches -30 PSI. After 1st vacuuming is done break the vacuum with the same refrigerant of the system to + 5 PSI. & then again vacuum the circuit for another 2-3 Hrs until the pressure reaches -30 PSI. When the circuit has been satisfactorily vacuumed, it must be then charged with desired refrigerant as per system requirement & the same used for vacuum breaking through a combination of filter & drier followed by starting up of the equipment.

SECTION-03 : AIR DUCT WORKS & ACCESSORIES –MECHANICAL PROCESS

CHAPTER-01 : AIR DUCT WORKS (FACTORY AND IN-SITU FABRICATED)

1. Works Included including	:	Air duct fabrication, installation, testing and commissioning , Air Distribution
2. Related Works	:	Ordinary Duct Work : GSS (IS-277)/ Aluminum (IS-377)- Latest Edition Special Duct Work : For Kitchen Exhaust (MS welded)
3. Quality control	:	Air Diffusers/Grilles: As per ratings by Air Diffusion Council / As per approved manufacturer. Fire / Smoke / Combination dampers: UL, NFPA 90A / 90 B. Submit manufacturer's product data for review
4. Submittals	:	Submit manufacturer's product data for review
5. Scope installation of	:	Scope of this section shall comprise of supply, assembly and Factory fabricated sheet metal ducts as per approved shop drawings, specifications and Bill of Quantities. Duct work shall include, all accessories like transverse joints, access doors, splitters, vanes, hanging/ supporting arrangement ,tie rods, stiffeners as may be required to make the system functional. In case of site fabricated ducts, the scope of work shall also include on site fabrication. On award of work, the contractor shall prepare detail duct layout shop drawings in relation to site condition and co ordinate the same with latest architecture ,reflected ceiling plans and other services. The contractor shall also test and balance the entire air distribution system including every air terminal as per approved shop drawing. Construct ductwork in accordance with SMACNA-HVAC duct construction standards- Metal and Flexible, and NFPA 90A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code". Fiberboard duct is not acceptable duct material except when used for fabricating return air sound traps.

Verify field measurements prior to fabrication.

Each duct system is constructed for the specific pressure classification selected by the designer. This information must be noted on the drawings or in this specification if the pressure class exceeds 1-inch w.g. For guidance on pressure classification refer to SMACNA HVAC Duct Construction Standards, Metal and Flexible. The following is an example.

Construct each duct system for a minimum pressure classification of 1 inch w.g., and as follows:

6 Duct design Standards and adopted parameters : SMACNA : For construction and sealing practices
DW-144 : for classification of pressure and testing.
Duct pressure rating: All ductwork as described shall be low pressure class A

.

7. Duct material-Rigid sheet, lock-forming quality, As specified in the BOQ conformance Along with installation / Erection accessories : **Galvanized Steel Ducts:** ASTM A653 galvanized steel having G120 zinc coating (120 GSM) in with ASTM A90

Steel Ducts: ASTM [A1008] [A1011] [A568].

Aluminum Ducts: ASTM B209, aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.

Stainless Steel Ducts: ASTM [A167] [A666], Type [304.] [316.]

Galvanized steel (GSS)		
Standard	Thickness	**Gauge**
Inch	**mm**	
0.0197	0.5	26(not to be used)
0.0236	0.6	24
0.0276	0.7	
0.0315	0.8	22
0.0354	0.9	
0.0394	1	20
0.0472	1.2	18
0.063	1.6	16
0.0787	2	14
0.0984	2.5	12

unless otherwise specified steel sheet and strip used for duct and connectors shall be G 120 coated galvanized steel of lock forming grade conforming to ASTM A 653 and A 924 standards. Minimum yield strength for steel sheet and reinforcements is 30000 psi (207 kPa). However the following table should be adhered for sheet thickness for fabrication of ducts.

8. Duct sheet :

Aluminum		
Standard	Thickness	**Gauge**
inch	**mm**	
0.0197	0.5	26
0.0236	0.6	24
0.0276	0.7	
0.0315	0.8	22
0.0354	0.9	

thickness

0.0394	1	20
0.0472	1.2	
0.063	1.6	18
0.0787	2	16
0.0984	2.5	14

Fasteners: Rivets, bolts, or sheet metal screws.
Hanger Rod: Fully threaded GI rod. Use galvanized steel or aluminum, 6061-T6, hangers in contact with aluminum duct.
Hanger Straps: ASTM A653 galvanized steel having G120 zinc coating in conformance with ASTM A90..

Galvanized Steel, Cold rolled, low carbon, Lock forming quality, Grade D, Spangled, Plain sheet. Zinc coating shall be of grade 120,having mass of coating on both sides as 120 GSM or class viii confirming to IS 277 - 1997. Mill test certificates shall be provided. In addition if deemed necessary, the customers site engineer shall take samples at random and get the same tested for thickness and zinc coating at contractors expense. Alternatively, based on application, the duct material can also be Aluminum, confirming to IS 737. For exposed (not concealed) ducts those need finish painting, Galvanized, Zero spangled sheet shall be considered. See BOQ. For factory fabricated ducts, GSS /aluminum sheet raw material shall be used in coil form only, to limit the longitudinal joints at opposite corner edges. However, for ducts those are fabricated at site, discreet sheet may be used.

9. Fabrication and Installation : SMACNA - 2005 for factory fabricated ducts ; 250-500 Pa pressure rating IS 655 - 2006, For site, manual fabricated ducts , the duct PRESSURE CLASS shall be 250 Pa.

Fabricate ductwork, duct access doors and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible. Furnish duct material, gages, reinforcing, and sealing for design pressure class indicated.
Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide airfoil turning vanes constructed and installed in accordance with SMACNA Standards. Vanes are not required in return air sound trap elbows and transfer ducts.
Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard.
Provide, at minimum, rectangular 45 degree entry fittings for rectangular ducts and 45 degree ve takeoffs for round ducts.
Duct sizes noted are inside clear dimensions. [For lined ducts, maintain duct sizes inside lining.]
No variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is permitted except by written permission from LANL STR. Round ducts installed in place of rectangular ducts shall be sized in accordance with ASHRAE table of equivalent rectangular and round ducts.

Increase duct size gradually, not exceeding 15 degree divergence wherever possible. Do not exceed 30-degree divergence upstream of equipment. Do not exceed 45-degree convergence downstream of equipment.

10. DUCT FABRICATION SMACNA (with : Each rectangular, rigid, duct piece length shall be, of minimum 1200 mm long.
Transverse duct joints shall be at 1200 mm c/c.
Transverse duct connector shall be 4 bolt, rolled on flange system. The flange

exceptionprofile (TDF)shall be made out of duct sheet to minimize air leakage and ensure as described in faster installation at site.this chapterLongitudinal joint shall be Pittsburgh type, located at diagonally opposite corners.

Transverse duct connector shall be complete in all respect including galvanized corners, cleats, **and in the BOQ)**carriage bolts, flanged nuts and gasket. Gasket shall be non toxic and of food grade quality.

The duct sheet panels shall have beads all around, at 300 mm c/c, perpendicular to air flow direction for rigidity as recommended in SMACNA.

All duct work including straight sections, tapers, elbows etc shall be factory fabricated. However, transformations collars and to suit pieces only may be made manually on site, as per site constraints.

Ducting shall be made using CNC plasma profile cutter, auto folder, roll former, flanger and other related machines for dimensional accuracy and consistent quality.

All ducts shall have 4 Bolt transverse joints. Longitudinal Pittsburgh seam shall be located only on two opposite corners. The longitudinal seam shall be air tight with smooth surface finish.

Ducts and accessories including insulation within ceiling spaces, visible from air conditioned area shall be provided two coats of matt black finish paint.

Changes in dimension and transformation shall be gradual with aspect ratio a dual, keeping aspect ratio preferably within 1:4, not exceeding 1:7.

Necessary air turns/vanes shall be provided in all elbows and bends with divided fittings and collars. Branch connection shall be as per SMACNA.

All sheet metal plenum shall be factory fabricated, panel type, and shall be assembled at site. Plenum shall be fabricated from 18 G / 16 G GS sheet. The plenum should be adequately reinforced and stiffened with 25x25x3 mm angles as required.

To suit duct pieces fabricated manually at site, should have 4 bolt duct connector. However, this shall be Slip on flanges, rolled from GI section. To arrest air leakage, the 4 Bolt system shall be with built sealant. These factory made 4 bolt flanges should be fixed to duct using pop rivets.

The flange shall be suitably sized to provide adequate strength to duct. The duct pieces should be adequately reinforced, if necessary, to keep ducts true to shape and prevent buckling and breathing. The sheet metal thickness and 4 bolt TDF rating shall be strictly as per Table detailed here under.

The duct pieces shall be shipped to site un assembled, in two L sections. Boxing shall be done at site using electric seam closures or wooden mallet. The duct jointing of two corresponding pieces would mean tightening of 4 no's carriage bolts and installing cleats at no more than 150 mm from ends with spacing of 250 mm maximum. Requisite gasket should be properly provided between the pieces.

To facilitate identification, all duct pieces shall have a part number, corresponding to serial number assigned to it in measurement sheet.

For each drawing, all supply of duct work must be accompanied by computer generated detail bill of material indicating duct size, quantity and piece length with relation to part/serial number.

Each duct system shall be constructed for the specific duct pressure classifications shown on the contract drawings. Where no pressure classes are specified by the designer, the (1"-2") water gage (250- 500 pa) pressure class is the basis of compliance with these standards, regardless of velocity in the duct, except when the duct is variable volume.

11. TABLE 1- :

(Longitudinal seam -Pittsburgh)

Rectangular duct (for factory fabricated duct)

Duct Size	Sheet Thickness	Piece length	Transverse Joint	Intermediate
Mm	(G)	mm		
	GSS		**Rolled Form/TDF**	**600 c/c**
Upto 1000	24	1200	4 bolt connector	For duct sizes more than 750 additional Stiffners of the same size of threaded rod to be provided at 500mm distance
1001-1800	22	1200	4 bolt connector	
1801-2200	20	1200	4 bolt connector	
2201-above	18	1200	4 bolt connector	

12. TABLE 2 :Manual Fabrication of Duct at site-IS 655

Duct Size mm	Sheet Thickness (G)	Piece length mm	Transverse Joint	Intermediate Reinforcement
			Slip on TDC	**MS Angle**
0-750	24	2400 max	8mm bolt at 150mm centre	-
751-1500	22	2400 max	8mm bolt at 150mm centre	32x32x3
1501-2200	20	2400 max	8mm bolt at 150mm centre	40x40x3
& 2201 above	18	2400 max	8mm bolt at 150mm centre	50x50x3

13. Material of : All fasteners used in GSS duct work shall be galvanized or cadmium coated steel. All MS fastner angle if used for reinforcement shall be painted.

14. Transverse joint : transverse & Sealing

All ducts with 250 Pa and above pressure rating ,shall be sealed at all longitudinal joints namely, duct to duct, duct to branch and duct to collar tap. In addition, the duct which is upstream of VAV box shall be sealed. The sealant should be water based, solvent free, and should not contain chemicals, detrimental to health namely, silicone, asbestos, lead, mercury and mercury compounds and should be non toxic. This is in accordance to Seal class C of SMACNA 2005.

Seal duct seams and joints in accordance to the duct pressure classification as described in SMACNA HVAC Duct Construction Standards-Metal and Flexible
Seal joints between duct sections and duct seams with welds, gaskets, mastic adhesives, mastic plus embedded fabric systems, or tape.

Sealants, Mastics and Tapes: Conform to UL 181A. Provide products bearing appropriate UL 181A markings. Do not provide sealing products not bearing UL approval markings.

Do not use pressure-sensitive sealant on ducts with a pressure class of 1 inch w.g. or greater.

15. Allowable leakage :

Duct Pressure class	**Static pressure limit (Pa)**	**Maximum air velocity**	**Air leakage limits (L/S/SqM of duct surface area)**

as per DW-144 standards in ductwork classification

	Positive	Negative	(m/Sec)	
Low pressure-Class-A	250	250	8	$0.027 * P^{0.65}$
Medium pressure-Class-B	1000	750	20	$0.009 * P^{0.65}$
High pressure-Class-C	2000	750	40	$0.003 * P^{0.65}$
$F=C_L * P^{0.65}$				
F= Maximmum leakage (cfm/100 SqFt)				
C_L = Leakage class				
P= Pressure (in H_20)				
Leakage Class (C_L) -CFM Leakage per 100 Sft @ 1 inch H_2O				
Rectangular, Metal	24	12	6	
Round , Metal	12	6	3	

Acceptable leakage loss as per DW-144 (for guidance / approximation purposes) is as follows:

Class-A	Low pressure	6%
Class-B	Medium pressure	3%
Class-C	High pressure	2%

Suggested range of testing:

Class-A	Low pressure	Refer item No. XX
Class-B	Medium pressure	15% of the duct (main) and / OR as specified by the consulting engineer.
Class-C	High pressure	100%

16. Leakage Testing **:** After main duct with branches are installed, visually inspect for pin holes at corner,

transverse joints, cleat spacing, tapers etc for leakages. The internal of duct can be illuminated using electric bulb, to check for light rays emanating from duct joints to take corrective action. This exercise needs to be done in parts meticulously, before insulation. However for ducts with pressure rating of 50mm and above, air leakage test of main duct should be done using test kit comprising of blower with means to vary flow rate, orifice plate and manometers. The applicable standard shall be SMACNA -HVAC air leakage test manual.

ASHRAE Standard 90.1 (Section 6.4.4.2.2) does require leakage testing for ducts designed to operate at static pressures in excess of 3 inches w.g. The following is an example leakage test spec for duct pressure class (4 inches w.g.). Refer to SMACNA HVAC Air Duct Leakage Test Manual for other duct class leakage classification.

Leak test ducts with a duct pressure class in excess of [4] inches w.g. (over 3 in. up to 4 in. w.g.)

Perform leakage tests in accordance with the DW-144 Duct Leakage Test Manual, using tests forms equivalent to those outlined in manual.

Maximum Allowable Leakage: Comply with the following requirements

Leakage Classification for round and flat oval ducts based on leakage class constants.

Leakage Classification for rectangular ducts on leakage class constants.
Remake leaking joints and retest to ensure leakage is less than the minimum allowed

19. Round / Spiral duct work : Rigid round duct shall be fabricated from Galvanized steel sheets, with specs stated earlier.

The ducts shall be factory fabricated from GSS sheet. Ducts shall be with Spiral seam. Contractor shall decide length of spiral seam duct considering job layout, fittings frequency, potential for damage during shipment, maneuverability etc. However, duct length between joints than 3000 mm. Duct to duct joint shall be thro slip joint coupling/sleeve having groove in between. The minimum length of the coupling shall be 135mm.Pop rivets or screwsmust be used to join the duct with the slip coupling around the circumference at not more than 200 mm interval along the circumference. The slip coupling/sleeve shall be same thickness of sheet as the duct. While the reducers/expanders shall be plain conical,the elbows shall be of segmented standing seam fabricated on high speed, CNC plasma cutter, Gore locker etc.

Machine made spiral lock-seam duct constructed of galvanized steel with light reinforcing corrugations.

20. Thickness schedule :

Duct Diameter	Seam Type	Sheet Thickness
75 to 250mm	Spiral	26G
275 to 350mm	Spiral	24G
375 to 600mm	Spiral	24G
650 to 900mm	Spiral	22G

21. Supporting arrangement : All horizontal duct shall be independently supported from ceiling slab / structural elements. Theducts shall be rigid and securely supported. However the design should facilitate level adjustment at site. The supporting trapeze arrangement should be approved type. The support trapeze to include M S angle, Galvanized threaded rod with nuts and washer. Dash fasteners/anchor fasteners of adequate loading capacity should be used for taking the supports. Sufficient margin should be available on either side of slotted channel/MS angle to accommodate insulation thickness. The threaded rod should have margin to make level adjustment. The MS angle, should be machine cut, ends chamfered, with holes drilled.

Duct Size	Trapeze size	Suspension rod dia	Support spacing
Upto 1000	25x25x3	10	2400mm
1001-1500	40x40x5	12	2400mm
1501-1800	40x40x5	12	2400mm
1801-2200	50x50x5	12	2400mm
2201 & above	50x50x5	12	2400mm

However at bends, equipment connection etc based on site conditions, additional support should be provided. Also two supports on either side of flexible connection shall be provided to prevent duct sagging. Self adhesive rubber 5 mm thick, of 12 mm wide, shall be provided between duct insulation and duct support. Vertical riser ducts should be supported at every floor level using MS angle frame fitted to the duct and resting on the floor slab as detailed in SMACNA. Round duct shall be supported using clevis hangers/Ring type supporting clamps. The supporting clamps shall also be provided by duct manufacturer. The clamp shall be fabricated from minimum 50x50x5mmMS angle grouted to shaft or wall with anchor fastner, encircling the duct with nut and bolt on top. Support spacing shall be 2500 mm maximum.

22. Flexible ducts : Where shown in drawings (see BOQ), flexible ducts shall be used for connectingdiffuser and

connections boxes. Flexible ducts shall have double lamination of metalized polyester filmaluminum for indoor, permanently bonded and reinforced to a coated, helix corrosion free steel wire. The duct shall be non flammable with Class 1 rating, as per ASTM E 84/BS 476 part 5/6.The duct shall also be tear and puncture resistant. In case thermal insulation is required, the duct shall be wrapped externally at factory with 25 mm thick, 24 kg/cum fiberglass, covered with outer jacket cum vapors barrier, made out of fiberglass reinforced metalized polyester film. Flexible duct shall be supported every 1200 mm to avoid sagging,followmanufacturer's recommendation/ SMACNA.

23. Flexible : All duct work connection to fans are to be provided with fire rated double flexibleconnection.

Connection This will prevent transmission of vibration from moving machinery to ducting system. Flexible connection should also be provided across building expansion joints. Connection shall not exceed 200 mm in length, and shall be made from fire and moistureretardant double canvass. The connection shall be secured to make suitable aiir tightconnection with duct. Thickness and strength of flexible connection shall be rated for duct operating pressure.

24. Access door : Access doors shall be provided for all accessories fitted in ducts which require frequent

servicing and inspection. Doors shall be of at least 450x450 size. It should be rigid and hinged type and shall be provided with air tight gasket. Insulated ducts shall be with insulated doors preferably double skin, so as not to damage the duct insulation every time the access door is opened.

25. Air Balancing : Subsequent to commissioning of air distribution system, air balancing should be

done following established practices in SMACNA and ASHRAE. Air flow should be measured at each outlet, and checked with design. The record of such measurements shall be documented AHU wise.

The total air quantity of the unit should be checked along with Fan RPM. If necessary, corrective action need to be taken. The damper quadrants should be locked.

