Ministry of Jal Shakti
(A Government of India undertaking)

1st Floor, JP Krishna Building, Pallimukh Junction,
Pettah, Thiruvananthapuram, Kerala-695024

EPC TENDER DOCUMENT FOR

DEVELOPMENT OF GENERAL HOSPITAL TRIVANDRUM

WAP/INFRA/KERALA/2025/GHT/512

Date: 18.06.2025

S. No.	EPC TENDER DOCUMENTS
1.	Volume I - Notice Inviting E-Tenders (NIT) & Instructions to Bidders (ITB)
2.	Volume II- General Conditions of Contract (GCC)
3.	Volume III- Particular Conditions of Contract (PCC)
4.	Volume IV- Employer's Requirements
5.	Volume V- Tender Drawings
6.	Volume VI- Financial Bid

DISCLAIMER

This document has been prepared by the WAPCOS Limited, a Government of India Undertaking, (Employer) on behalf of The Secretary, Department of Health & Family Welfare, Government of Kerala (The Authority). The information is provided to prospective Bidders, who are interested to Bid for “Development of General Hospital Trivandrum” in Engineering Procurement Construction (EPC) mode. The Kerala Infrastructure Investment Fund Board (KIIFB), Kerala is the Funding Agency of the project and shall directly release all the payments pertaining to this Project to the selected Successful Bidder, upon recommendation by the Employer.

The purpose of this Instruction to Bidders (ITB) is to provide interested parties with information to assist in the preparation of their Bid. While due care has been taken in the preparation of the information contained herein, and it is believed to be complete and accurate, neither the authorities nor their agencies or any of their respective officers, employees, agents nor advisors give any warranty or make any representations, expressed or implied as to the completeness or accuracy of the information contained in this document or any information which may be provided in association with it.

Further, The Employer do not claim that the information is exhaustive. Interested parties are required to make their own inquiry/ survey/ site visit and will be required to confirm, in writing, that they have done so and they did not rely solely on the information given herein.

The Employer reserves the right not to proceed with the project or to change the configuration of the project, to alter the timetable reflected in this document or to change the process or procedure to be applied. It also reserves the right to decline to discuss the Project further with any interested party.

No reimbursement of cost of any type or on any account will be made to persons or entities submitting their Bid.

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NOTICE INVITING E-TENDERS (NIT)
&
INSTRUCTIONS TO BIDDERS (ITB)

PRESS NOTICE

NOTICE INVITING E-TENDER

Date: 18.06.2025

Tender Document for the "Development of General Hospital Trivandrum"

The Employer on behalf of the Authority invites online Bids in Engineering Procurement Construction (EPC) through e- tendering from eligible Successful Bidder/ firms in single stage, two cover bid systems for the following work.

Name and Description of Project	Estimated Cost (INR)	Completion Period of Work	Tender Fee (INR)	Last date & time to submit the e-tender	Bid Security (INR)
Development of General Hospital Trivandrum	1,11,49,15,574/- (excluding GST)	27 months	17,700/-	02.08.2025 at 04:00 PM	5,00,000/-

*It is an indicative cost and not binding on the Employer, Bidders have to do their own due diligence for "Working out the Project Cost"

For submission & other tender details, please refer to the detailed NIT on http://www.wapcos.co.in; e-tender portal of Government of Kerala (GoK), www.etenders.kerala.gov.in; and Central Public Procurement (CPP) e-tender portal https://eprocure.gov.in.

The Employer reserves the right to accept or reject any Bid without assigning any reason or incurring any liability whatsoever. Prospective Bidders are advised to regularly scan through http://www.wapcos.co.in; e-tender portal of Government of Kerala (GoK), www.etenders.kerala.gov.in; and Central Public Procurement (CPP) e-tender portal https://eprocure.gov.in.; as corrigenda/amendments, etc., if any, will be notified on this portal only and separate advertisement will not be made for this.

1. The intending bidder must read the terms and conditions of the Notice Inviting Bids and the Bid documents carefully. They should submit the Bid only if they consider themselves eligible and they are in possession of all the documents required.

2. Information and Instructions for Bidders posted on the website shall form part of the bid document.

3. If no rate is quoted by the bidder, the rate shall be treated as "0" (ZERO) and the tender shall be treated as invalid.