26. Duct Velocities :

	Supply	Extract
Main Runs	6-8 m/s	6-9 m/s
Branch Runs	4-6 m/s	5-7 m/s
Spigots	3-5 m/s	5-7 m/s

SECTION-03: AIR DUCT WORKS & ACCESSORIES –MECHANICAL PROCESS

CHAPTER-02 : AIR DUCT ACCESSORIES

1. Air Registers : Shall be of Extruded aluminum construction colour &as per the specifications detailed , hereunder.

The scope of this section includes supplying, installation, testing, balancing and commissioning of various air distribution products as specified here under. All air distribution products shall have guaranteed performance rating as regards to air quantity, throw, noise level and pressure drop etc. Contractor has to provide selection curves at the time of supply. Supply and return air registers and ceiling terminals shall be made of extruded Aluminum section as specified in BOQ. The registers/terminals shall be either anodised or powder coated in finish as mentioned in BOQ. Supply air registers/terminals shall be provided with screw operated opposed blade volume control device of extruded Aluminum in mill finish. The registers shall be suitable for fixing arrangement, concealed or visible screw as approved by architect/consultant

2. Linear Registers : Linear continuous supply or return air register shall be extruded Aluminum construction with fixed horizontal bars at 0 ° or 15 ° inclination with one way or two way deflection and flanges on both sides. The thickness of fixed bar louvers shall be5 mm in front and the flange shall be 20 mm wide with round edges. The register shall be suitable for concealed fixing and horizontal bars of the register shall be mechanically crimped from the back to hold them. Volume control device ofextruded Aluminum construction in mill finish shall be provided in S.A. duct collars.

NOTE: ALL DUCTWORK , FALSE CEILING CHANNELS / MEMBERS, SUPPORTS FOR FIXING OF GRILLS / LINEAR SLOT DIFFUSERS TO BE BLACK PAINTED (MAT FINISH) WHEREVER IT IS VISIBLE EITHER FROM BELOW OR FRONT.

3. Single Individual : Single individual adjustable horizontal /vertical supply or return air register shall be made of Adjustable Louvered extruded Aluminum construction. The louvers shall hold deflectionsettings under all condition supply air or return of velocity and pressure since mounted onNylon bushes. The registershall have 20 mm wide flange all around with front screw fixing

4. Double : The register shall be adjustable as each louver shall be pivoted to provide pattern with Adjustable 0° to plusor minus 15° arc up to 30° deflection down towards. Thelouver shall Holdair Louver register withdeflection S / Rsettings under all conditions of velocity and pressure . The Rear louverhorizontal / Verticalof the register shall bein black shade.Volume control device of extruded Aluminum louver Arrangement construction with mill finish shallbe provided in S.A. duct collars.

5. Rectangular : Supply/Return air all side flange air register shall be extruded Aluminum construction fixed bar with horizontal bars at 0° or 15° inclination with one way or two way deflection and flanges Register ron both sides. The thickness of fixed bar louvers shall be 5 mm in front andthe flange shall

be 20 mm wide with round edges. The register shall be suitable for concealed fixing and horizontal bars of the register shall be mechanically crimped from the back to hold them.

6. Exhaust Air horizontal register louvers : Exhaust air register shall be made of extruded Aluminum with fixed at 40° angle setting on a 20 mm louver pitch. The register shall have 20 mm wide flange with round edges all around. The register shall be suitable for front screw fixing.

7. Square ceiling Air terminals spring : Square/Rectangular ceiling air terminals shall be made of extruded Aluminum construction with pattern. The terminals shall have Anti-Smudge ring and loadedremovable central core in various pattern for air flow direction. The terminal shall be mounted by concealed screw fixing arrangement. The supply air terminal to be supplied with Volume control device of extruded Aluminum construction in mill finish.

8. Ventilation air shop intake drawing louvers : Ventilation air intake louvers 50 mm deep wherever required as per will be madeof extruded Aluminum construction duly Powder coated. Bird/insect screen to & be provided with the intake louvers. The blades are inclined at 45 °on a 40 mm blade pitch to minimise water ingress. The lowest blade of the assembly shall extended out slightly to facilitate disposal of rain water without falling in door/wall on which it is mounted. the intake louvers shall be provided with factory fitted all Aluminum construction volume control dampers in mill finish.

10. Air transfer provided as grill /double register : Extruded Aluminum construction air transfer door register will be approved shop drawings. The register will be complete with single frame to be mounted on door panel from both sides. The central core shall be NO-SEE-THRU type. The register shall be anodised or powder coated as per Architect's requirement. The register shall be provided with insect screen to prevent movement of insects from inside to outside or vice versa.

11. Fire and Smoke Damper : Motorized Combined Smoke & Fire damper- spring return type:

Damper Fire Rating Minimum 120 minutes.

All Supply and Return Air Ducts at AHU room crossings and at all floor crossings shall be provided with approved make fire and smoke dampers of at least120 minutes fire rating certified by CBRI Roorkee as per UL 555:1973. Fire Damper blades & outer frame shall be formed of 1.6 mm galvanized sheet steel. The damper blade shall be in pivoted on both ends using chrome plated spindles in self lubricated bronze bushes.

In normal position damper blade shall be held in open position with the help of a 24V operated electric actuators thereby providing maximum air passage without creating any noise or chatter.

The damper shall be actuated through electric actuator. The actuator shall be energized with the help of a signal from smoke detector (supplied by others) installed in AHU Room/R.A.Duct/Damper. The Fire Damper shall also close due to Temporize in S.A. Ducts thru the Electric Temp. Sensor factory set at 165° F micro switches with Bakelite base will be provided to

stop fan motor and give open & close signal at remote panel in case of motorized actuator. Each Dampers in case of motorized Smoke-cum-Fire Damper shall have its own panel which will incorporate necessary circuit required to step down voltage available from UPS or Emergency Power Supply to shown status of the damper (open or close), to allow remote testing of damper & indication in event of damper closure due to signal from smoke sensor/Temp. Sensor & reset button. Additional Terminal will be provided to have signaled (sound beep or visual) in Central Control Room. Damper Actuator shall be spring return so as to close the damper in the event of power failure automatically and open the same in case of power being restored. The Fire Dampers shall be mounted in fire rated wall with a duct sleeve 500 mm long. The sleeve shall be factory fitted on fire damper. The joints at sleeve end if ducted shall be factory .fabricated TDF jointsMinimum thickness of G1 Sheet for sleeveshall be 18 G. The damper shall be installed in accordance with the installation method recommended by the manufacturer.

After installation of Fire Dampers, contractor will seal the balance openings and then finally finish the same.

12. Volume control : Volume control dampers shall be provided to facilitate air balancing and isolation. For Dampers proper air distribution, dampers should be provided at each duct branch take offs those are located close to AHUs. Dampers are also required for areas which do not operate simultaneously for physical isolation. Damper shall be louver type in design, with opposed blade configuration. Thedamper shall be complete with suitable link, lever, quadrant and lacing device and shall be Box type in design.4 Bolt flange connector shall be provided with duct dampers for joining with duct. For sturdy design and limiting torque on blades, the damper blade length shall be based on shorter side of duct. The damper blades will be supported on bronze bush. All dampers shall have a locking device located on the outside of the case and shall give clear indication on the actual blade position. Length of single blade shall not be more than 900mm. If the length is more than 900 mm additionalstiffners shall be provided on the damper frame & blade.

Damper Frame : Minimum 16 gage [galvanized] / [stainless] steel with flanges for attaching to walls and flangeless frames for installing in ducts.

Blades : [Round, Single] [Multiple, Opposed] blade design. Minimum 16 gage [galvanized] [stainless] steel, maximum 8 inchwidth for multi-blade dampers. If required, stiffen damper blades for stability.

Bearings : [Molded synthetic, bronze, Nylon, or Teflon] as specified.

Mounting : Provide locking, indicating quadrant regulators on single and multi-blade dampers. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.

Duct Connection : Vertical] [Horizontal, air flow up] [Horizontal, air flow down] [Round] / [Rectangular] as specified in the drawings / BOQ

Types (as mentioned in the BOQ) : Hit & Miss damper for Slot Diffusers
Box type Dampers to be installed in ducts
Key operated dampers for collars for grill/diffuser outlet

13. Fresh Air / Exhaust from extruded Air Registers : All the louvers shall be rain protection type and shall be fabricated aluminum section. The minimum depth of louver assembly shall be 105mm. The louvers shall additionally be provided with heavy duty expanded metal (aluminum-alloy) bird screen.

14. Collar / Grill collars for Damper : Grill / Collar dampers shall be provided to facilitate air balancing In supply air proper air distribution, dampers should be provided at each supply air collar. Damper shall be louver type in design, with opposed blade configuration. Thedamper shall be complete with suitable link, lever, quadrant and lacing device and shall be Box type in design. For sturdy design and limiting torque on blades, the damper blade length shall be based on shorter side of duct. Length of single damper shall not be more than 900mm. If the length is more than 900 mm additional stiffners shall be provided on the damper frame. Grill / Collar dampers shall be made of Aluminium Construction finished in Mat Black colour.

SECTION-03: AIR DUCT WORKS & ACCESSORIES

CHAPTER- 03 : MECHANICAL INSTALLATION GUIDELINES

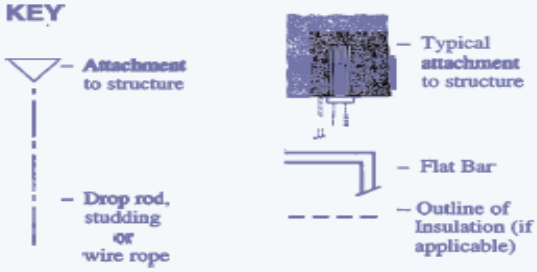
1. Metal Duct Work close duct openingswith : During the construction, the contractor shall temporarily sheet metal covers to prevent debris entering the duct. Great care shouldbe taken to ensure that the duct work is installed as per levels indicated in drawing. After ward of work the contractor shall visit site, take measurementsand ensure that his shop drawings are prepared accordingly so that ductlevels are maintained. Where duct spass thro brick partition wall, isolationbarrier should be provided between duct and opening. This can be done using UL listed .These are areas, where by design, return air is not supposed to, be moving aroundsupply air duct. All necessary allowances and provisions shall be made by the contractor for beams and other services whether the same is shown in the drawingor not. Toilet exhaust ducts in case of guest rooms/patient rooms ,cabins in office areas shall have gooseneck collars to avoid cross talk. Allducts shall be totally free from vibration under all conditions of operation, whenever duct work are connected to fans, air handling units. Flexible connections shall be provided. All material for supporting arrangement including anchor fasteners shall be as approved by consultant / client. The contractor shall provide and erect duct as may be required to carry out the intent of these specifications and drawings. The work shall meet with the approval of owners site representative in all its parts and details. If a duct cannot be run as shown in 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 representative. All support angles, if of MS, shall be primer coated and finish painted with black matt finish air drying synthetic enamel paint.

2. Horizontal duct-work suspended : All supporting / suspension / hanging arrangement for horizontally Ductswill be in the following manner, to be read in conjunction with the minimum requirements of material involved, as described above:

Arrangement of Bearers and Hangers

(to be read in conjunction with Table 15
which lists material sizes relative to duct sizes)

KEY

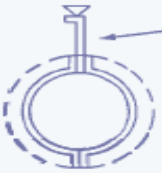


Limits refer to actual duct sizes – insulation is additional

Fig. 68 Rolled or Profiled Bearer Limit: NONE

Fig. 64 Wrap-Round Hanger Limit: 315 DIA

Fig. 69 Stirrup Limit: 600 wide



Limit: 315 DIA

Fig. 65 Flat Strap Hanger & Split Clips

Fig. 70 Flat Strap Hanger Limit: 600 wide

Fig. 66 Stirrup Limit: 2000 DIA

Fig. 71 Stirrup Limit: 1040 wide

Fig. 67 Flat Strap Hanger Limit: 2000 DIA

Fig. 72 Flat Strap Hanger Limit: 1040 wide

SUPPORT BEARERS

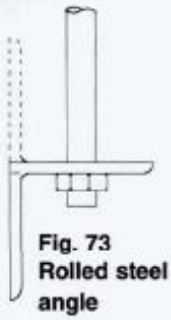


Fig. 73
Rolled steel angle

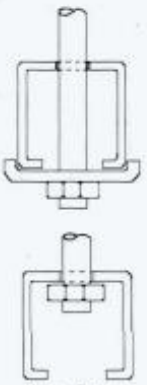


Fig. 74
Profile channel (alternatives)

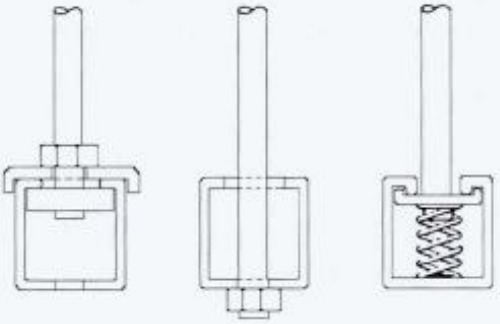


Fig. 75 Inverted profile channel (alternatives)

VERTICAL DUCTS

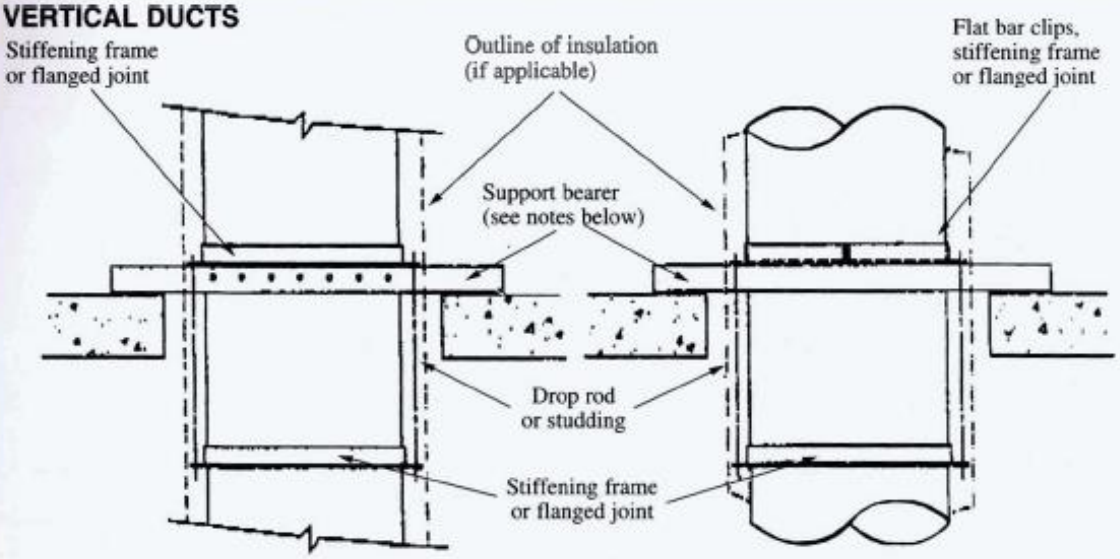


Fig. 76 Vertical rectangular ducts

Fig. 77 Vertical circular ducts

The support bearer, which, depending on duct/structural opening size, could be either channel or angle section, may be utilised in any of the following arrangements:-

a) Fixed directly to duct skin with sealed fixings (flat face only of either rectangular or flat oval)

b) To support the underside of a flat bar clip in halves (circular or flat oval)

c) To support the underside of either the stiffening frame of the flanged joint of any duct section

d) To support either a stiffening frame or a flanged joint below using drop rods/studding.

SECTION-04 : INSULATION WORKS

CHAPTER-01 : MECHANICAL PROCESS

1. Duct line Insulation

1.1	Insulation Material glasscloth, Closed cell	:	Anti-Microbial type, UL approved factory laminated elastomeric Nitrile Rubber class 'O'
1.2	Density	:	40-60 Kg/m3
1.3	Thickness	:	As per mentioned below
1.4	Thermal Conductivity	:	Shall not exceed 0.035 W/m.K at mean temperature of 0°C
1.5	Water Vapour Permeabilty Diffusion Resistance Factor	:	Shall not exceed 1.74 x 10^{-14} Kg / (m.s.Pa), i.e. Moisture or 'μ' value should be minimum 10000.
1.6	Special Features	:	Insulation material shall have anti-microbial product, which is EPA (Environmental Protection Agency), USA approved, as an integral part of insulation that cannot be washed off or worn off. It shall give enhanced level of protection against harmful Microbes such as bacteria, mold, mildew and fungi and should confirm to following standards: Fungi Resistance – ASTM G21 and Bacterial resistance – ASTM G 22 / ASTM 2180. The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990.
1.7	Life Safety Features	:	No toxic fumes upon burning should be emitted by the material. The thickness of the nitrile rubber insulation shall be as per in the schedule of quantity.
1.8	Class Surface	:	O' , Self extinguishing type, as per UL, and building regulation, spread of fumes as per class 1 conforming to BS 476 part 7: 1997
1.9	Submittals	:	Submit manufacturer's product data for review
2.	**Design Basis**	:	Condensation Control
	Non - Coastal Area specific	:	Pune, Delhi, Hydrabad, Bangalore etc.
	Duty condition	:	Design Conditions: 30 Deg. C & 82 % RH Required Thickness (mm)
	Supply Air Duct (Line Temperature 14 Deg. C	:	19mm
	Return Air Duct (Line	:	9mm

Temperature 24 Deg. C)

3. Exposed roof Insulation (If mentioned in BOQ)

3.1	Insulation Material	:	EPS, 'TF' Quality
3.2	Density	:	Kg / Cu M 24
3.3	Thickness	:	As per BOQ
3.4	Thermal Conductivity	:	mW/cm deg C 0.32
3.5	Water Vapour Permeabilty	:	1%
3.6	Special Features (Environmental)	:	Insulation material shall have anti-microbial product, which is EPA (Environmental Protection Agency), USA approved, as an integral part of insulation that can not be washed off or worn off. It shall give enhanced level of protection against harmful Microbes such as bacteria, mold, mildew and fungi and should confirm to following standards: Fungi Resistance – ASTM G21 and Bacterial resistance – ASTM G 22 / ASTM 2180.
3.7	Life Safety Features	:	No toxic fumes upon burning should be emitted by the material. The thickness of the nitrile rubber insulation shall be as per in the schedule of quantity.
3.8	Submittals	:	Submit manufacturer's product data for review

4. Pipe Insulation

4.1	Insulation Material	:	EPS, 'TF' Quality
4.2	Density	:	32Kg / Cu M
4.3	Thickness	:	50mm upto 150mm dia, 75mm above 150mm dia
4.4	Thermal Conductivity	:	mW/cm deg C 0.32
4.5	Water Vapour Permeabilty	:	1%
4.6	Special Features (Environmental)	:	Insulation material shall have anti-microbial product, as per EPA (Environmental Protection Agency), USA approved, as an integral part of insulation that can not be washed off or worn off. It shall give enhanced level of protection against harmful Microbes such as bacteria, mold, mildew and fungi and should confirm to following standards: Fungi Resistance – ASTM G21 and Bacterial resistance – ASTM G 22 / ASTM 2180.
4.7	Life Safety Features	:	No toxic fumes upon burning should be emitted by the

material.

4.8	Submittals	:	Submit manufacturer's product data for review

5.	**Design Basis**	:	Pipe Insulation (Condensation Control)
	Non - Coastal Area specific	:	Pune, Delhi, Hydrabad, Bangalore etc.
5,1	Duty conditions	:	) OUTDOOR & INDOOR) Design Conditions: 30 Deg. C & 82 % RH
	Application	:	Chilled water piping
	LINE TEMP	:	7 Deg.C
	Pipe NB (mm)	:	Required Thickness(mm)
	up to mm100		50mm
	125mm above &		75mm
	Chilled Water Tank		75mm
5.2	Application	:	Drain Piping
	LINE TEMP	:	14 Deg.C
	Pipe NB (mm)	:	Required Thickness(mm)
	up to mm50		25mm
5.3	Application	:	Refrigerant Piping
	LINE TEMP	:	3 Deg.C
	Pipe NB (mm)	:	Required Thickness(mm)
	up to 12mm		9mm
	12mm to 19mm		19mm
	19mm & above		32mm

SECTION-04 : INSULATION WORKS

CHAPTER-02 : MECHANICAL INSTALLATION GUIDELINES

1. Duct Insulation with Nitrile Rubber prior to : Duct surfaces shall be cleaned to remove all grease , oil,dirt carrying out insulation work.

Measurement of surface dimension shall be taken properly to cut Insulation material to size & sufficient allowances in dimensions.

Material should be fitted under compression & no stretching of material should be allowed.

A thin layer of adhesive shall be applied on the metal surface & on the insulating material at a ratio of 5 Smt./Lit.

When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond.

All longitudinal and transverse joints shall be sealed with 50mm wide and 2mm thick tape same as of insulation material.

2. Exposed Roof Insulation with with Expanded polysterene foreign material (Thermocole) : The underside of the slab should be thoroughly cleaned wire brushand rendered free from all matter and dirt .

Metal screws shall be fixed with rawl plugs to form a grid work of 1000mm x 500mm. 22G GI wire shall be tied to each screw with 2 equal ends

One coat of black japan paint at a ratio of 0.6 lit/Smt. shall be applied on the cleaned surface of the slab an a coat of of CPRX compound at a ratio of 1.2 Kg/Smt. shall be applied on the Extruded polystyrene Slabs.

Material should be then fixed tightly in position .

The joints of the interface of the insulating material shall be sealed with CPRX compound & then fixed with 2" x 2" of 26G GI washers tightly with screws & GI wire

All ceiling supports for the equipment, duct, etc. shall be done prior to fixing of Insulating Material.

3. Pipe Insulation with Expanded upto polysterene (Thermocole)-Indoor above 400mm dia : Insulating material in pipe sections of specified thickness 400mm & insheet form of specified thickness

The pipes should be thoroughly cleaned with wire brush and rendered free from all foreign material, oil and dirt

Apply a coat of Zinc chromate paint of approved make at a ratio of 0.4 lit/Sq.mt.

Fix Thermocole pipe sections of adequate size & thickness with CPRX at a ratio of 1.2Kg/Smt.

The joints of the interface of the insulating material shall be sealed with CPRX compound.

Cover it with 500 gauge polyethylene

Apply Jacketing on pipes as mentioned in Section-04, Chapter- 3 **(Jacketing-item no.3)**

4. Pipe Insulation with Expanded upto polysterene (Thermocole)-Outdoor above 400mm dia : Insulating material in pipe sections of specified thickness 400mm & insheet form of specified thickness

The pipes should be thoroughly cleaned with wire brush and rendered free from all foreign material, oil and dirt

Apply a coat of Zinc chromate paint of approved make at a ratio of 0.4 lit/Sq.mt. Fix Thermocole pipe sections of

adequate size & thickness with CPRX at a ratio of 1.2Kg/Smt.

The joints of the interface of the insulating material shall be sealed with CPRX compound. Cover it with 500 gauge polyethylene

Apply Jacketing on pipes as mentioned in Section-04, Chapter- 3 **(Jacketing-item no.1)**

SECTION-04 : INSULATION WORKS

CHAPTER-03 : MECHANICAL INSTALLATION GUIDELINES (JACKETING OF PIPES/ DUCTS /VESSELS)

1.	Sand Cement Plaster	:	Apply 2 layers of 1:3 sand cement plaster mixed with water proofing compound each of 12 mm thickness achieving smooth surface finish.
2.	Aluminium Sheet	:	Clad the Insulated pipes & valves with 24G Aluminium Sheet with screws to give a smooth finish.
3.	Fire proof Compound	:	Cover pipes/Ducts/vessels with 7 miles glass cloth/ fire proof canvass cloth – allow an additional 50mm for the overlap of the covering material. The Overlap shall be securely fixed using recommended Compound Apply UV compound paint liberally on Glass cloth/ canvass cloth at a ratio of 1.2Kg/Smt. in 3 layers. Even out with brush to give a smooth finish allow it to dry.

CHAPTER-01 : LT SWITCHBOARD (PANEL) AND SWITCHGEARS

General

This section covers the detailed requirements of medium voltage switchboard for 415 volts, 3 phase, 50 Hz, 4 wire system.

Standards and Codes

Updated and current Indian Standard Specifications and Codes of Practice will apply to the equipment and the work covered by the scope of this contract.

Low Voltage switchgear Assemblies IEC61 439-1/2, IS 8623
Low Voltage switchgear & control gear IEC 60 947 /IS 13947: 1993
Part I : General rules
Part II : Circuit Breakers
Part III : Switches, disconnectors, switch disconnectors and fuse combination units
Part IV : Contactors and Motor starters
Part V : Control circuit devices and switching elements Degree of Protection of Enclosures for low voltage switchgear. IEC60529 /IS 2147: 1962
Internal arc – IEC 61641

LT SWITCHBOARDS(FOR MAIN AC PANEL)

General

- The LV switchboards shall be **as per the standards IEC 61439-1.** The switchboards and the associated equipment including switchgear, control gear, Busbar supports, Busbar orientation, Busbar links etc shall be identical in construction to the assembly which has undergone the type test. The drawings of the type-tested assemblies shall be made available for inspection.

- Switchboards shall have a short circuit level withstand as per Schedule of Quantities and drawings.

- The enclosures shall be designed to take care of normal stress as well as abnormal electro-mechanical stress due to short circuit conditions. All covers and doors provided shall offer adequate safety to operating persons and provide ingress protection of IP 42 unless otherwise stated. Ventilating openings and vent outlets, if provided, shall be arranged such that same ingress protection of IP 42 is retained. Suitable pressure relief devices shall be provided to minimize danger to operator during internal fault conditions.

- The switchboard along with ACBs and connections should have been be type tested design at **CPRI**/Independent international test house for short circuit, temperature rise, protective earth short circuit test and dielectric tests of the ratings required .

For operator safety IP2 X (touch proof) protection to be available even after opening the feeder compartment door. The compartmentalization to be achieved by using metal separators, use of PVC sheet / Hylem sheets shall not be allowed.

As specified in the BOM the switchboard shall be form 4b, for form of separation only metallic covers shall be used, Hylem / PVC sheets shall not be allowed.

Switchboard Configuration

a) The Switchboard shall be configured with Air Circuit Breakers, MCCB's, MCB's and other equipment as called for in the schedule of quantities.

b) The MCCBs shall be arranged in multi-tier formation whereas the Air Circuit Breakers shall be arranged in Single or Double tier formation only to facilitate operation and maintenance.

c) The Switchboards shall be of adequate size with a provision of spare space to accommodate possible future additional switch gear.

d) OEM & Partner's name should be mentioned on Top of each all columns of switchboard.

e) There should be total discrimination and co-ordination between upstream and downstream switchgear & protection on devices i.e. ACBs, MCCBs etc. up to the service breaking capacity level as per IS/IEC -60947-2 for better continuity of supply and fault localization.

Constructional Features

i) The Switchboards shall be metal clad totally enclosed, floor mounted free standing type of modular extensible design suitable for indoor mounting.

ii) Switchboards construction shall employ the principle of compartmentalized and segregation for each circuit.

iii) Incomer and bus section panels or sections shall be separate and independent and shall not be wired with sections required for feeder. The incomer panel shall be suitable for receiving bus trunking or MV cable of size specified.

iv) Switchboards shall be made up of requisite vertical sections, which when coupled together, shall form continuous dead front switchboards.

v) Switchboard shall be readily extensible on both sides by addition of vertical sections after removal of the end covers.

vi) The switchboards shall be designed for use in high ambient temperature and humid tropical conditions as specified. Ease of inspections, cleaning and repairs while maintaining continuity of operation shall be provided in the design.

vii) Metal based neoprene gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust and vermin proof to provide a degree of protection of IP 42/IP 54 as stipulated in schedule of quantities . The unused openings within the switchboards shall be closed using suitable grommets.

Degree of Protection shall be IP54 Upto 2000A and IP42 above 2000A

viii) Special care to be taken to ensure effective earthing of the frame and doors of the switchboards

ix) Each vertical section shall be provided with a rear or side cable chamber housing the cable end connections and power/control cable terminations. There should be generous availability of space for ease of installation and maintenance with adequate safety for working in one vertical section without coming into contract with any live parts. The design of the switchboard shall allow standard extension chambers if required to accommodate cables.

x) Some switchboards may be required to be installed against the wall, for such application-documented designs shall be available.

xi) Switchboard panels and cubicles shall be fabricated with CRCA Sheet Steel of thickness not less than 2.0 mm and shall be folded and braced as necessary to provide a rigid support for all components. The doors and covers shall be fabricated from CRCA sheet steel of thickness not less than 2 mm. Joints of any kind in sheet metal shall be seam welded and all welding slag ground off and welding pits wiped smooth with plumber metal.

xii) All panels and covers shall be properly fitted and square with the frame. The holes in the panel shall be correctly positioned.

xiii) Switchboard shall be provided with "Danger Notice Plate" conforming to relevant Indian Standards.

xiv) Internal arc withstand of 65kA for 0.4sec

xv) Tested for internal arc performance as per IEC 61641 offering high ingress protection for dusty and humid environment meeting seismic zone -4 requirements

Switchboard Dimensional Limitations

- The overall height of the switchboard shall be limited to 2400 mm for all the Busbar ratings and type of switchboards. Panel should have integral base frame of 75mm, hence total panel height should not be more than 2475mm.

- The height of the operating handle, push buttons etc shall be restricted between 300 mm and 2000 mm from finished floor level.

- Other dimensional limits if any are specified separately.

Switchboard Compartmentalization

- For compartmentalized switchboards, separate totally enclosed compartments shall be provided for horizontal busbars, vertical busbars, ACBs, MCCBs, and cable alloys.

- The main board shall be with **Form 4b Construction with metallic shrouding only, FRP is not acceptable.**

- Earthed metal or insulated shutters shall be provided between drawout and fixed portion of the switchgear such that no lives parts are accessible with equipment drawn out. Degree of protection within compartments shall **be atleast IP 2X.**

- Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker in "ON" and "OFF" position.

- For all Circuit Breakers separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, control contactors and control MCB etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, busbars and connections.

- For Some MCCB feeders for critical loads like UPS it may be required to have operation only after opening the door, all other facilities like padlockable rotary handle to be provided for such feeder. It shall be possible to do this change during execution of order

- Each switchgear cubicles shall be fitted with label in front and back identifying the circuit, switchgear type, rating and duty. All operating device shall be located in front of switchgear only.

- A horizontal wire way with screwed cover shall be provided at the top to take interconnecting control wiring between vertical sections.

- Separate cable compartments running the height of the switchboard in the case of front access boards shall be provided for incoming and outgoing cables.

- Cable compartments shall be of adequate size for easy termination of all incoming and outgoing cables entering from bottom or top. The construction shall include necessary and adequate and proper support shall be provided in cable compartments to support and clamping the cable in the cable alley / cable chamber.

Switchboard Bus Bars

(a) Busbars shall be made of high conductivity, and high strength Aluminum E91 grade Busbars shall be of rectangular cross sections , not more than 6mm thickness better suitable for full load current for phase bus bars and half/ full rated current for neutral bus bar or as stipulated in schedule of quantities. Busbar shall be suitable to withstand the stresses of fault level as specified in schedule of quantities**.**

(b) Main Horizontal busbar and Neutral should be in same compartment.

(c) The bus bar system may comprise of a system of main horizontal bus bars and auxiliary vertical bus bars

run in bus bar alloy on either side in which the circuit could be arranged with front access for cable entrances

(d) The bus bars shall be supported on non-breakable, non-hygroscopic epoxy resin or glass fiber reinforced polymer insulated supports able to withstand operating temperature of 110^{O} C at regular intervals, to withstand the forces arising from a fault level as stipulated in schedule of quantities. **The material and the spacing of the Busbar supports should be same as per the type tested assembly**

(e) Auxiliary buses for control power supply, space heater power supply or any other specified service shall be provided. These buses shall be insulated, adequately supported and sized to suit specific requirement. The material for auxiliary supply bus will be insulated electrolytic copper. Wires.

(f) Clearances between phases should be in line with IEC.

Switchboard Interconnection

4. All connection and tap offs shall be through adequately sized connectors appropriate for fault level at location. This shall include tap off to feeders and instrument/control transformers.

5. For unit ratings upto 250 amps, PVC insulated 105 dg withstand, copper conductor wires of adequate size to carry full load current shall be used. The terminations of such interconnections shall be crimped. Solid connections shall be used for all rating of above 250 amps.

6. All connections, tappings, clamping, shall be made in an approved manner to ensure minimum contact resistance. All connections shall be firmly bolted and clamp with .even tension. Before assembly joint surfaces shall be filed or finished to remove burrs, dents and oxides and silvered to maintain good continuity at all joints. All screws, bolts, washers shall be zinc plated. Only 8.8 grade nuts and bolts shall be used for busbar connections.

Draw out Features

Air Circuit Breakers shall be provided in fully drawout cubicles, unless otherwise stated. These cubicles shall be such that drawout is possible without disconnection of the wires and cables. The power and control circuits shall have self-aligning and self-isolating contacts. Mechanical latches shall be integated in ACB at service, test and isolated position to ensure that Breaker is firmly latched in respective position. It shall not be possible to move the breaker from the position unless latch is manually operated.

Instrument Accommodation

- Al voltmeter and ammeter and other instruments shall be flushed mounted type of size 96 sq. mm conforming to class 1.5 to IS 1248 for accuracy. All voltmeter shall be protected with MPCBs.

- Instruments and indicating lamps shall not be mounted on the Circuit Breaker Compartment door for which a separate and adequate compartment shall be provided and the instrumentation shall be accessible for testing and maintenance without danger of accidental contact with live parts of the Switchboard.
- For MCCBs, instruments and indicating lamps can be provided on the compartment doors.
- The current transformers for metering and for protection shall be mounted on the solid copper/aluminium busbars with proper supports.
- On all the incomers of switch boards ON/OFF indicators lamps shall be provided suitable for operation on AC 230 volts supply. All lamps shall be protected by MCBs.

- For Incomer and important outgoing feeders comprehensive power meters shall be provided which shall display A , V, Pf , Hz ,Kw , KVA,KVAr, Kwh , Kvarh , average and maximum values , demand values , THD on current and Voltages. Also add on modules for RS485 port , programmable contacts, analogue output etc to link to BMS/SCADA system

Wiring

All wiring for relays and meters shall be with PVC insulated copper conductor wires. The wiring shall be coded and labeled with approved ferrules for identification. The minimum size of copper conductor

control wires shall be 2.5 sq. mm. Runs of wires shall be neatly bunched and suitably supported and clamped. Means shall be provided for easy identification of wires. Identification ferrules shall used at both end of wires. All control wires meant for external connections are to be brought out on a terminal board**. The cables and control wires shall be suitable for withstanding 105 deg C.**

Space Heaters

Anti- condensation heaters shall be fitted in each cubicle together with an ON/OFF isolating switch suitable for electrical operation at 230 volts A.C 50 Hz single phase of sufficient capacity to raise the internal ambient temperature by 5° C. The electrical apparatus so protected shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the switchboard is in operation. As a general rule, the heaters shall be placed at the bottom of the cubicle.

Earthing

Continuous earth bus sized for prospective fault current to be provided with arrangement for connecting to station earth at two points. Hinged doors / frames to be connected to earth through adequately sized flexible braids.

Sheet Steel Treatment And Painting

Sheet steel used in the fabrication of switchboards shall undergo a rigorous cleaning and surface treatment seven tank process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognised phosphating process after which a coat of primer paint compactively with the final paint shall be applied over the treated surface. Final paint coat of oven baked powder coating, of minimum 50 micron thickness, of sheet approved by Engineer-in-Charge shall then be provided.

Name Plates and Labels

Suitable engraved white on black name plates and identification labels of metal for all Switchboards and Circuits shall be provided. These shall indicate the feeder number and feeder designation.

Type test reports.

Switchboard configurations offered shall be CPRI /Independent international test house tested for all the tests as per IEC61439-1 and internal arc tests. Copies of the test certificates shall be submitted with the tender.

Testing at Works

Copies of type test carried out at ACB/ MCCB manufacturers works and routine tests carried out at the switchboard fabricators shop shall be furnished along with the delivery of the switchboards. Engineer-in-Charge reserves the right to get the switchboard inspected by their representative at fabricators works prior to dispatch to site to witness the followings.

a) Physical variation and dimensional check
b) Verification of bill of material
c) Functional check
d) HV test
e) IR test

LV Panel Communication general characteristics

The communicating switchboard system comprises:

One or more interfaces

The following information shall be accessible: in accordance with the IEC/EN 60947-5-1 standard for circuit breakers at all the layers of electrical distribution architecture (modular feeders up to incomer circuit breakers) :ON/OFF position (O/F) / trip indication (SD) / fault-trip indication (SDE).
Cradle management : Draw out position

The following commands shall be possible in accordance with the IEC/EN 60947-5-1 standard

Open / close / reset.

When advanced trip units are used the following information shall be accessible:
Instantaneous and demand values, maxi meters/minimeters, energy metering, demand current and power, power quality.

Protection and alarm setting
Time-stamped trip and alarm histories and event tables Maintenance indicators.
Gathering digital and analog inputs and controlling output.
Energy meter in accordance with the IEC/EN – 62053-21 & 31standard

Interfaces required for Smart Panel

Energy management system shall offer main interface and secondary interfaces for energy management issue. Data shall be collected via Ethernet TCP/IP and ModBus networks which communicating circuit breakers, I/O digital and analog input modules, pulse counter, power meter and energy meter will be connected to interface.

A switchboard display shall be connected via Ethernet TCP/IP network to switchboard interface and shall offer a real time direct data access to monitor and control devices and load.

Ethernet Communication interfaces will be compliant to Device Profile Web Service (DPWS) for discovery on the local area network (LAN).

Energy management interface shall offer direct access to data collection to monitor and control devices and load.