4. The Technical Bid shall be opened first on the due date and time as mentioned in Clause 1.1 KIT. The time and date of opening the Financial Bid of Contractor qualifying the technical bid shall be communicated to them at a later date.

5. E-Tender Fee (NON-REFUNDABLE): The tender document(s), may be downloaded free of cost from the e-Government Procurement (e-GP) website (www.etenders.kerala.gov.in). However, the tender fee, as mentioned in the NIT, is required to be submitted along with the online bid.

6. Bid Security: Bidders shall remit the Bid Security using online payment options of the e-Procurement system only. Bidders are advised to visit the “Downloads” section of the e-Procurement website. No exemption is allowed for Bid Security.

7. The complete set of Tender Document comprises of six volumes shall be made available, as per the above schedule, on the above-mentioned websites.

8. It is advisable to visit the site and acquaint themselves with the actual site conditions and Employer’s Requirements.
    - Pre-Bid queries can be emailed to wapcoscochin@gmail.com on or before 07-07-2025 05:00 pm.

9. Corrigenda/ amendments, etc., if any, will be notified on these portals only and separate advertisement will not be made for this. Bidders are advised to check all these websites regularly.

10. In addition to above, the Bidder shall follow all the KIIFB guidelines as given in the website https://kiifb.org/resources.jsp.

(Signature)
Project Director (Kerala),
WAPCOS Limited

GENERAL INSTRUCTIONS TO BIDDERS FOR E-TENDERING

A. Online Bidder registration process:

Bidders should have a Class III B Digital Signature Certificate (DSC), preferably Class III to be procured from any Registration Authorities (RA) under the Certifying Agency of India. Details of RAs will be available on www.cca.gov.in.

Once, the DSC is obtained, The Bidders have to register on www.etenders.kerala.gov.in website for participating in this tender. Website registration is a one- time process without any registration fees. However, Bidders have to procure DSC at their own cost.

Bidders may contact e-Procurement support desk of Kerala State IT Mission over telephone at 0471-2577088/188/388 or 0484-2336006, 2332262 or 0497-2764788, 2764188 or 0483-273294 or through email: etendershelp@kerala.gov.in OR helpetender@gmail.com for assistance in this regard. Also, for CPP portal a 24 x 7 Help Desk Number 0120-4200462, 0120-4001002.

B. Online Tender Process:

The tender process shall consist of the following stages:

(i) **Downloading of tender document:** Tender document will be available for free download on www.etenders.kerala.gov.in. https://eprocure.gov.in and http://www.wapcos.co.in. However, tender document fees shall be payable at the time of bid submission as stipulated in this tender document.

(ii) **Publishing of Corrigenda:** All Corrigenda shall be published on www.etenders.kerala.gov.in; https://eprocure.gov.in; and http://www.wapcos.co.in.

(iii) **Bid submission:** Bidders have to submit their Bids along with supporting documents to support their eligibility, as required in this tender document on www.etenders.kerala.gov.in. No manual submission of bid is allowed and manual Bids shall not be accepted under any circumstances.

(iv) **Opening of Technical Bid:** The technical Bids will be opened, evaluated and shortlisted as per the eligibility and technical qualifications. All documents in support of technical qualifications shall be submitted (online). Failure to submit the documents online will attract disqualification. Bids shortlisted by this process will be taken up for opening the financial bid.

(v) **Opening of Financial Bids:** Bids of the technically qualified Bidders only shall be considered for opening and evaluation of the financial bid. The date and time of Financial Bid opening shall be intimated to the technically qualified Bidders.

C. Documents Comprising Bid:

i. The First Cover (Technical Bid):

Technical Bid shall contain the scanned copies of the documents, which has to be uploaded in the e tender portal.

The Employer does not take any responsibility for any technical snag or failure that has taken place during document upload.

ii. The Second Cover (Financial Bid):

The Bidder shall complete the Financial Bid as per format provided to be downloaded along with this tender.

Note: The blank Financial Bid should be downloaded and saved on bidder's computer without changing filename; otherwise Financial Bid will not get uploaded. The Bidder should fill in the details in the same file and upload the same back to the website.

Bid Price: Prices quoted by the Bidder shall be fixed during the Bidder's performance of the contract and not subject to variation on any account. A Bid submitted with an adjustable/ variable price quotation will be treated as non - responsive and rejected.

D. E-Tender Fee and Bid Security

The Bidder shall remit E-Tender Fee and Bid Security **as mentioned in the NIT to participate in the Bid.**

The Bid Security of unsuccessful Bidder(s) except lowest three will be refunded after finalization of tender process. The Bid Security submitted by the successful bidder(s) shall be retained by the Employer until the Performance Security is submitted. The Successful Bidder shall submit the Performance Security within 21 days from the date of issue of Letter of Acceptance (LOA) and shall sign the Contract Agreement within 28 days from the date of issue of LOA, failing which the Bid Security shall be forfeited and the award of work (LOA) may liable to be cancelled.

If any Bidder(s) withdraws or make any changes in his offer already submitted before the expiry of the above validity period or any extension thereof without the written consent of the Employer, the Bid Security amount will be forfeited for such act of the bidder(s). Bid Security shall not carry any interest.

The Employer reserves the right of forfeiture of Bid Security in case of the successful Bidder(s) under the following circumstances but not limited to:

i. Does not commence the work within the period as per LOA/ Contract.
ii. Bidder engages in a corrupt practice, fraudulent practice, coercive practice, undesirable practice or restrictive practice as specified in Section IV of this Tender Document.
iii. Bidder withdraws its Bid during the period of Bid validity as specified in this Tender Document and as extended by mutual consent of the respective Bidder(s) and the Employer.
iv. In the case of Selected Bidder, if it fails within the specified time limit, to sign and return the duplicate copy of LOA; or to sign the Agreement; or to furnish the Performance Security within the period prescribed therefore in the Agreement; or having signed the Agreement, commits any breach thereof prior to furnishing the Performance Security.

Online Payment modes: The e-tender fee and Bid Security can be paid in the following manner through e-Payment facility provided by the e-Procurement system:

State Bank of India Multi Option Payment System (SBI MOPS Gateway): The Bidders are required to avail Internet Banking Facility in any of the Nationalised and Scheduled Banks of India for making tender remittances in e Procurement System.

During the online Bid submission process, The Bidder shall select SBI MOPS option and submit the page, to view the Terms and Conditions page. On further submitting the same, the e-Procurement system will re-direct the Bidder to MOPS Gateway, where two options namely SBI and Other Banks* will be shown. Here, Bidder may proceed as per below:

a) SBI Account Holders shall click SBI option to with its Net Banking Facility., where the Bidder can enter their internet banking credentials and transfer the Tender Fee and Bid Security amount.
b) Other Bank Account Holders may click “Other Banks” option to view the bank selection page. Here, Bidders can select from any of the 54 Banks to proceed with its Net Banking Facility, for remitting tender payments.

- Transaction Charges for Other Banks vide SBI Letter No. LHO/TVM/AC/2016-17/47 - 1% of transaction value subject to a minimum of Rs.50/- and maximum of Rs.150/-.
- Bidders who are using “Other Banks” option under SBI MOPS Payment Gateway, are advised by SBI to make online payment 72 hours in advance before tender closing time.

Any transaction charges levied while using any of the above modes of online payment has to be borne by the Bidder. The bid will be evaluated only if payment status against bidder is showing “Success” during bid opening.

E. SUBMISSION PROCESS:

For submission of Bids, all interested Bidders have to register online as explained above in this document. After registration, Bidders shall submit their Technical bid and Financial bid online on www.etenders.kerala.gov.in, along with online payment of tender fees and Bid Security.

It is necessary to click on “Freeze bid” link/ icon to complete the process of bid submission otherwise the bid will not get submitted online and the same shall not be available for viewing/ opening during bid opening process.