Energy management interface shall collect:

7. Data from communicating circuit breaker with embedded measurement capability
8. Pulse from metering pulse electrical, gas, water counters
9. Data from communicating energy meters or power meters
10. Logic state of technical devices or equipment
11. **Device alarms with time logs**
12. Temperature analog sensor value.

Energy management interface shall display via web pages:

- Energy consumption
- **Electrical data network monitoring**
- **Alarms and events**
- Energy quality monitoring
- Equipment or devices status (open, close, tripped, NA) and indication of fault types (LT, ST, instantaneous, ground fault) faulty phases, Interrupted current.
- Operation and predictive maintenance monitoring.

Energy management interface shall integrate simple control functions via web pages:

- Load and devices via digital output
- Orders of actuator

Technical Specifications Ethernet Gateway

Dimensions (HxWxD) 80.8 x 72 x 65.8 mm
Mounting Din rail
Power supply 24 Vdc
Operating temperature -25 to 70°C
Humidity rating 5 to 95% relative humidity (without condensation) at +55°C
Immunity as per EN 61000

Serial ports

- Number of ports 1
- Types of ports RS232 or RS485 (2-wire or 4-wire), depending on settings
- Protocol Modbus RTU/ASCII, PowerLogic (SY/MAX), Jbus
- Maximum baud rate 38400 or 57600 baud depending on settings

Ethernet port

- Number of ports 1
- Type of port 10/100 Base TX (802.3af) port
- Protocol HTTP, Modbus TCP/IP, FTP, SNMP (MIB II), BootP

Web server

- Memory for logging the custom web pages
- Minimum memory of at least 512 Mb

CONSTRUCTIONAL FEATURES(for AHU/FAN PANELS)

- The MV Panel shall be modular in design. There shall be welding only in the main frame of the panel. The frame shall be assembled with Mild Steel tripod for three dimensional flexibility in design configuration. The profiles used in the assembly of the panel shall be restricted to only two designs. Each profile should have holes of standard size punched at standard pitch throughout the length of the profile. This facilitates the joining of vertical and horizontal members with three dimensional joiners of Mild Steel The joining of these members shall be dust and vermin proof and for this plastic profiled washers are to be used.

- Doors shall be with concealed hinges and flush type locks. The doors shall be reversible in design from LHS to RHS and vice-versa. All doors shall be earthed to the profile by a yellow green 2.5 Sq. mm. wire lugged at both ends. Doors that are bolted for busbar chambers should be flush in design such that the bolt head and the door surface are in one level. Each bolt shall have plastic washers on the other side of the door such that the bolt will remain with the door on removal of the door.

- All switchgears shall be mounted on clamps and fixtures such that there shall be flexibility for adjustments in X, Y & Z axis. All partitions shall be made out of CRCA sheets. These partitions shall not be used for load bearing of switchgears. The profiles and doors shall be of 2 mm thick CRCA sheet and powder coated to RAL 7032. The partitions shall be of 1.6 mm CRCA sheet as specified above.

- Modular type MV Panel to assemble low voltage switchgear and Aluminium busbar arrangement. The switch handle shall be interlocked such that the door of enclosure cannot be opened unless the switch is in OFF position, however, mechanical interlock defeat mechanism has to be provided. All MCCB's / Switches only operating knob / handle shall only be visible other portion should be covered by suitable sheet. All rear doors shall be of hinged type with locking arrangement. Detachable bottom plates shall be provided at the cable compartments and terminal chamber. Liberal space shall be provided in the cable compartment as well as switch compartment to facilitate termination of cables. Provision shall be made for clamping the cables in the cable compartment.

- The panel shall have easily-removable and interchangeable sections. All service shall be capable of being performed with access from the front plus and a choice of any one side or rear for installation flexibility. A tool shall be required to remove the exterior panels, which access the hazardous voltage area of the unit. To ensure grounding integrity and for static protection and EMI/RFI shielding, the removable exterior panels shall be grounded to the frame by way of stranded copper wire. Hinged doors shall provided access to the main input circuit breaker, and to all output switchgears.

- The unit shall be naturally convection-cooled. No fans for forced-air cooling system shall be used. The convection cooling method shall allow continuous full-load operation without activation of over-temperature circuits. Aluminium bus bars, sized in accordance with the NEC shall withstand 900C minimum. Both for reliability and Heat rejection shall be through screened protective sides, which prohibits entry of foreign material.

- The busbar sizes should not be less than 120% of the rated current in amps & it should be so selected that the temperature should not rise 50 C above ambient. Aluminium busbar shall be supported with high quality non-hygroscopic insulating material. Separate busbar compartment

provided on the sides housing three phase and neutral busbar should have front bolted cover, side busbar chamber shall have standardized dimension of 300 mm. The rating of the neutral busbar shall be 100% of that of phase busbar wherever required. The busbar shall be of Aluminium.

- Power terminal blocks or bus-bar or bus-bar extensions shall be provided for each input and output feeders as per the switchgear rating and a parity-sized insulated ground conductor. All the outputs of 63A TPN & below shall be terminated to a Busbar type terminal connector at the rear side of the panel using C-rail. All the live parts of the terminations shall be provided with shrouding by transparent perplex sheet of not less than 4 mm thick. A separate housing for the Power Capacitor inside the panel shall be made. The accessories for proper fixing of the CT's shall be provided.

- The frame shall be configured to accept future field augmentation of additional cubicle sections.

- The panel shall be supplied along with base plinth of 100 mm. height for each modular section and shall be made of C – channel forming sectional `Box'.

- The panel shall be powder coated with mat finish. The colour of the panel shall be siemens grey (color code IS:952) and block color to the plinth.

LT Switchgear

Air Circuit Breakers (ACB)

General

- The ACB shall confirm to IEC/IS – 60947-2. The ACB shall have a rated service short circuit breaking capacity (Ics) as specified in BOQ "Technical parameters" at rated operational voltage(Ue) at 415V, frequency at 50 Hz. The ultimate breaking capacity (Icu) shall be equal to Service breaking capacity (Ics) and Short Ckt Withstand capacity (Ics=Icu=Icw for 1 see) rated Impulse withstand voltage(Uimp) shall be 12kv and rated insulation voltage (Ui) at 1000V. The ACB release should have true RMS sensing .ACB should have single frame size up to 4000A and shall be suitable for "Switch Disconnect" function (AC 23 utilization category). The construction of circuit breakers shall be as per **pollution degree 4**.

- The breaker shall provide class II insulation between the front panel and internal power circuits to avoid any accidental contact with the live main current carrying path with the front cover open.

- Protective devices, metering, CTs, PTs, push buttons and indicating lamps shall be provided as per schedule of quantities.

Constructional Features

- The Circuit Breaker shall be flush front, metal clad, horizontal draw-out pattern, three/four pole as required and fully interlocked. Each Circuit Breaker shall be housed in a separate compartment enclosed on all sides.

- The Circuit Breaker cradle shall be designed and constructed to permit smooth withdrawal and insertion. The movement shall be free of jerks, easy to operate. Mechanical Latch to be provided to identify the Isolated , test & service position of breaker to prevent over racking.

- All current carrying parts in the breaker shall be silver plated and suitable arcing contacts shall be provided to protect the main contacts which shall be separate from the main contacts and easily replaceable. In addition, Arc chutes shall be provided for each pole, and these shall be suitable for being lifted out for the inspection of the main and the arcing contacts.

- The circuit breaker shall have indication of mechanical wear of contacts enabling visible indication of contact life.

- Self aligning cluster type isolating contacts shall be provided for the Circuit Breaker, with automatically operated shutters to screen live cluster contacts when the Breaker is withdrawn from the cubicle. Sliding connections including those for the auxiliary contacts and control wiring shall also be of the self aligning type. The fixed portion of the sliding connections shall have easy access for maintenance purposes.

- There shall be flexibility in changing the types of terminals at site to suit the bus bar orientation if required.

- The frame of the circuit breaker shall be uniform upto 4000Amps.

- The cubicle for housing the Breaker shall be free standing dead front pattern, fabricated from the best quality sheet steel.

Operating Mechanism

- The Circuit Breaker shall be trip free with independent manual spring operated or motor wound spring operated mechanism as specified and with mechanical ON/OFF indication. The operating mechanism shall be such that the circuit breaker is at all times free to open immediately the trip coil is energised. The breaker shall be provided with in built antipumping mechanism.

- The closing time shall be less than or equal to 70 ms to ensure faster closing of the breaker. And tripping time should be less than 30 ms to reduce the let through energy in the event of fault.

- The operating handle and mechanical trip push button shall be at the front of and integral with the Circuit Breaker.

- There shall be mechanical indicator on the front panel for 'Ready to close' situation for the breaker by checking all interlockings.

- The Circuit Breaker shall have the following four distinct and separate positions which shall be indicated on the face of the panel. The breaker shall get latched in each of three position namely Service , Test and Isolated, operator to de latch before racking in/out to other position

"Service" -- Both main and secondary isolating contacts closed
"Test" -- Main isolating contacts open and secondary isolating contacts closed
"Isolated" -- Both main and secondary isolating contacts open

Circuit Breaker Interlocking

- Sequence type strain free interlocks shall be provided to ensure the following:

- It shall not be possible for the Breaker to be withdrawn from the cubicle when in the "ON" position. To achieve this, suitable mechanism shall be provided to lock the Breaker in the tripped position before the Breaker is isolated.

- It shall not be possible for the Breaker to be switched "ON" until it is either in the fully inserted position or, for testing purposes, it is in the fully isolated position.

- It shall not be possible for the Circuit Breaker to be plugged in unless it is in the OFF position.

- A safety latch shall be provided to ensure that the movement of the Breaker, as it is withdrawn, is checked before it is completely out of the cubicle, thus preventing its accidental fall due to its weight.

- Mechanical and electrical antipumping devices shall be incorporated in the ACB's as required.

Circuit Breaker Auxiliary Contacts

The Circuit Breaker shall have suitable free / minimum 4 NO/NC auxiliary contacts rated at 10 amps 415 volts 50 Hz. These contacts shall be approachable from the front for connecting all external wiring from the front. They shall close before the main contacts when the Circuit Breaker is plugged in and vice versa when the Circuit Breaker is Drawn Out of the cubicle.

Electrical Auxiliaries

- All electrical auxiliaries, including the spring charging gear motor shall be instalable on site without requiring adjustment or any tools other than a screw driver

- The auxiliaries shall be placed in a compartment which under normal operating conditions, shall not contain any conducting parts capable of entering into electrical contact with the circuit breaker poles. It shall be possible to connect all auxiliary wiring from the front of the circuit breaker.

Circuit breaker Releases

The Air Circuit Breakers should have microprocessor release.

The Incoming circuit breaker to be equipped with the microprocessor based release with adjustable short circuit protection with adjustable time delay, Over current protection , and adjustable earth fault protection with adjustable time dely. The release should have graphical display showing the IDMT curve. It should have display of all electrical parameters like V , A , W , VAR, VA , Wh, VARh, Vah It should be possible to store tripping history of last ten faults with time and date of fault and the type of fault with values .

ACB should have thermal Memory and Zone selective interlocking for logic discrimination to reduce thermal/electrodynamics stresses in the event of short circuit and earth fault.

The outgoing ACBs should have microprocessor based Release with Short circuit and overload protections with Display of current. Percentage loading indication of all the three phases of the breaker to be available on the release.

On line setting of the parameters should be possible.

The setting of the ACB should be possible digitally as well as with dial settings with the help of screwdriver.

Option of communication port on all types of the releases, even if the same is not specified at the time of ordering.

As an option it should be possible to have programmable contacts if required at later date.
96X96 Display Module shall be provided on the panel door which should have following features

Earthing

The frame of the Circuit Breaker shall be positively earthed when the Circuit Breaker is racked into the cubicle.

MOULDED CASE CIRCUIT BREAKERS (MCCB)

General

The Molded case circuit Breaker (MCCB) shall confirm to the latest IEC 60947-2 and IEC 947-3-1989. MCCB's shall be suitable for rated operation voltage up to 415 VAC & rated insulation voltage up to 690 VAC.

MCCB's in AC circuits shall be of triple pole / four pole construction as per enclosed BOQ. Operating mechanism shall be Double break quick-make, quick-break and trip-free type. The "ON", "OFF" and "TRIP" positions of the MCCB's shall be clearly indicated and visible to the operator when mounted as in service. Front of door operating handle shall be provided with pad lock and door interlock. Front of door operating handle shall be provided with door interlock defeat mechanism to facilitate inspection of the

MCCB during 'ON' position. MCCB shall be suitable for Positive isolation / disconnection according to IEC 60947-1 & 2 for optimum user safety.

The Service short circuit Breaking capacity (Ics at 415 VAC) of all MCCB's shall be as specified in BOQ and shall have (Ics=100% Icu).

All MCCB should have "Class-II" front facia as per IEC 60664.

Construction, operation, environment

For maximum safety, the power contacts shall be insulated in an enclosure made of a thermosetting.

All poles shall operate simultaneously for circuit breaker opening, closing and tripping.

MCCBs shall be actuated by a toggle or handle that clearly indicates the three positions: ON, OFF and TRIPPED.

In order to ensure suitability for isolation complying with IEC 60947-2 § 7-27:

- The operating mechanism shall be designed such that the toggle or handle can only be in OFF position (O) if the power contacts are all actually separated,
- In OFF position, the toggle or handle shall indicate the isolation position.

Isolation shall be provided by a double break on the main circuit.

MCCBs shall be equipped with a "push to trip" button in front to test operation and the opening of the poles.

MCCB rating, "push to trip" button, performances and contact position indication must be clearly visible and accessible from the front, through the front panel or the door of the switchboard.

MCCBs shall have cross bolted/shrouded terminals to withstand thermodynamic stress at higher short circuit current.

MCCB's for Main LT Panel shall be provided with Plug-in Base.

Discrimination, Durability

MCCBs shall be capable of greatly limiting currents. For short-circuits, the maximum thermal stress I^2t shall be limited to:

- 10^6 A^2s for ratings up to 250 A,
- 5×10^6 A^2s for ratings between 400 A and 630 A.

The electrical durability of MCCBs, as defined by IEC 60947-2 standard, shall be at least equal to 3 times the minimum required by the standard.

MCCBs shall be equipped with a self-test of the connection between the electronic trip unit, the current transformers and the actuator, that will not cause the circuit-breaker to trip.
The self-test will be of positive logic and visible through the flashing of a green LED in case the self-test occurred correctly and the extinction of the LED in case the self-test failed.
The MCCB shall trip in case the environmental conditions of the circuit-breaker get out of their specified range. However, it will be possible to overrule this feature.
Having double break contacts for minimum let through energy and better current limitation

Auxiliaries and Accessories

It shall be possible to equip MCCBs with a motor mechanism for electrically controlled operation. An "auto/manual" switch in front shall, when set to the "manual" position, lock out electrical control; when set to "auto", lock out the manual control; remote indication of "manual" or "auto" mode shall be possible. It shall also be possible to seal the access to the "auto" control.

Following tripping due to electrical faults (overload, short-circuit, earth fault), remote reset shall be inhibited.
It shall however be possible if opening was initiated by a voltage release.
The operating mechanism shall be of the stored-energy type only

The addition of a motor mechanism or a rotary handle shall in no way affect circuit breaker characteristics:
- only three stable tripping mechanism positions (ON, OFF and TRIPPED) shall be possible with the motor mechanism,
- Suitability for isolation shall be provided by positive contact indication (ON and OFF) in front of the motor mechanism module

MCCBs shall be designed to enable safe on-site installation of auxiliaries such as voltage releases (shunt and under voltage releases) and indication switches as follows:
- they shall be separated from power circuits,
- all electrical auxiliaries shall be of the snap-in type and fitted with terminal blocks,
- all auxiliaries shall be common for the entire range,
- Auxiliary function and terminals shall be permanently engraved on the case of the circuit breaker and the auxiliary itself,
- The addition of auxiliaries shall not increase the volume of the circuit breaker.

The addition of a motor mechanism module or a rotary handle, etc., shall not mask or block device settings

Protection functions

General recommendations

MCCBs shall have interchangeable trip units.

Electronic and thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorized access to the settings

Electronic trip units shall comply with appendix F of IEC 60947-2 standard (measurement of rms current values, electromagnetic compatibility, etc.)

Protection settings shall apply to all circuit breaker poles

The trip units shall not augment overall circuit breaker volume

All electronic components shall withstand temperatures up to 125 °C.

Thermal-magnetic trip units (up to 250 A)

Characteristics:
- Adjustable thermal protection from 0.7 to 1.0 times the current rating
- Fixed magnetic protection for current ratings up to 200 A
- Adjustable (from 5 to 10 times the current rating) for current ratings greater than 200 A.

It shall be possible to ensure neutral protection. The tripping threshold shall be equal to that of the phases or to a reduced value (generally half of that of the phases).

Microprocessor trip units (above 250 A)

Characteristics

- Long time protection (LT)

Selectable Ir threshold settings from 36% to 100 % of the trip unit rating

- Short time protection (ST)

Isd threshold shall be adjustable from 1,5 to 10 times the thermal setting Ir,
The time delay shall be either adjustable or fixed at 40 ms,
- Instantaneous protection
The threshold shall be either adjustable or fixed (starting from 1.5 times In and up to a value between 11 and 15 times In, depending on the rating)

Communication

MCCB should have option for communication in the Main LT Panel for critical feeders i.e RS 485 communication port wherever mentioned in BOM.

Load monitoring function

The following monitoring functions shall be integral parts of electronic trip units:

- 2 LED for load indication, one lighted above 90 % of Ir, and one lighted above 105 % of Ir

Thermal memory

All the MCCBs should have thermal memory feature.

In the event of repeated overloads, the electronic trip unit shall optimize protection of cables and downstream devices by memorizing temperature variations.

Multi-Function Meters
Meters for Main LT Panel

Power Meter Specifications

- The present specification applies to power meter devices from 110V to 690V direct connect or up to 1MV with potential transformers in different system configurations from single phase to three phase AC (50/60Hz).
- The Power meters with following features shall be included as part of this project and identified on the single-line drawings:
- Basic level Monitoring with the features to include energy, demand, power, harmonics, 3 current transformer inputs and real time battery backed
- Serial communication, 8-rate multi tariff, up to 15th Individual harmonics, 1 digital outputs & total of 33 alarms events.

Compliance to Standards

- **ANSI**: ANSI C12.20
- **European Standards:** EN 50470-1, EN 55011
- **Federal Communications Commission:** FCC 47 CFR Part 15
- **IEC:** IEC 61000-3-2, 61000-3-3, 61000-3-4, 61000-3-5, 61000-3-6, 61000-3-8, 61000-3-11, IEC 61010-1, IEC 61557-12, IEC 62052-11, IEC 62053-22, IEC 62053-23,
- **ISO:** ISO 9001, ISO 14001, ISO 14062
- **Underwriters Laboratories, Inc:** UL 61010-1

Power meter design
General Provisions– Common Features

- The power meter may be applied in single phase, three-phase, three- or four-wire systems in WYE or Delta mode and shall be capable of being applied without modification at nominal frequencies of 50 or 60Hz.
- The power meter shall have a **real time clock with battery back-up** with at least 1 year ride through time without external power.