For & on behalf of Bidder

SECTION I

1.1. KEY INFORMATION TABLE

S No	DESCRIPTION	DETAILS
1.	Title of the Project	Development of General Hospital Trivandrum
2.	Mode of Project Delivery	Engineering Procurement and Construction (EPC)
3.	Method of Selection	Least Cost Selection
4.	District	Thiruvananthapuram
5.	Corporation/ Municipality/ Panchayat	Thiruvananthapuram Corporation
6.	Portal for bid submission	GoK e-Tender Portal: https://www.etenders.kerala.gov.in; The information related to the bid process would also be available in: http://www.wapcos.co.in and https://eprocure.gov.in;
7.	Estimated Cost (EC)	Rs. 1,11,49,15,574/- (Excluding GST)
8.	Tender Fee	Rs. 17,700/- (Including GST) (Bidders shall remit the Tender Fee using the online payment options of the e-procurement system only)
9.	Bid Security	Rs. 5,00,000/- (Refundable) (Bidders shall remit the Bid Security using the online payment options of the e-procurement system only.)
10.	Pre-Bid Meeting (Online or Offline)	Date : 07-07-2025 Time: 11:00 AM Venue: WAPCOS Limited, 1st Floor, JP Krishna Building, Pallimukku, Pettah, Trivandrum – 695024 Online Meeting Link: https://meet.google.com/jit-kiaz-wqy
11.	Pre-Bid Meeting response	Pre-Bid Meeting response shall be provided in : https://www.etenders.kerala.gov.in; http://www.wapcos.co.in https://eprocure.gov.in;
12.	Commencement Date	Date of signing of agreement or date of handing over of site whichever is later
13.	Project Completion Period	**Total Twenty Seven (27) Months:** Two (2) months for Survey, Planning, Investigation including Geotechnical Investigation, Detailed Engineering, Design & Drawings; One (1) month for approvals Drawings and other statutory approval/ clearance from appropriate Authorities/ Agencies;

S No	DESCRIPTION	DETAILS
		Twenty Four (24) months for Demolition, Procurement, Construction, Installation, Testing and Commissioning.
14.	Performance Security	5.0% of the Contract Price for Works as specified in Volume-I RFP of the Tender Document, Clause 2.1.9. Additional Performance Security is applicable in case of abnormally low Bids/ unbalanced Bids
15.	Security Deposit (Retention Money)	2.5% of the gross amount of each bill of value of work done.
16.	Defects Liability Period	5 Years for Civil Works and 3 Years for Electrical, Mechanical, Plumbing and Electronics works from date of issuance of Completion Certificate.
17.	Validity of Bid/Tender	120 (One Hundred and Twenty) days
18.	Last date & time of Procurement / download of tender Document	02.08.2025 up to 11:00 AM The Bidder must officially procure/ download the tender documents from the portal of WAPCOS Limited, CPPP and E Tender Kerala before the last date and time of sale of tender document in order to bid.
19.	Last date & time for online submission of Technical & Financial Bid.	02.08.2025 up to 03:00 PM
20.	Online opening of Technical Bid	04.08.2025 up to 03:00 PM
21.	Online opening of Financial Bid	After Evaluation of The Technical Bid Date and Time of opening will be intimated to the Technically Qualified Bidder (s)
22.	Employer's Contact information	WAPCOS Limited represented by its Project Director (Kerala), 1st Floor, JP Krishna Building, Pallimukku, Pettah, Thiruvananthapuram – 695024 Land Line : 0471- 2998886 Email : kochi@wapcos.co.in, wapcoscochin@gmail.com
23.	Signing of Contract	The Successful Bidder will have to execute an agreement in stamp paper (Government of Kerala) worth 0.1% of the accepted Contract Price subjected to a maximum of Rs.1,00,000/- in the prescribed form. The cost of the requisite stamp paper shall be borne by the successful Bidder.

Note: If the Regional Office of WAPCOS Limited - Kerala, Thiruvananthapuram happens to be closed on the last date and time mentioned for any of the events, the said event will take place on the next working day at the same time and venue.

1.1.1 The estimated capital cost of the Project (the “Estimated Cost”), as mentioned under the Key information Table (KIT) Clause 1.1 is indicative. The assessment of actual costs, however, will have to be made by the Bidders.