Mechanical

The power meter unit shall have removable connectors for voltage inputs, control power, communications, input and outputs.

The power meter unit shall be easily mounted in the pre-made cut-out without tools.

Power meter form factor shall be ¼ DIN with 92 x 92 mm (3.622" x 3.622") cut-out and 96 x 96 mm (3.78" x 3.78") panel mount integrated display.

Sampling and Harmonic Resolution

The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 15th harmonic (fundamental of 50/60 Hz). The circuit monitor shall provide continuous sampling at a minimum of up to 64 samples/cycle simultaneously on all voltage and current channels in the meter.

Current Inputs

0-10 amps with 5 amps nominal input from CT secondary.

The power meter may be applied in three-phase, three- or four-wire systems.

Residual current shall be calculated by vectorial addition of the phase currents.

Voltage Inputs

Nominal of 400 V L-N / 690 V L-L.

Maximum of 480 V L-N / 828 V L-L.

Control Power (Device)

The monitoring device control power shall be:

100-415 VAC L-N ±10% or 125-250 ± 20% VDC .

Environmental Characteristics

Operating Temperature Range of meter: 25 to 70 °C (-13 to 158 °F),display -20 to 70 °C (-4 to 158 °F)

Accuracy

The power meter unit shall use four-quadrant metering. The power meter shall sample current and voltage simultaneously without gaps with 64 samples per cycle (zero blind)

The power meter device shall comply with ANSI C12.20 Class 0.5 and IEC 61557-12 Class 0.5 for revenue meters

Accuracy for Active energy of the power meter shall be class 0.5S as per IEC 62053-22

Accuracy for reactive energy of the power meter shall be class 2S as per IEC 62053-24 (reactive energy)

No annual calibration shall be required to maintain this accuracy.

Input /Output

The power meter shall support 1 solid state output.

Energy quantities

Cumulative quantities for real, reactive and apparent energies shall be stored in non-volatile memory.

The power meter shall allow pre-setting of the energy quantity at any value within the register range via communications, to match a unit being replaced in the field.

The power meter shall provide the user the ability to reset the cumulative energy quantities from the display of the unit or via communications.

Alarming

Alarm events shall be user definable.

Setpoint driven alarm events shall be available for voltage/current parameters, input status, and end of interval status. For each over/under metered value alarm, the user shall be able to define a pick-up, drop-out, and delay

The power meter shall have a minimum of 28 set-point driven alarms

There shall be four alarm severity levels in order to make it easier for the user to respond to the most important events first.

Historical alarms shall have a time stamping with 1 second accuracy. The meter's real time clock shall be able to synchronize using communications command.

Indication of an alarm condition shall be given on the front panel.

Communications

The power meter shall communicate via serial RS-485 Modbus or Jbus protocol.

Display

The power meter display shall be backlit dot-matrix LCD for easy viewing, display shall also be anti-glare and scratch resistant with a minimum of 128x128 pixels.(PM Device)

The power meter display shall be capable of allowing the user to view four values on one screen at the same time. A summary screen shall also be available to allow the user to view a snapshot of the system. (PM Device)

The power meter display shall allow the user to select a date/time format.

The power meter display shall allow configuration for IEC or IEEE visualization of quantities.

Firmware Upgrade

It shall be possible to field upgrade the firmware in the power meters to enhance functionality. These firmware upgrades shall be done through the Ethernet or serial communication connection and shall allow upgrades of individual meters or groups.

Measured Values

The power meters shall provide the following, true RMS metered quantities. In addition, the power meters shall record and save in nonvolatile memory the minimum and maximum values of all

listed values since last reset. The power meters shall also record and save in nonvolatile memory the interval minimum, maximum, and average of any of the values pre-defined over a user specified interval

Real-time readings

Current (Per-phase, 3-Phase Avg, % Unbalanced)
Neutral and Ground (4CTs)
Voltage (L–L Per-phase, L-L 3-Phase Avg, L–N Per-Phase, 3-Phase Avg, % Unbalanced)
Real Power (Per-phase, 3-Phase Total)
Reactive Power (Per-phase, 3-Phase Total)
Apparent Power (Per-phase, 3-Phase Total)
Power Factor (True/Displacement)(Per-phase, 3-Phase Total)
Frequency
THD, thd, TDD (Current and Voltage), Individual harmonics up to the order of 15th

Energy Readings

Accumulated Energy (Real kWh, Reactive kVARh, Apparent kVAh) (Signed/Absolute)
Active Energy Delivered for 4 independent rates
Reactive Energy Delivered for 4 independent rates in

Demand Readings

Demand Current Calculations (Per-Phase, 3-Phase Avg, Neutral)- Present and Peak

Demand Calculations (3-Phase Total):

Real Power
Reactive Power
Apparent Power

All power demand calculations shall use any one of the following calculation methods, selectable bythe user:

Thermal demand using a sliding window technique.
Block interval, with optional sub-intervals. Block methods available are Sliding, Fixed and Rolling.
Demand can be calculated using a Synchronization signal:
Demand can be synchronized to an input pulse from an external source.
Demand can be synchronized to a communication signal.
Demand can be synchronized to the clock in the power meter

Power Analysis Values

THD, thd – Voltage, Current (3-Phase, Per-phase)
Power Factor (Per-phase, 3-Phase)
Displacement Power Factor (Per-phase, 3-Phase)
Fundamental Voltage, Magnitude and Angle (Per-phase)
Fundamental Currents, Magnitude and Angle (Per-phase)
Fundamental Real Power (Per-phase, 3-Phase)
Fundamental Reactive Power (Per-phase)
Harmonic Power (Per-phase, 3-Phase)
Unbalance (Current and Voltage)
Harmonic Magnitudes (Per-phase)
Total Demand distortion factor (TDD)

MOTOR PROTECTION CIRCUIT BREAKER :

The Motor Protection Circuit Breaker (MPCB) shall be used for DOL / STAR-DELTA starting of motors up to 110.0 KW shall offer protection to motors against overload, short circuit and phase failure. The MPCB's shall be suitable for Type 2 co-ordination. It shall have quick make, quick break mechanism suitable for AC 3 duty and shall be capable of operating in temperatures up to 55 degree centigrade and temperature compensated. The MPCB's shall have a minimum breaking capacity of 50 KA at 415 V 50 Hz. The MPCB's shall have rotary door operating mechanism handle and shall have a facility to accommodate auxiliary contact, short circuit signaling contact, under voltage release and shunt trip.

6. Miniature Circuit Breaker (MCB)

Miniature circuit breakers shall be of approved design and make and must be tested and validated as per IS/IEC 60898, IEC/EN 60898 and IEC 60947-2 standards.

MCBs shall be suitable for operation at 230V/415V, 50Hz supply. The MCB ratings shall be available from 1--125A in 1P/2P/3P/4P versions. The rated short circuit capacity acc to IS/IEC 60898 shall be of 10,000A. MCBs shall be offered with B, C or D tripping characteristics as per the BOQ requirements. The MCBs shall be suitable for mounting on a 35mm DIN rail.

MCBs shall carry ISI and CE marking. The MCB manufacturer (through the bidder) has to submit the valid BIS license certificate at the time of offer submission.

MCBs shallensure complete electrical Isolation of downstream circuit or equipment, when the MCB is switched OFF **(to be marked on the MCB in symbolic form)**

IP 20 Degree of Protection shall be ensured to prevent electrical shocks by accidental touch to any live parts, by providing finger touch proof terminals.

Energy Limitation Class-3 shall be to ensure minimum let through energy in the event of a fault, for safety & longevity of downstream circuit equipment. **(to be mentioned on the MCB as per standards)**

MCBs shall be line-load reversible with no derating.

MCBs shall have bi-connect facility to terminate fork type busbar and wires, simultaneously. Terminal capacity shall be minimum 25 sq.mm. for ratings up to 25A, and 35 sq.mm. for ratings 32A & above to ensure perfect termination of wires and cables. Terminals of MCBs shall have captive screws.

Basic technical parameters, rating, operating voltage, energy limiting class 3 etc. shall be printed on front face of MCB for ease of identification.

The devices must be capable of heavy-duty operation and to that end, the manufacturer shall guarantee the following performance levels, defined by IEC / EN 60947-2 standards:

- suitability for isolation (section 7.2.7)
- rated insulation voltage (section 4.3.1.2): 500 V
- pollution degree (Part 1, section 6.1.3.2): 3
- rated impulse-withstand voltage (section 4.3.1.3): 6 kV
- Discrimination for power continuity
- Validated Cascading tables as per standard IEC 60947-2

Operating knob shall have provision to lock in ON / OFF condition without affecting any automatic tripping

Circuit-breakers shall be capable of operation under ambient temperature up to **50 °C, without derating** of their overload tripping threshold with respect to their rated operating current. The same must be tested and validated as per IEC 60947-2 standard.

The material used to manufacture MCB shall be 100% recyclable and must comply to **RoHS and REACH standards.**

MCBs shall be suitable for field-fittable Protection auxiliaries (viz. Over-voltage release, Under-voltage release, Shunt trip) and Indication Auxiliaries (like Auxiliary Contact, Trip alarm contact).

MCBs shall be upgraded on communication (On/Off/Trip) at site by adding communication capable auxiliaries and communication can be over RS485 or Ethernet i.e.TCP/IP through Ethernet gateway.

7. Motor Control & Protection

There should be total coordination between MPCB, Overload relay & Contactor.

Totally coordinated starter up to 15KW as per IEC 60947-6-2,starter module should have breaking capacity of 50kA at 480V, which can be increased up to 130 kA. Overload and Short circuit fault discrimination should be available on power base of starter module. DOL starter should be available in 45 m width. All 5 starter functions should be available in single module of 154*45mm.Starter module

should be modular type to adopt late customization of function. Starter Module should have facility of current base protection, monitoring and control of motor feeder.. Low consumption coils should be available in wide voltage band selection from 24V -220V AC/DC.

Wide operational ambient temperature of -25°C to +60°C.Electrical life of starter module as per AC3 should be 2.1 million operations.

SECTION – 06 :CHILLER PLANT MANAGER

CHAPTER-01 : WATER COOLED CHILLED WATER PLANT AUTOMATION

GENERAL

1.1 SCOPE – WATER COOLED CHILLED WATER PLANT CONTROL SYSTEM DESCRIPTION

- This specification applies to the automation of a water-Cooled Chiller Plant, which has identical/ Non-identical water cooled Chillers in parallel, and with headered constant speed primary and headered variable speed secondary pumps.
- The system description is available in the annexed documents and as below:

  Pumping : PSV

  Parallel

  No. of zones : 1

  Chilled water supply demand : DP sensor based

  The chiller system manager shall be a Hand Held Module based system. It shall combine the latest state of the art technology and shall be used to control & manage alarms and monitor building service installations.
  The system shall be logically structured into distinctive levels which are management level, automation level and field level.

  Each level shall be autonomous from the other. Peer to peer communication shall be possible on all system levels and the system design be modular in structure to allow straightforward extensions.

  The essential functions of the system are as follows: Centralized operation of the plant (remote control)
  - Early recognition of faults
  - Faults statistics for identification
  - Trend register to identify discrepancies, energy consumption, etc.
  - Preventive maintenance and plant servicing
  - Optimum support of personnel
  - Control optimization of all connected electrical and mechanical plant
  - Prevention of unauthorized or unwanted access
  - Own error diagnosis integrated system
  - Communicate with the IBMS over the Energy management system software for reporting and G.U.I.

- The plant control system shall be supplied with all the hardware, software and programming required to control the required water cooled chillers, cooling towers, primary / secondary (as the case may be) , condenser water pumps and all associated modulating / isolation valves etc. including 1 system by-pass valve to maintain minimum

flow (in case of PVF chillers) and up to 5 zone demand sensors (which can either be differential pressure or temperature sensors).

- The quantity of chillers, pumps, valves and demand sensors to be controlled shall be independently configurable (from 1 to the values in paragraph B) on-site at the graphic user interface by selection from pull down menus, without requiring reprogramming or software download. All schematics, tables and menus in the graphic user interface shall show only the data and graphics corresponding to the selected configuration.

- Deleted

- The plant control system shall be supplied with all the hardware, software and programming required to be seamlessly integrated with the reporting and remote read-write capabilities of the building automation system (BAS). The control system shall allow field adjustments of control parameters as described below.

- To be quoted as a separate additional price: A remote fault detection and diagnostics service shall be provided including quarterly performance reports and calibration for the first full year following commissioning.

- To be quoted as a separate additional price: Preventative maintenance and service shall be available directly from the manufacturer. This service should include inspection and review of key components, assessment of operation conditions, control system tuning, software upgrades as they are released, back-up and secure storage of parameters and annual training for the Building Operators.

1.2 RELATED SECTIONS

- HVAC instrumentation and controls / Section : Integrated Automated Facility Controls

- Chiller

- HVAC packaged pumping system

- BUILDING AUTOMATION AND CONTROL

- Building Systems Controls

- HVAC Control Systems

1.3 STANDARDS REFERENCES AND QUALITY ASSURANCE

- The Chilled Water Plant Control System shall be assembled with components that conform to the latest edition of the following as applicable:

  - ANSI – American National Standards Institute
  - NEMA – National Electrical Manufacturers Association
  - UL – Underwriters Laboratories
  - CSA – Canadian Standards Association
  - IEC - Degrees Of Protection Provided By Enclosures (IP Code)
  - ASHRAE 90.1-[2013] - American Society of Heating, Refrigeration and Air-Conditioning Engineers – Energy Efficient Design of New Buildings
  - ASHRAE 100 - American Society of Heating, Refrigeration and Air-Conditioning Engineers – Energy Efficient Design of Existent Buildings

- The chilled water plant control system manufacturer must hold an ISO 9000 QA certification or approved equal.

1.4 INSTALLATION AND CONTROL CONTRACTOR RESPONSIBILITIES

- The controls contractor is responsible for the following:
  - Inspect interior and exterior and report any obvious damage or equipment shifting that may have taken place between the time the unit arrived on site and when in its final resting position
  - Mechanical installation of the control package and mount in place. Re-align and level the control panels.
  - Install all life safety equipment as needed
  - All field electrical connections to the unit. Hook up electrical supply needed by the plant control system (including field sensors). Connect with the BAS and confirm that BAS is ready to send/receive commands to the control system. Provide internet connection to the automation system.
  - Field connect equipment including pressure/temperature sensors, flow meters and their associated wiring to the unit (a list of field installed equipment will be supplied, along with installation instructions). As required by device instructions, where necessary, calibrate all sensors and auto valves.
  - Touch up and paint scratches and minor dents occurred during hoisting and rigging
  - Permits and inspections needed to start up the system
  - Start-up of system with the supervision of manufacturer personnel

1.5 SUBMITTALS

- Provide a complete Chilled Water Plant Control System Submittal with all requirements as defined in the GENERAL requirements of these specifications. As a minimum, the Submittal shall include the following:
  - Dimensional drawings of the main components, also indicating weight and any special hoisting or working space clearances requirements
  - Description of system operation
  - Electrical power and control wiring diagram
  - Control layout drawing with sequence of operation

1.6 OPERATION AND MAINTENANCE MANUALS

- As a minimum, the Operation and Maintenance Manual shall include:
  - System summary sheet
  - Description of system operation, with equipment and control sequence of operation
  - Electrical power and control wiring diagrams
  - Installation and maintenance manuals from equipment manufacturers
  - Snapshots of all graphic user interface screens, with description of all variables and recommended tuning values or tuning methods.

- Submittals and operation and maintenance manuals shall be assembled in a neat and orderly manner and bound in booklet form. Include a front page that identifies the job particulars followed by a table of contents.

1.7 START-UP, COMMISSIONING, WARRANTY AND SERVICE

- The start-up and commissioning will be by a local Armstrong representative who is fully supported by Armstrong factory staff remotely.
- Warranty period: the latest of [12] months from commissioning sign off or [18] months from shipment.
- To be quoted as a separate additional price: First Year - diagnostic services
  - Following the date of commissioning completion, the vendor shall provide a ___ year (1 year minimum) of continuous diagnostic and health management service covering the central chilled water plant.
  - The service shall include a web based self-serve interface.
  - Included in the web interface shall be:
    - Tracking of the project energy savings relative to the baseline:
    - The baseline shall be calculated using measured equipment performance over a minimum of 90 days of continuous plant operation, or from building modelling software in accordance with ASHRAE Standard140 Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs.
    - Summaries via the web shall also include ongoing tracking of the performance relative to the predicted performance. The predicted performance will be based on daily measured building loads and external temperature and humidity. The assessment of the chilled water plant will include kW draws from each of the following: chiller(s), chilled water pump(s), condenser water pump(s) and cooling tower fan(s)
    - Financial savings shall be calculated using the $/kWh rate provided by the customer. This shall include a provision for time of use "TOU" rates (if applicable) by applying the specific TOU rate to the savings per hour as measured and reported in the ongoing diagnostic service. Savings in energy shall be the difference between the actual chiller plant kW draw per hour compared to the baseline adjusted for the prevailing weather and building load to match that particular hour of measured consumption.
  - The service shall include 4 (quarterly reports) that at a minimum include:
    - Summary of plant efficiency profiled against operating loads
    - Detailed chart of how the chilled water plant performed relative to the predicted performance.
    - The predicted performance will be calculated as outlined above
    - The report shall summarize of key findings regarding overall performance
    - Recommendations to improve the efficiency of the overall chilled water plant based on the analysis
    - The detailed quarterly report will be delivered electronically no later than 6 weeks at the end of the preceding quarter.
  - Daily summaries shall be generated and provided in email or other electronic notification that summarize the actual measured efficiency of the chilled water plant relative to the predicted efficiency. The predicted efficiency shall be based on the

outdoor weather conditions for the day (temperature and humidity in combination with the building load).

- An automatic email summary of notifications shall be customizable to fit the project specific instrumentation selected by the owner. Daily email notifications shall include options for the following:
  - Chiller high evaporator approach (only available for Chillers with Serial communication)
  - Chiller high condenser approach (only available for Chillers with Serial communication and Outside Air Temperature sensor is provided by others)
  - Chiller excessive run hours
  - Unstable chilled water supply
  - Low delta t syndrome
  - Chiller efficiency below expectations
  - Pump rpm different than recommended
  - Compressor excessive vibration (available if vibration sensors installed are provided by others)
  - Pumps excessive vibration (available if vibration sensors installed are provided by others)
  - High pump kW relative to chiller kW

PART 2- PRODUCT

1.1 MANUFACTURERS

- Acceptable Manufacturer: The water cooled chilled water plant control system shall be the IPC9511
- Substitutions: Not permitted.

1.2 HARDWARE

- CHILLED WATER PLANT CONTROL SYSTEM AND ASSOCIATED EQUIPMENT
  - The chilled water plant control system shall be a stand-alone system capable of operating independently of the Building Management System (BMS), and at the same time capable of receiving remote instructions from the BMS.
  - The plant automation shall be performed solely by the PLC alongwith the hand held device and the PC shall not be required for plant operation, other than initial setup or configuration.
  - The chilled water plant control system shall include a combination of hand held device-based and PLC controller.
  - The chilled water plant control system shall have an internal circuit breaker and run on 100-240 Vac /1Ph/50-60Hz power supply.
    - 10.4" back-lit touch screen LCD panel
    - Operation temperature range: 0°C - 45°C (32°F-113°F) (must not be exposed to direct sunlight)
    - Operation humidity range: 5% - 95%, non-condensing
    - Power supply: AC 100-240V, 500 W
    - {select one of the following} {UL mark, FCC compliant} or {CE mark, EN 61000-4-3 compliant}
  - The control system shall have a key lockable {select one of the following} {NEMA 12} or {NEMA 4} or {IP54} or {IP55} rated cabinet. All operator interface control switches, indicators and displays shall be physically separated from any field

terminations. Manual backup control switches and indicators must be protected from unauthorized operation by a key lockable door.

- The plant control system shall have Hand-Off-Automatic (H-O-A) control for each variable speed primary pump. The virtual H-O-A switch shall be accessible through the touch screen display, and in Hand mode, the control system shall allow the pump speed to be manually set and changed.

- **SCREEN**

- The chilled water plant control system shall include a back-lit touch screen color display operator interface of at least 10.4" and show active-element schematic displays with links to sub-menus for status reports, data and setup menu options. Keypad based interfaces, LCD readouts, and LED displays will not be accepted. The control system shall perform online self-diagnostic testing of the CPU(s), RAM, and flash memory. No data shall be lost during power supply interruptions.

- The control system shall be self-prompting. All messages shall be displayed in plain English, French, Spanish, Chinese and Portuguese. The operator interface shall have store in memory at least 50 faults and be able to recall them on the screen, on-screen help functions, and separate user screens for:
  - Chiller configuration
  - Pump configuration
  - Differential pressure, flow, and temperature sensors' setup
  - Zone setups (including calibration of differential pressure/temperature sensor range)
  - Alarm history and event review
  - Display of zone status, chiller status, pump status and system status
  - Factory default / commissioning setup data
  - Best Efficiency Point speed setup
  - PID control parameters setup
  - BAS communication setup
  - System schematic(s) showing chillers, pumps and valves operating parameters and sensors readings

- **INSTRUMENTATION**

- The chilled water plant control system shall provide the following remote mounted transmitters and sensors to be installed and wired back to the central plant control system by the installing contractor:

- Temperature sensors, pressure sensors and flow meter shall be installed by the contractor as indicated in the shop drawings to modulate the chilled water system.

- Temperature sensors shall be self-contained RTD type temperature transmitter with a temperature range of (-400 to 1076°F) (-240 to 580°C) for chilled water systems designed to meet NEMA-4X (IP66) construction. The temperature probe shall use a platinum, wire wound, sensing element in a 316SS sheath, spring loaded and inserted into a ½" NPT stainless steel thermo well. The thermo well shall penetrate one-half the pipe diameter. The two probes of the supply and return temperature sensors shall be matched pair. Sensors shall not be locally adjustable. The accuracy of the temperature sensor shall be 0.5% of span and shall be calibrated and traceable to NIST. The temperature transmitter shall receive its power input and send its current output, 4-20 mA, over the same pair of low voltage wires. Sensors shall be mounted such that effects of radiation from heating elements are minimized and rapid response to changing temperature is achieved. The stability of the transmitter/probe assembly shall be +/0.001% of

span/100 Ohms of lead resistance. Wiring installed by the contractor between the control system and the transmitters shall be Belden 9320, 2-wire, shielded, twisted cable (or equivalent) and shall not be placed in conduit containing wiring for alternating current. Supply and return temperature sensor shall be field installed and wired by the contractor between the chillers and the bypass line.

- Pressure sensors shall be complete, self-contained, variable capacitance type, stainless steel construction differential pressure transmitters designed to meet NEMA-4X (IP66) construction and provide a 4-20 mA signal output. The accuracy of the pressure sensor shall be 0.5% of span including linearity, hysteresis and repeatability. Wiring terminals and electronics shall be in separate compartments, so the electronics remain sealed during installation. Reverse polarity protection shall be included to keep wiring mishaps from damaging the transmitter. Wiring between the control system and the transmitters, provided by the installing contractor, shall be Belden 9320, 2 wire, shielded twisted cable (or equivalent) and shall not be placed in conduit containing AC electrical wiring. Pressure switches shall have adjustable ranges and adjustable differentials to suit the application. Pressure sensor shall be field installed and wired by the contractor.
- The flow sensor shall be a high precision magnetic flow meter with no moving parts. Paddle and turbine type sensors will not be accepted. The sensor shall have a maximum operating pressure of 300 psi, operating temperature range of 5°F to 158°F. Accuracy shall be within 0.5% of actual reading at the calibrated typical velocity and within +2% of reading over 200:1 turndown (from 0.05 to 10 m/s). Provide certificate of calibration with each flow sensor. The sensor shall have integral 4-20mA analog output linear to within +0.1% of calibrated span for connection to the control system. The flow sensor shall be constructed of stainless steel with NEMA 4 (IP65) protection. Contractor shall supply hot tap installation, in order to be both insertable and removable through a ball valve when the pipe is under pressure. Flow meter shall be field installed and wired by the contractor. The sensor shall be field mounted and wired in accordance with manufacturer's instructions.

- **SOFTWARE**

- Capabilities: The chilled water plant control system software shall be preprogrammed to perform, but will not be limited to, the following:
  - Manual or automatic control system
  - Schedule start/stop
  - Duty cycling
  - Automatic lock-out of malfunctioning equipment
  - Backup sequences of control for any sensor failure
  - Automatic temperature control
  - Pump control to satisfy zones demand
  - Control sequences for dedicated and for headered pumps
  - Control sequences for dual dedicated pumps with options for duty/duty, duty/standby and lead/lag operation
  - Optimized sequencing of headered pumps
  - Control sequences for Sensorless™ and zone sensors pump speed control options
  - Zone setpoints reset based on most open load valve
  - Optimized sequencing of chillers based on cooling demand
  - Sequencing of chillers override to prevent exceeding their kW rating and FLA
  - Supply temperature set point reset
  - Load shedding / Demand limit
  - Scanning and alarm processing
  - Graphic screen reporting

- Trend Logging

- User Friendliness: The chilled water plant control system software shall be easy to operate. Operators shall be able to perform the following operations after one day of training:
  - View systems parameters
  - Select relevant screens, systems and points
  - Turn on and off controlled points manually
  - Acknowledge alarms
  - Log trend data

- Input/Output: A complete point schedule shall be provided detailing analogue and digital input and output point description, functions, types and any special requirements. The control system shall be capable of accepting and processing appropriate signals (Differential Pressure, Temperature, or Flow) for the following dedicated terminal blocks:
  - Up to 5 analog inputs (AI) for zone differential pressure, Temperature, signals 4-20 mA
  - 2 AIs one for DP transmitter and one for flow sensor
  - 5 digital inputs (DI), one per pump, differential pressure switch
  - 1 DI for remote connection for start/stop
  - 5 DIs for Isolation Valve Feedback
  - 5 DOs for Isolation valve control
  - 5 DIs for chiller alarm
  - 5 DOs for chiller start/stop signal
  - 5 AOs for chiller demand limit control
  - 1 AO for chiller Chilled Water Setpoint
  - 1 DI for alarm silencer,
  - 3 DO for alarms: (a) controller communication alarm, (b) differential pressure transmitter alarm, (c) general system alarm
  - 1 serial RS485 port and 1 Ethernet port for communication with the BMS,
  - 1 serial port for communication with the VFDs,
  - 1 terminal block for power supply 100-240 Vac/1 phase/50-60 Hz

- Trending and Reporting Capabilities: The control system shall provide a data-logging feature with 1 year of data at 5 minutes intervals and shall be capable of displaying the alarm history on its graphical touch screen display. The data must be easily downloadable monthly in a csv format file.

- The chilled water plant control system shall display live and trend data on demand. The control system shall provide graphic screens of system schematics.

- Communication Protocol: The chilled water plant control system shall be able to communicate with the Building Automation System over one or more of the following protocols: Modbus RTU, Modbus TCP, BACnet MS/TP, BACnet IP, Lonworks.

- The control system shall have preprogrammed Modbus communication points for Danfoss, Yaskawa and ABB drives and for Yorktalk 2, Yorktalk 3, SmartDT, McQuay AWG and McQuay Water-cooled chillers, AND / OR as applicable for the project, based on client domain information (to be discussed during bidding process).

- The plant control system shall allow changes to the field the network address of equipment it communicates with (chillers, variable speed pumps, etc.) and its own address on the interface it communicates to the BAS. Network addresses cannot be hard coded.

- Remote Access: The chilled water plant control system shall include webserver functionality and be accessible through an internet TCP/IP internet address with read/write functionality. This access shall allow the relevant staff to:
  - Remotely view all screens available at the local graphic user interface (GUI), with the same functionality. I.e.: view plant status, view and modify parameters and setpoints, override equipment and navigate screens.
  - View all available live and historic data
  - Receive alarm messages, automatically processed and conveyed via the network and via email.
  - Upgrade the plant control system software from the remote stations. Such remote upgrading shall not interrupt the plant operation and shall not require local intervention, (like locking equipment in manual).
  - BAS/BMS and Internet connection shall be provided by others, but the controls contractor installing the plant control system is responsible of requesting it and coordinating with the IT contractor.
  - Remote manual override by the BAS shall be possible for the following equipment settings:
    - Control System ON/OFF
    - Plant Mechanical mode/Stand-by mode

- Alarms: Alarms shall be generated and the alarm messages shall be displayed in clear textual form on the screen, until it is acknowledged by the operator. Alarms shall include but not limited to the following list:

1.2 System fault alarms
1.3 General alarm
1.4 Pumps run feedback alarms
1.5 Chiller alarms
1.6 Pump alarm
1.7 Drive fault alarms
1.8 No flow alarm
1.9 Zone/sensor alarm
1.10 Drive communication alarm
1.11 4 potential free contacts shall be provided for general alarm, hooter/ buzzer, communication alarm and general sensor alarm

- Safety Features shall include but not limited to the following list:
  - Auto omission of pump in case of pump failure
  - Auto omission of chiller in case of chiller failure
  - Auto omission of zone/sensor in case of any zone sensor
  - Backup sequences in case of flow sensor failure, temperature sensor failure, and all zone sensors failure.
  - Sequencing of chillers to prevent the flow through the running chillers to exceed their rated maximum (or fall below their minimum), or to exceed the power consumed by the running chillers to exceed their rated maximum
  - Program distributed over several PLCs in such way that if those handling the most complex functions and remote communications fail, the lower level ones will keep the plant running with simpler logic.
  - Indication of any Failure (or) malfunctioning in the touchscreen screen user interface, the remote access screens, in the BAS communication and via email to the operator.
  - Pumps status confirmation with differential pressure switches
  - Remote stop for emergency shutdown.

- Graphics shall be included for ease of system operation. Graphic screens shall include, but will not be limited to, the following:
  - System schematic
  - Chiller system schematic

- Building loop schematic

- Access Security: The control system shall have at least three levels of password security: one level for field adjustable parameters, a second for factory/commissioning setup parameters and a third for BAS communication commissioning.

- Sequence of Operation:
  - All plant control system settings, including the number of chillers and pumps, as well as how they are connected (headered or dedicated) can be modified at the graphic user interface (GUI) after entering the appropriate password.
  - The plant control system determines the most efficient combination of operating pumps, and pump operating speed based on the zone differential pressure, zone Temperature sensor signals and/or Parallel Sensorless as per the field adjustable configuration.
  - The control system shall continuously monitor all zone signals to determine an active control zone. Use of a multiplexer for multiple sensor inputs is not acceptable.
  - The control system shall respond to the most dissatisfied zone by increasing either, the number of operating pumps, or the pump speed.
  - The control system shall automatically disable any zone differential pressure or Temperature signals that are not within limits and alert the operator of a possible transmitter failure. If system found all differential pressure/temperature sensors failure in the building, the pump speed will default to a pre-defined percent of full speed (factory default loaded as 95% of full speed).
  - The pump logic control system shall sequence the pumps based on a field adjustable interval of operating hours with a "bump-less" transfer algorithm. The control system incorporates an adjustable PID control loop and embedded logic to prevent hunting.
  - The control system shall determine the optimum numbers of chillers to operate based on the plant load (thermal energy rejected) or to prevent the flow through the running chillers to exceed their rated maximum (or fall below their minimum), or to exceed the power consumed by the running chillers to exceed their rated maximum, or to prevent the supply temperature to exceed the setpoint by a field adjustable offset.
  - For each chiller the control system has an adjustable field to enter its capacity. The plant load (in Tons and %) is displayed on the touch screen display and used to Stage On and Off the chillers, in conjunction with the other conditions explained in the previous paragraph.
  - The control system shall rotate the Lead chiller on a field adjustable interval of operating hours. Should any chiller fail, the control system will trigger an alarm on the touch screen display and remove said chiller from the auto sequence and rotation.
  - The control system shall be capable of interfacing with up to 5 isolation valves (used when the chillers are headered). A digital output opens and closes the valves, and a digital input provides open/close feedback.
  - The control system modulates the bypass valve to maintain the minimum flow required by the operating chillers.
  - Automatic operation mode: When the chilled plant control system is in automatic operation mode, the chiller plant is automatically started and all equipment is sequenced and modulated entirely automatically to meet the current cooling load with optimum operating efficiency.
  - Manual operation mode (for commissioning): When the chilled plant control system is switched to the manual operation mode by the operator, there is no automatic operation or sequencing of any equipment and

operation of chillers, chilled water distribution pumps, condenser water pumps, cooling towers and cooling tower fans continue at the same status when operation mode was switched to manual mode, until further changes by the operator. When operation mode is switched back to auto, the automatic operation mode is restarted.

- The chilled plant control system shall be capable of providing parallel pump station control for speed and sequencing of pumps using one or more of the following methods:
  - Remote zone differential pressure (dP) sensor
  - Local pump station dP sensor with simulated quadratic control curve
  - Zone return temperature sensor
  - Building return temperature sensor and/or
  - Sensorless pump speed and parallel Sensorless pump control.

PART 2 -EXECUTION

2.1 ELECTRICAL WIRING AND INSTALLATION

The wiring for data communication between sensors, control systems and valve actuator shall be shielded so as not to be susceptible to electrostatic, magnetic, mode and cross talk noise. Electrical wiring shall conform to the requirements of the electrical services section of the specifications and the local electrical code.

2.2 TESTING

- Upon completion of all systems startup and checkout procedures and while the mechanical systems are being monitored and controlled in a "normal operating" condition, the manufacturer and the facility personnel shall jointly demonstrate the performance of the complete system to maintain flows, temperatures, levels and pressures for 7 days, with no alarms. The test must meet the particular building's design requirements to be considered passed and acceptable. Any failures or alarms shall require the test to be restarted.

2.3 CALIBRATION AND COMMISSIONING

- The chilled water plant control system shall be commissioned and fully operational after delivery to the site at the practical date agreed with the building owner representative on-site. Commissioning procedure shall conform to the "Mechanical Services" section of these specifications.
- The calibration and commissioning procedure shall consist of validating field I/O calibration, loop checks, actuator stroking and integrated system operation validation. All commissioning information shall be documented on commissioning data sheet forms which shall be submitted to the commissioning agent, if available, or the facility personnel for approval prior to testing. Notify the facility personnel of the testing schedule so that operating personnel may observe calibration and commissioning.

2.4 TRAINING

- The chilled water plant control system manufacturer shall instruct the personnel of the facility in the operation of the control system. Drawings, operation and maintenance manuals are to be provided to the customer in a single binder, clearly indexed.

PART-4 MINIMUM REQUIREMENTS TO OTHER SYSTEMS

4.1 CHILLER SPECIFICATION

The chillers shall have variable speed compressors {select the following if applicable} {with variable speed drives (VSDs)} and shall be capable of capacity turndown to provide less than 41% of full load capacity by way of compressor {select one of the following} {speed control} or {slide valve} or {refrigerant bypass} and without adjustment to the compressor inlet guide vanes.

The chillers shall include their own control system such as to optimize their speed for a given chilled water supply set point and outdoor temperature that may range from 45°F to 120°F.

The chiller shall accept external demand limiting instructions through serial communication signals.

The chiller proposal shall include operating chiller data from 10% to 100% of rated full load in 10% increments at the following constant outdoor dry bulb temperatures (95°F, 85°F, 75°F, 65°F, 55°F).

The chiller shall have a flow turndown to less than 50%.

The chiller controller must be capable of communicating through one of the following protocols: Modbus RTU, Modbus TCP, BACnet MS/TP, BACnet IP or Lonworks.

4.2 PLANT DESIGN SPECIFICATIONS

The chilled water plant shall be an air cooled variable speed plant with {indicate the quantity} __ (qty) identical variable speed chillers and __(qty) identical variable speed distribution pumps. The plant configuration shall provide {select one of the following} {headered pumps and headered chiller} or {a dedicated {dual-arm} or {twin} or {single} pump to each chiller} and a system decoupler line with a 2-way bypass valve sized to provide the minimum flow required by one chiller when the pump head is 40% of design head. The plant shall supply a single distribution line from the supply header, and receive a single return line from the loads. The bypass line shall be installed between the supply and return lines and shall not have ends in the headers.

4.3 CHILLED WATER SYSTEM PUMPS SPECIFICATION

The chilled water system distribution pumps shall be variable speed (primary or secondary : as the case may be) pumps sized to provide the desired plant design flow at their design head under all probable conditions of operations of the project.

{Note: If there are two headered pumps sized for 100% of the design flow and one fails, the other one is capable of providing about 80% of the design flow over the same system curve, delivering about 95% of the design cooling energy

With 3 headered pumps, 2 can supply about 90% of the design flow, or 98% of the cooling energy}

4.4 ENERGY MANAGEMENT SYSTEMS (INTEGRATION ONLY):

The system will be supplied by IBMS contractor with the following features:

1. Calculate the exact requirement (optimum Set points) of energy to run the HVAC & other systems
2. Indicate if there is any deviation from the set energy level, this enables operators to take corrective actions immediately & rectify the faults at desired time.
3. Capture energy data & provides the trends for energy consumption which equipped to analyze the energy data
4. Support customized, graphically displayed schedules for building, floors, zones or equipment groups to flexibly manage energy use. Which helps in saving of energy.

4.5 Sequence of operation

The CPM shall provide coordinating control for multiple chillers, cooling towers, pumps and valves as described herein. All logic for the control of these devices shall reside in the CPM application software.

The application software in the CPM shall provide sequencing and staging of chillers, leaving chilled water temperature control, cooling tower control, condenser water pump control, scheduling and alarm processing for the CPM system and the chillers.

The CPM shall enable and disable chillers, so that the current cooling capacity is matched to the current cooling load by controlling all running chillers to a common supply water temperature.

4.5.1 Sequencing of chillers

Chillers shall be sequenced based on run-time; the chiller with the lowest number of run hours as the lead chiller, the chiller with the second lowest number of run hours as the second chiller, and so forth. Chiller must run at energy efficient mode.

4.5.2 Staging of chillers

The CPM shall calculate the load of all chillers running to determine when the number of enabled chillers should be increased or decreased. Each chiller shall communicate its current load status to the CPM.

The CPM staging control shall ensure sufficient chillers are running to maintain correct cooling capacity and flow demand at all times.

The CPM shall disable a chiller and stage-up so that another chiller is started when any operating chiller becomes unavailable due to chiller failure.

The CPM shall decrease the system capacity by one stage when the chiller system load decreases by the capacity of the chiller that is the next to be switched off in the sequence.

The stage down strategy must ensure correct cooling capacity is maintained to match current load whilst chillers shall be staged off as quickly as possible to save energy.

4.5.3 Chiller load limiting

The CPM shall provide load limiting of each chiller through a Capacity Limit Set-point of 40-100%, which shall be sent to each applicable chiller. The value will be a common value sent to all chillers.

4.5.4 Chiller diagnostics

The CPM shall provide built in logic for chiller diagnostics. The diagnostics should include as a minimum.

- Evaporator delta T
- Evaporator approach
- Condenser delta T
- Condenser approach
- Compressor suction superheat
- Compressor Discharge superheat
- Net oil pressure

The above values are monitored and compared to two envelopes of low and high limits. Should a value drift out of the first envelop a warning is generated. Should the value drift out of the second envelope a fault is generated.

4.5.5 Cooling tower

This control strategy is designed to maintain the condenser entering temperature at a predefined set-point or wet bulb calculated set-point using VFD controlled cooling tower fans. The function calculates a variable frequency speed signal that is controlling the speed of all running cooling tower fans.

As fan power reduces by the cube of the fan speed and fan and tower capacity reduces linearly, the most efficient mode of operation is to keep all fans operating at low speed as long as possible, this strategy also maximizes the use of all the available cooling tower heat exchanger surface.

Minimum recommended fan speed is ~30%, this is because VFD drive efficiency falls away rapidly below 25% and excess vibration may be encountered. In addition, in a gear driven fan the gearbox usually has a minimum speed requirement of 30% in order to maintain lubrication capabilities.

4.5.6 Condenser water pumps

Pumps shall be sequenced based on run-time; the pumps with the lowest number of run hours as the lead pump, the pump with the second lowest number of run hours as the second pump, and so forth.

Chilled water pumps (Scope of Pump Logic Control System)

The primary pumps maintain a differential pressure at a specific point in the system. This point is the pressure difference across the most significant distant load. The pressure difference is the coil, piping, and control valve pressure drop at design flow. As the building cooling loads are satisfied, the coil two-way control valves move toward the closed position, this increases the differential pressure measured across the cooling coil, valve and piping. As the differential pressure starts to rise, the frequency converter slows

The pump to maintain the differential pressure setpoint value. The frequency converter setpoint value is the sum of the pressure drop of the cooling coil, coil piping, and two-way control valve under design flow conditions.

Pump Logic Control System (Diff. Pressure Sensor) is continuously monitoring the individual chiller flow. If particular chiller flow goes below the required chiller flow then PLCS will ramp up the VFD speed. Similarly PLCS will modulate the bypass valves to compensate the flow.

When CPM/Scheduler gives start command to Chiller Plant, CPM will give first command to PLCS to start one Pump. Once Chilled water flow established in chiller, CPM will give command to Condenser Pump & Cooling Towers. Now Chiller will conform the condenser flow also & thus CPM will give command to Chiller.

CPM will also give feedback of total running chillers to PLCS.

4.5.7 I/O points

The following minimum number of I/O points should be included in CPM: REFER BOQ FOR MORE DETAILS

- For all Condenser pumps and fans: Command (DO), Trip (DI), Feedback (DI), Manual/auto (DI)
- Chilled Water Supply and return temperature (AI)
- Condenser supply & return temperature (AI)
- Ambient temperature and humidity (AI)

- Isolation valves: Command (DO), Status open (DI)

Chiller data points on Modbus

- **Plant description**

1.1 Comfort cooling application, for Hospital project

1.2 Redundancy designed and agreed is as under, per component:

1.2.1 Chiller: Water cooled;

1.2.2 Primary constant & Secondary variable chilled water pumps: Vertical Inline, split coupled, Sensorless technology; N+1

Chilled water distribution lines:

Air treatment stations, re-circulatory air handlers, and other ventilation fans

Control valves on AHU: PIBCV;

2 **Energy management system & other features**

2.1 Chiller plant manager (CPM) is proposed to be installed which will domain the embedded intelligence pertaining to the followings:

2.1.1 Duty cycling of the chillers: lead and lag chillers for equal run time management duty will be performed by the CPM.

2.1.2 Load management and conservation of energy, based on the surrogate index of chilled water return temperature from the site (data centre).

2.1.3 Start / Stop functions of the chiller plant.

2.1.4 Primary / Secondary variable flow chilled water pumping system with unit mounted VFD and a sensor-less technology / Demand based chilled water flow based on DP sensors located in critical load AHU stations will stage the pumps and conserve energy as a stand-alone intelligent program. CPM will only interface with the VSPS for information, and shall not control the pumps for the staging.

3 **CPM description**:

A factory furnished, programmed, microprocessor based controller shall be provided to supervise and optimize the operation of the individual Product Integrated Controllers (PIC) for each chiller. All application software actually performing the required control functions shall be factory supplied with the controller and shall be pre-tested and pre-configured.

The networked chiller Product Integrated Controllers (PICs) shall interface with a CPM installed on the network. The CPM shall include software that allows dynamic interaction between the CPM and the chiller PIC(s) to create a complete chilled water plant system as described within this specification.

The CPM shall include inherent input and output capability. The input/output capability shall include as a minimum a combination of standard HVAC sensor inputs (5k, 10k, 4-20ma and discrete) an output to drive an alarm annunciator and/or alarm light, and two analog outputs for differential pressure control. Each analog input channel shall include an operator adjustable sensor trim (adjustable to 1/10°F) and programmable low and high alarm/alerts, as applicable.

The CPM shall not interfere with the PIC's stand-alone operating or safety algorithms but shall enhance the operation by providing the following inherent capabilities as a minimum:

- Control of up to eight chillers (staged or rotary) of equal or unequal sizes.
- Enable/disable the chiller plant based on its internal time schedules, remote contact closure, analog temperature override, network command, or time schedule override.
- Chiller fault logic and automatic starting of lag chiller(s).
- Automatic alarming and switching to backup sensors if any primary sensor fails
- Diverse operator selectable chiller sequences including a sequence with a designated chiller to perform "feathering" functions.
- Algorithms that properly match the chillers with the load.
- Chiller inhibit timers
- Bypass valve control
- KW balancing and Ramp loading
- Demand limiting
- Chilled water reset
- Power fail restart

The CPM shall contain factory programmed software for the following types of mechanical systems:

- Two to eight chillers with dedicated chilled water pumps and no secondary piping.
- Two to eight chillers with chilled water pumps in a parallel arrangement and no secondary piping.
- Two chillers piped in series with a single chilled water pump and no secondary piping.
- Two to eight chillers with dedicated primary (production loop) pumps and secondary (distribution loop) pumps piped in a parallel arrangement.
- Two to eight parallel chillers, common primary pumps, constant flow (common constant speed secondary pumps), variable flow (two-way valves) with a differential pressure valve and bypass line.
- Two to eight parallel chillers, common primary pumps, variable flow (two-way valves), with a differential pressure valve and bypass line.

3.1 CPM Attributes

The controller shall be powered from standard, off the shelf, Class II, 24 volt transformers. The controller shall be listed under UL916-PAZX (Energy Management), UL 864-UDTZ (General Utility Signaling), VDE, and CSA. Products shall be manufactured in a facility having a Quality System that is registered to either ISO 9002 or ISO 9001 Quality Assurance Standard. The controller shall be designed to be easily mounted in a standard NEMA 1 type enclosure without special rails or mounting hardware and as local and national code dictates.

The controller shall include a 365 day real time clock and watchdog timer diagnostic indicator provided by a LED. The watchdog timer shall reset upon power on and be resettable by software thereafter. Should the watchdog timer not be resettable during the timing period, it shall time out and set all outputs to their non-powered state. The LED shall illuminate solidly to indicate this failure.

The controller shall not require a battery. All configuration data will be stored in non-volatile memory. The controller shall provide a minimum of two days data retention for the time clock. Systems that require a battery to store data are not acceptable.

The controller shall include the capability to provide a local interface for all operating values, alarms, etc., via a panel mounted, Local Interface Device. The controller shall also be capable of interfacing to a portable PC for configuring or altering the configuration, setting the address, performing uploads/downloads, etc. through a separate, additional RJ14 plug.

3.2 CPM System Requirements

The CPM shall utilize common chilled water supply and return water temperature sensors wired to the CPM as its primary control sensors. An optional load return sensor shall be supplied if the I/O summary requires such or the sequence of operation requires the starting and stopping of equally sized chillers as a function of how much water is being bypassed. **The chiller manufacturer will program the CPM as per the intent of this narration, provide the integration and communication software to enable CPM perform, and also communicate with the resident IBMS of the data centre.**

The CPM shall monitor the status of each chiller's present local/auto selector position, through network communications. Whenever the position is indexed to local, the PIC shall perform its stand-alone control functions as described in in this specification. When the PIC is indexed to the local mode the CPM shall determine that the chiller is not available for chiller plant control and shall be bypassed by the CPM. When the mode is indexed to the remote position the chiller PIC shall have the following programs superseded by the CPM:

- Lead/lag
- Chilled water reset
- Remote contact start
- Demand limiting
- Start the designated lag chiller (based on the current schedule) to kick in first during the eventuality of any electric source change-over, so as to maintain the chilled water temperature of the line, and minimise the lag time, to avoid any temperature rise in the cold aisle of the data centre.
- Record the redundant line chilled water return and supply temperatures to enable quick change-over function, as described in item No. 5, below.
- Communicate with the installed IBMS system(Siemens make), and allow for the following over-riding features by the IBMS prompt:

Remote START / STOP of the chillers and pumps.
Remote chilled water temperature reset.
Remote monitoring of the chiller plant.
Remote changing of the lead / lag chillers
Remote monitoring of the redundant circuit chilled water temperatures.

4 **Chiller plant operations and controls: Data archiving & reporting criterion**
Recommended chiller monitoring points (MINIMUM) as per ASHRAE 1474

Chilled Water (or other secondary coolant)	Flow	Condenser Water	Flow
	Inlet Pressure		Inlet Pressure
	Inlet Temperature		Inlet Temperature
	Outlet Pressure		Outlet Pressure
	Outlet Temperature		Outlet Temperature
Evaporator	Refrigerant Pressure	Condenser	Refrigerant Pressure
	Refrigerant Temp.		Refrigerant Temp.
Oil	Level	Refrigerant	Level
	Pressure		Compressor Discharge Temp.
	Temperature		Compressor Suction Temp.
	Addition of		Addition of (in Refrigerant Log)
Vibration Levels			PPM Refrigerant Monitor Level
Purge	Exhaust Time	Logs	Date and Time Data
	Discharge Count		Signature of Reviewer
Ambient Temperatures	Dry Bulb	Motor	Amperes Per Phase
	Wet Bulb		Volts Per Phase

For the VPF, the CPM should take the following considerations :

Bypass flow

- Select a high-quality control valve with linear-flow characteristics
- Select flow-sensing devices that deliver precise, repeatable measurements
- Minimize control lag by hard-wiring the controls or by selecting devices that communicate directly

Chiller sequencing

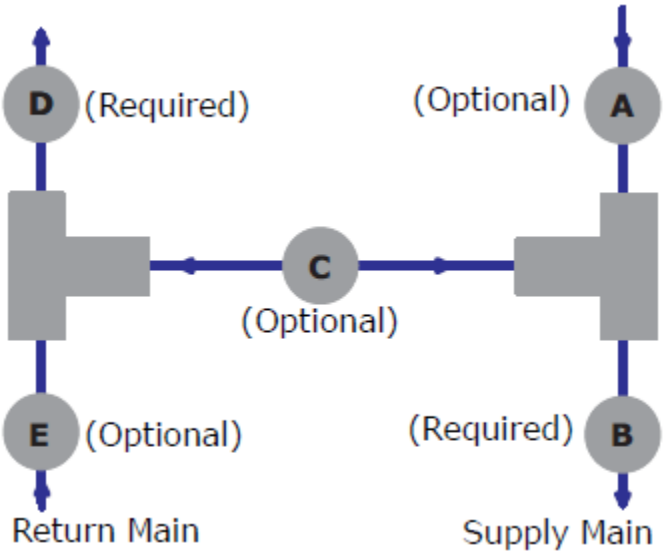
- Temporarily unload the operating chillers before starting the next
- Open chiller isolation valves *slowly* to encourage stable operation
- Let the operating chiller(s) load *almost* fully before starting another
- Prevent short-cycling by devising a "stop" strategy based on the power draw of the operating chillers

Subtracting and addition of chiller in the VPF has to be guided by the limitations of response time, to enable proper flow in the evaporator at all times. Transient water flow conditions need to be managed.

For the secondary variable flow systems:

De-coupler line flow of water needs to be monitored, and chillers / pumps to be operated in a manner to effect maximum savings in operating costs.

In case of temperature sensing approach:



The five temperatures sensed—at points A, B, C, D, and E—are received by a programmable controller. (Some control systems use only two sensors, at points B and D, in conjunction with "pre-programmed" algebraic mixing equations.) Processing software applies the classic mixing equations and determines the resulting action to properly control the chilled-water system.

Note that sensor D needs to be very accurate, especially if there are many chillers, since small temperature changes may warrant chiller sequencing. Either temperature-sensing strategy has a cost and flexibility advantage if a building or chiller-plant management system already exists or is planned.

In case of flow sensing approach:

Direct flow-sensing in the bypass line can be accomplished in several ways. A number of flow-metering technologies have been used successfully. These include Pitot tube, venturi, orifice plate, differential pressure, turbine, impeller, vortex, magnetic, and ultrasonic transit-time. The accuracy, ease of installation, maintainability, and cost of meter technologies vary widely. To give accurate results, a flow meter must be calibrated periodically, with some flow meters requiring more-frequent calibration than others. When using flow-sensing devices, it is important to understand the range of flows a device can properly measure and its calibration requirements. The readings will only be as good as the instrumentation. Also note that many flow-measurement devices require several diameters of straight pipe for accurate readings.

1	Water cooled/Air-cooled screw Chiller	YORK/TRANE/CARRIER/DAIKIN-McQUAY
2	V RF unit	DAIKIN / TOSHIBA / HITACHI / SAMSUNG / LG
3	Air tempering and Handling Equipment (Double Skin)	SAVEAIR / CARYAIRE / WAVES / ZECO / EDGETECH / VTS_ CLIVET
4-1	Cooling Towers (STANDARD / CTI APPROVED) : INDIGENOUS	BELL / PAHARPUR / ADVANCE / FLOWTECH
4-2	Cooling Towers (STANDARD / CTI APPROVED) : IMPORTED	MARLEY / BALTIMORE / NIHON SPINDLE
5	Centrifugal Pumps Fixed speed	XYLEM/ GRUNDFOSS/ARMSTRONG
6	Cooling /Heating Coils	ZECO/ CARYAIRE/WAVES / SYSTEM AIR / SUVIDHA / VTS_CLIVET
7	Fan Coil Units (Low static)	CARYAIRE / ZECO / SYSTEM AIR / EDGETECH / WAVES
8	High static Fan-coil units	CARYAIRE /ZECO / CARRIER / EDGETECH / WAVES
9	Air –Washer / Air – Scrubber	AMBASSADOR / ZECO / CARYAIRE / ROOTS AIR SYSTEM / WAVES
	Ventilation Fans	
10	Ventilation fan sections (Sectionalized construction as per specifications)	ZECO / SYSTEM AIR / AIR FLOW / WAVES / EDGETECH
11	Centrifugal Fans for AHUs	KRUGER / COMEFRI / NICOTRA / SYSTEM AIR/WOLTER
12	Centrifugal Fans for ventilation units	KRUGER / COMEFRI / NICOTRA / SYSTEM AIR/FLAKT/WOLTER
13	Jet Impulse Fan and its Accessories	SYSTEM AIR / FLAKT / KRUGER / NICOTRA / WOLTER
14	Inline Fans	CARYAIRE/KANALFLAKT/SYSTEMAIR/KRUGER/WOLTER
15	Axial fans / Vane Axial Fans	KRUGER / NICOTRA / COMEFRI / GREENHECK/ WOLTER /SYSTEM AIR / AIR FLOW
16	Mixed Flow Fans	KRUGER / NICOTRA / COMEFRI / GREENHECK / WOLTER / WOLTER/SYSTEM AIR
17	Propeller Fans	ALSTOM / MARATHON / KHAITAN
18	Duct Attenuators / Acoustic Louvers	CARYAIRE / AIRFLOW / TRISTAR / AIR MASTER
19	Desiccant coated Enthalpy Recovery Unit (Latent + Sensible): Wheel Only	DRI / OSTBERG
20	Filters	THERMADYNE / KLENZOID / KIRLOSKAR / CANFIL / SUPERCUT
21	VFD	SIEMENS / SCHNIEDER / DANFOSS / ABB / FUJI
22	Variable Speed Pumping System (Including Pumps)	ARMSTRONG / GRUNDFOSS / XYLEM
23	Plate type Heat Exchanger	GEA/ALFA LAVAL
	PIPING (Chilled / Condenser / Drain Water)	
23	MS pipe (Upto 200mm)	JINDAL-HISSAR/ITC
24	Pipes (Beyond 200mm)	JINDAL-HISSAR/SAIL/MUKUT
25	Pre Insulated Pipe	ZECO / SEVEN STAR
26	Air separator, closed vessel exp. tank	ANERGY / EMERALD
27	Pot Strainers	EMERALD/RAPID COOL
28	Y-Strainers	EMERALD/RAPID COOL
29	Butterfly Valves (Water duty) (Gear Operated beyond 350mm Dia)	ADVANCE / AIP / JAYHIWA / AUDCO
30	Check Valves (Water duty)	ADVANCE/LEADER

31	Ball Valves With or Without Strainer (Water duty)	CIM/RB/ARCO/RAPID CONTROL
32	Manual Balancing Valves (Water duty)	ADVANCE
33	Automatic Balancing Valves (Water duty)	FLOWCON / T & A / DANFOSS
34	Two way / Three way motorized modulating Valves (Water duty) for AHUs	DANFOSS / JOHNSON CONTROL / HONEYWELL / SIEMENS / ANERGY
35	Pressure gauges	FEIBIG / DWYER
36	Industrial thermometers	DWYER/TEDDINGTON
37	Globe valves	ADVANCE
38	Two way Valves for Fan Coil Units	ANERGY / HONEYWELL / JOHNSON CONTROL / STAEFFA / SAUTER
39	Actuator for Two way valves and fire dampers	BELIMO / SIEMENS / HONEYWELL / SAUTER
40	Water Flow switch	DANFOSS / RAPID CONTROL / EMERALD / JOHNSONS CONTROL
41	Modulating Motors	BELIMO / RAPID CONTROL
42	Flexible couplings for pipes	RESISTOFLEX / KANWAL
43	Binder test point	ANERGY/DWYER
44	Room thermostat	JOHNSON CONTROL/ SIEMENS / HONEY WELL
45	Humidistat	JOHNSON CONTROL/ SIEMENS / HONEY WELL
46	Safety thermostat for heater	ANERGY
47	Dial Thermometer Capillary Type.	PENN / TADINGTON/DWYER
48	Auto air vent	ANERGY / RAPID CONTROL
49	Airstat	RAPID CONTROL
50	Digital Manual Balancing Valve	T&A / FLOWCON / OVENTROP/ CIM (SKS)
51	Differential Pressure Controller	T&A / FLOWCON / OVENTROP
52	Suction guide with dirt separator	ANERGY / RAPID CONTROL
53	Vibration Isolators	DUNLOP / EMERALD / GERB / POLYBOND / RESSITOFLEX
54	Welding rods	ADVANI / L&T
55	Dash fasteners	HILTI / FISHER/ TKS
56	Paints	ICI/BERGER
	AIR – DISTRIBUTION / DUCT WORK	
57	GI Sheets	JINDAL / NATIONAL / SAIL / LLOYD / NIPPON / TATA
58	Extruded Aluminium Grilles/ Diffuser	CARYAIRE/RAVISTAR/SERVEX/COSMOS/DYANACRAFT/ AIR MASTER/ AIR FLOW / PINE AIR / TRISTAR
59	Combined fire/smoke Dampers	CARYAIRE / RAVISTAR / DYNACRAFT / AIR MASTER / AIR FLOW
60	Ventilation / Exhaust Air Grilles	CARYAIRE / SERVEX / RAVISTAR / COSMOS /TRISTAR / MALBROS / AIR MASTER / AIR FLOW / PINE AIR / TRISTAR

61	Factory fabricated duct	TECHNOFAB / ROLASTAR / ZECO / WAVES / DUCTOFAB / DUSTECH
62	Jet Nozzles	DYNACRAFT / TROX/ RAVISTAR / AIRFLOW / CARYAIRE / AIR MASTER
63	Box type dampers (Opposing blade with tight fit arrangement)	CARYAIRE / RAVISTAR / SERVEX / AIRFLOW / AIR MASTER / DYNACRAFT /PINE AIR / TRISTAR
64	Fire Sealant	HILTI / BIRLA -3M
65	Fresh / Exhaust Air Louvers with Bird Screen	CARYAIRE / RAVISTAR / SERVEX / AIRFLOW / AIRMASTER / DYNACRAFT / PINE AIR / TRISTAR
66	Back Draft Dampers	CARYAIRE / RAVISTAR / AIRFLOW / DYNACRAFT / PINE AIR / TRISTAR
67	Collar / Grill Damper (Aluminum)	CARYAIRE / RAVISTAR / SERVEX / AIRFLOW / DYNACRAFT / AIRMASTER PINE AIR / TRISTAR
	INSULATION	
68	Expanded Polystyrene (TF Quality)	METTUR-BEARDSELL / LLOYD INSULATION / STYRENE PKG./ A.R.K.C.
69	Duct Cross Linked Polythene Foam	THERMAFLEX / TROCELLENE
70	Pre laminated/Plain Fiber Glass rigid boards	UPTWIGA / OWENS CORNING
71	Pre laminated Glass wool Blankets	UPTWIGA / OWENS CORNING
72	Glass wool blankets	UPTWIGA / OWENS CORNING
73	Closed cell Elastomeric Nitrile Foam for Duct / Pipe (Class 'O')	ARMAFLEX / K-FLEX / A-FLEX
74	Premoulded PUF section for pipe supports	MALANPUR /LLOYD
75	Protective Coating over Closed Cell Elastomeric (Exposed duct)	POLYBOND / PARAMOUNT
76	Fire sealant	HILTI / BIRLA 3 M
77	Black Japan Paint / CPRX compound	SHALIMAR
78	Adhesive for Duct & pipe	PIDLITE SR-505
79	Aluminum Tape	BIRLA- 3M, JONSON
80	Aluminum Sheet	BALCO / HINDALCO / NALCO
81	RP Tissue Paper	UP TWIGA / OWENS CORNING
82	GI Channel	SAIL / NATIONAL / JINDAL
	ELECTRICALS & ASSOCIATED WORKS	
83	Electrical Panel Manufacturer	EAP / KEPL / ADLEC / ADVANCE / INDIA TECH
84	Motors	SIEMENS / BHARAT BIJLEE / GREAVES / ABB / KIRLOSKER
85	MCB	MDS / HAGER/SIEMENS / LEGRAND/ABB
86	MCCB	L&T / SIEMENS / ABB / SCHNEIDER
87	ACB	SPECTRONS / ABB / L&T / SCHNEIDER
88	Starters/Contactors/Push Buttons/Overload Relays	L&T / SIEMENS / ABB
89	Single Phase Preventers	L&T / SIEMENS
90	Rotary switches	L&T / BCH / GE
91	Toggle switches/Selector switches	KAYCEE / SAZLER

92	Changeover switches	ELECON/L&T
93	Ammeter, Voltmeter, PF, KW, Hz meter, KWH (Digital with LED display)	AUTOMATIC ELECTRIC /CONSERVE(ENERCON) / ABB
94	IndicatingLamps	L&T/SIEMENS/BCH/TELEMECONIQUE/VAISHNO
95	Power Cables and accessories	FORT GLOSTER / NATIONAL / POLYCAB / ASIAN
96	Control cables and accessories	GLOSTER / GRANDLAY / NATIONAL / SKYTONE / ASIAN
97	MS conduits	BEC / STEEL CRAFT / AKG (ISI MARKED)
98	TDRs	LT-LK / BCH
99	Soft Starter	ALLEN BRADLEY / GROUPE SCHNEIDER / GE POWER CONTROLS
100	Current Transformers	AUTOMATIC ELECTRIC / KAPPA
101	Isolator Box (Weather / Non weather proof)	
102	PVC Wire Control	SKYLINE / FINOLEX / POLYCAB
103	Cable Tray Ladder Type	SLOTCO / PILCO / RICCO
104	Cable TrayPerforated Type	SLOTCO / PILCO / RICCO
105	Bi-metallic Cable Lugs	DOWELL'S (BILLER INDIA PVT. LTD.) HAX (BRASS COPPER ALLOY INDIA LTD.) JAINSON
106	Cable Glands Double Compression with earthing links	COMET/BALIGA LIGHTING LTD./SMI/GRIPWELL

GRIHA / IGBC/ LEED RATING

Introduction:

Following measures must be ensured during construction to meet GRIHA certification compliance.

Site Management

(a) Topsoil shall be stripped to a depth of 200 mm from areas proposed to be occupied by buildings, roads, paved areas and external services.

(b) Top soil shall be stockpiled to a height of 400 mm in pre – designated areas for preservation and shall be reapplied to site during plantation of the proposed vegetation.

(c) Top soil shall be separated from sub-soil debris and stones larger than 50 mm diameter.

24.4.1 Measures should be applied to control erosion of preserved top soil.

(d) Young trees (Young trees are those that have a height less than 2 m, and a 0.1 m trunk girth at 1 m height from ground, and a 2 m crown) or saplings identified for preservation within the construction site must be protected using tree guards of approved specification.

(e) Maintenance activities should be performed, as and when needed, to ensure that the vegetation remains healthy.

(f) Spill prevention and control plans should be made, clearly stating measures to stop the source of the spill, to contain the spill, to dispose the contaminated material and hazardous wastes, and stating designation of personnel trained to prevent and control spills. Hazardous wastes include pesticides, paints, cleaners, diesel and petroleum products.

(g) Staging should be done to separate undisturbed land from land disturbed by construction activity and material storage.
(h) Existing drainage patterns through or into any preservation area should not be modified unless specifically directed by the landscape architect/architect/engineer-in-charge.
(i) Existing grades of soil should be maintained around existing vegetation.
(j) Lowering or raising the levels around the vegetation should not be allowed unless specifically directed by the landscape architect/architect/engineer-in-charge.
(k) The preserved vegetated area should be inspected by the landscape architect/architect/ engineer-in-charge at regular intervals so that it remains undisturbed. The date of inspection during construction activity and type of maintenance or restorative action followed should be recorded in a log book.
(l) Temporary drainage channels and perimeter dike/ swale should be constructed to carry the pollutant laden water directly to the treatment device or facility (municipal sewer line). The plan should indicate how the above was accomplished onsite, well in advance of the commencement of the construction activity.
(m) Employ measures to segregate the waste on-site into inert, chemical or hazardous wastes.
(n) Recycle the unused chemical/hazardous wastes such as oil, paint, batteries, and asbestos.
(o) As per Government of India Regulations, published on May 30th, 2008, smoking in prohibited in all 'open spaces' (includes work spaces and common areas)
(p) Date stamped photographic evidence of the measures documented above as applicable

Measures for Sanitation and Safety Facility for Construction workers

5 Comply with the safety procedures, norms and guidelines (as applicable) as outlined in NBC 2005 (BIS 2005c), Part 7: Constructional Practices & Safety.
- Protective Equipment like safety helmets, boots, vest etc. should be provided mandatorily

24.4.2 Provision for safety harness and safety net when working at heights

6 In respect of all labor directly or indirectly employed on the works by the contractor, the contractor shall comply with the provisions of the Contract Labor (Regulation and Abolition) Act 1970, Minimum Wages Act 1960, Payment of Wages Act 1956 and any amendments thereof and at legislations and rules of the State and / or Central Government or other local authorities, framed from time to time, governing the protection of health, sanitary arrangements, wages, welfare and safety for labour employed on building and construction works and for bonus, retirement benefits, retrenchment/ layoff, compensation and all other matters involving liabilities of employees. The rules and the other matters involving liabilities of employers to employees. The rules and the other statutory obligations regarding fair wages, welfare and safety measures, maintenance of registrar etc. will be deemed to be part of the Contract. No child labour will be employed on the site and the Contractor shall fulfill the Child Labour act (Protection and Regulatory Act 1986, 1988 & 1998 along with the amendments thereof, if any).

7 In respect to all labors directly or indirectly employed by every establishment which employs, or had employed on any day of the preceding twelve months, ten or more building workers in any building or other construction work shall also comply with The Building and Other Construction Workers Act (Regulation of Employment and Conditions of Service) Rules, 1996.

8 The employer shall make in every place where building or other construction work is in progress, effective arrangements to provide and maintain at suitable points conveniently situated for all persons employed therein, a sufficient supply of wholesome drinking water.

9 All such points shall be legibly marked "Drinking Water" in a language understood by most of the persons employed in such place and no such point shall be situated within six meters of any washing place, urinal or latrine.

10 In every place where building or other construction work is carried on, the employer shall provide sufficient latrine and urinal accommodation of such types as may be prescribed and they shall be so conveniently situated as may be accessible to the building workers at all times while they are in such place.

11 The employer shall provide, free of charges and within the work site or as near to it as may be possible, temporary living accommodation to all building workers employed by him for such period as the building or other construction work is in progress.

12 The temporary accommodation provided shall have separate cooking place, bathing, washing and lavatory facilities.

13 As soon as may be, after the building or other construction work is over, the employer, shall, at his own cost, cause removal or demolition of the temporary structures erected by him for the purpose of providing living accommodation, cooking place or other facilities to the building workers and restore the ground in good level and clean condition.

14 In every place wherein, female building workers are ordinarily employed, there shall be provided and maintained a suitable room or rooms for the use of children under the age of six years of such female workers.

15 Such rooms shall-

15.8.1 provide adequate accommodation;

15.8.2 be adequately lighted and ventilated;

15.8.3 be maintained in a clean and sanitary condition;

15.8.4 be under the charge of women trained in the care of children and infants.

16 Every employer shall provide in all the place where building or other construction work is carried on such first-aid facilities as may be prescribed.

17 The appropriate Government may, by rules, require the employer-

18 To provide and maintain in every place wherein not less than two hundred and fifty building workers are ordinarily employed a canteen for the use of the workers;

19 Where in any establishment an accident occurs which causes death or which causes any bodily injury by reason of which the person injured is prevented from working for the period of forty-eight hours or more immediately following the accident, or which is of such a nature as may be prescribed, the employer shall give notice thereof to such authority, in such form and within such time as may be prescribed.

20 Date stamped photographic evidence of the measures documented above as applicable

Measures for Air Pollution Prevention

19.0 Adopt measures to prevent air pollution in the vicinity of the site due to construction activities. There is no standard reference for this. The best practices mentioned below should be followed (as adopted from international best practice documents and codes).

Measures to reduce air pollution

Site preparation

- Clear vegetation only from the areas where work will start right away
- Vegetate/mulch areas where vehicles do not ply
- Apply gravel/landscaping rock to the areas where mulching/paving is impractical
- Identify roads on-site that would be used for vehicular traffic. Upgrade vehicular roads (if these are unpaved) by increasing the surface strength by improving particle size, shape, and mineral types that make up the surface and base. Add surface gravel to reduce source of dust emission. Limit amount of fine particles (smaller than 0.075 mm) to 10%–20%

- Limit vehicular speed on-site to 10 km/h

  Water spraying

  This could be done by wetting the surface by spraying water on

- any dusty materials before transferring, loading, and unloading,
- areas where demolition work is being carried out,
- any unpaved main-haul road, and
- areas where excavation or earth-moving activities are to be carried out.

  Cover and enclosure

  This could be done by

- providing hoardings of not less than 3 m high along the site boundary, next to a road or other public area,
- providing dust screens, sheeting or netting to scaffold along the perimeter of a building,
- covering stockpiles of dusty material with impervious sheeting,
- covering dusty load on vehicles by impervious sheeting before they leave the site, and
- transferring, handling/storing dry loose materials like bulk cement and dry pulverized fly ash inside a totally enclosed system.

20.0 Provision in the contract document that the contractor will undertake the responsibility to prevent air pollution (dust and smoke); ensure that there will be adequate water supply/storage for dust suppression; devise and arrange methods of working and carrying out the work in such a manner so as to minimize the impact of dust on the surrounding environment; and provide experienced personnel with suitable training to ensure that these methods are implemented. Prior to the commencement of any work, the methods of working, plant equipment, and air-pollution-control system to be used on-site should be made available for the inspection and approval of the engineering- charge to ensure that these are suitable for the project.

21.0 Date stamped photographic evidence of the measures documented above as applicable

Water Management Onsite during Construction

Measures for reducing water demand during construction to avoid wastage of curing water, following guidelines are to be followed:

1) Materials such as pre-mixed concrete for preventing water loss during mixing.
2) Providing and applying curing compound to RCC Structure as coverage.
3) Curing water should be sprayed on concrete structures; free flow of water should not be allowed for curing.
4) After liberal curing on the first day, all concrete structures should be painted with curing chemical to save water. This will stop daily water curing hence save water.
5) Concrete structures should be covered with thick cloth/hessian cloth and then water should be sprayed on them. This would avoid water rebound and will ensure sustained and complete curing.
6) Ponds should be made using cement and sand mortar to avoid water flowing away from the flat surface while curing.
7) Water ponding should be done on all sunken slabs
8) Adequate provision for recycling of waste water generated on site during construction activities.
9) Adequate storage provision for rain-water and reuse on site
10) Recycled treated water to be used for curing
11) Date stamped photographic evidence of the measures documented above as applicable

Ensure water from all sources (such as groundwater and municipal water) meets the water quality norms as prescribed in the IS for various applications (Indian Standards for drinking [IS 10500–1991], irrigation applications [IS 11624-1986]).

Various treatment techniques

- One of the options for providing quality water at low cost is to use 'package plants'. Package plants consist of various components of the treatment process (such as chemical feeders, mixers, flocculators, sedimentation basins, and filters) in a compact assembly. As these units are assembled based on the standard designs, they are cheaper as compared to those built on-site.
- Slow sand filtration is a technique, which is low energy consuming and does not require high-end technical expertise to operate.
- Water-treatment systems based on ion exchange and reverse osmosis can provide high quality water after removal of heavy metals, suspended solids, and so on.

Structural Requirements

1) Fly Ash use in RC : Minimum 25% replacement of cement with fly ash by weight of cement used in the total structural concrete.
2) Fly ash use in Building blocks for 80% load bearing and non-load bearing wall to be AAC/fly-ash. Minimum 40% utilization of fly ash by volume of materials.
3) Fly ash use in plaster and masonry mortar: Minimum 25% use of fly ash in place of cement by weight.
4) Use insulation with zero-ODP (ozone depletion potential)

GRIHA Standard for Use of Low VOC Materials

All the paints and coatings used in building interiors should meet the below mentioned thresholds for volatile organic compounds (VOC) limits.

Paint applications		VOC limits (g of VOC per liter)
Interior coatings	Flat Non-flat	<50 <150
Exterior coatings	Flat Non-flat	<200 <100
Anti corrosive	Gloss/semi gloss/flat	<250

Note: VOC limits for paints should not exceed above mentioned thresholds.

Adhesives and sealants should be urea-formaldehyde free.

List of Documents to be Maintained During Construction

Site Management

1. Top soil fertility test report
2. Photographic evidence of preserved top soil
3. PERT Chart (timeline of various construction stages)
4. Site management plan - during construction
5. Site drainage plan – during construction
6. Plan indicating vehicular moment on site
7. Monthly log of material wise waste generated on site
8. Receipt and gate pass of waste construction materials being sold to scrap dealers

Sanitation and Safety Facility for Construction workers

1. Purchase invoices of safety gears

Water Management Onsite During Construction

1. Monthly log of quantity and source of water used for construction and purchase invoices to substantiate the same
2. Half yearly Test report of drinking water provided for construction workers
3. Purchase invoice and technical sheet of curing compound

Structural Requirements

1. Test report for cement, RMC and AAC blocks indicating fly ash content
2. Purchase invoices of the same
3. Test report, technical sheet and purchase invoices for insulation

Low VOC Paints, Adhesives and Sealants

1. Technical sheets, purchase invoices and test reports

SECTION 4

BILL OF QUANTITIES

Name of Work: **Construction of Cultural & Information center with Interior, Electrical, HVAC, Plumbing, Fire Fighting and other Allied Services work and Landscaping at Jabalpur (M.P.).**

Probable Amount of Contract: RS. 1-------- Crore

In Words, Rupees ---------- Lacs Only

SECTION 5

AGREEMENT FORM

AGREEMENT

This agreement, made on the _____ day of _____ between: _____ (name and address of Employer) (hereinafter called "the 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 meaning 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 Sumas 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 _____