1.1.2 The scope of work broadly includes:

(i) Demolition, Planning, detailed design and Engineering, Surveys & Investigation (Pre- Engineering, Pre-Construction and Post-Construction), Procurement, Fabrication, Transportation, Construction (Civil, Structural, Mechanical, Electrical, HVAC, Fire Fighting, STP and other related services) and Installation, Testing, Pre - commissioning, Commissioning and handing over as per the terms of the EPC Contract. The detailed scope is provided as part of Volume- IV: Employer’s Requirement, which is part of this tender document.

(ii) Performance and fulfilment of all other obligations of the Contractor in accordance with the provisions of this Agreement and matters incidental thereto or necessary for the performance of any or all of the obligations of the Contractor under this Agreement of the Project during the Defects Liability Period (DLP), which shall be for period as specified from completion of Construction work and on issuance of Completion Certificate

(iii) Satisfactorily handing over and training to staff of Hospital Authority. The handing over and training activity shall be done within One month of completion.

1.2. BRIEF DESCRIPTION OF BIDDING PROCESS

1.2.1 The Employer has adopted a single stage two-cover system (referred to as the "Bidding Process") for selection of the Bidder for award of the Project. Under this process, the bid shall be invited under two parts. Eligibility and qualification of the Bidder will be first examined based on the details submitted under first part (Technical Bid) with respect to eligibility and qualifications criteria prescribed in this Tender Document (the “Bidder”, which expression shall, unless repugnant to the context, include the members of the Joint Venture).

1.2.2 The complete set of EPC Tender Document consist of following:

- Volume- I: Notice Inviting e-Tenders (NIT) & Instructions to Bidders (ITB)
- Volume- II: General Conditions of Contract (GCC)
- Volume- III: Particular Conditions of Contract (PCC)
- Volume- IV: Employers Requirement
- Volume- V: Tender Drawings
- Volume- VI: Financial Bid
- Any other necessary documents (if any) that is available online at e-tender portal.

1.2.3 The intending Bidder must read the terms and conditions of Notice Inviting e-tender and the Bid documents carefully. The Bidder should submit the Bid only if the Bidder considers themselves eligible and is in possession of all the

documents required for Bid submission. Intending Bidder is eligible to submit the Bid provided they have definite proof from the appropriate Authority, which shall be to the satisfaction of the Employer, of having satisfactorily completed the works given in the Eligibility Criteria specified in Clause 2.2**.**

1.2.4 The statements and explanations contained in this Tender Document are intended to provide a better understanding to the Bidders about the subject matter of this Tender Document and should not be construed or interpreted as limiting in any way or manner the scope of services and obligations of the Contractor set forth in the Agreement or the Employer's rights to amend, alter, change, supplement or clarify the scope of work, the Project to be awarded pursuant to this Tender Document or the terms thereof or herein contained. Consequently, any omissions, conflicts or contradictions in the Tender Document are to be noted, interpreted and applied appropriately to give effect to this intent, and no claims on that account shall be entertained by the Authority / Employer.

1.2.5 Bidders are requested to submit their queries online through email as per the schedule detailed above in Clause 1.1 Key Information Table (KIT) of this document. The Bidders need to register on the e-tender portal in order to submit their queries. The registration on the e-tender portal is free of cost. The queries submitted in any other mode shall not be entertained or replied to. The Employer responses to queries from prospective Bidders (including an explanation on the query but without identifying the source of the inquiry) will be uploaded as per the schedule detailed above in Clause 1.1 Key Information Table (KIT) of this document.

1.2.6 The Employer shall receive Bids pursuant to this Tender Document in accordance with the terms set forth herein as modified, altered, amended and clarified from time to time by the Employer (collectively the "Tender") and all Bidders shall be prepared and submitted in accordance with such terms on or before the date specified in Key Information Table as per clause 1.1 of the Tender Document for submission of Bids (the "Bid Due Date").

1.2.7 The selected Bidder (the "Successful Bidder") shall be responsible for designing, engineering, procurement and construction under and in accordance with the provisions of an Engineering, Procurement and Construction Contract (the "EPC Contract"), which sets forth the detailed terms and conditions for award of the Project to the Successful Bidder, including the scope of the Successful Bidder's services and obligations, to be entered into between the Contractor and the Employer in the form provided by the Employer as part of the Bidding Documents pursuant hereto.

1.2.8 The EPC Contract shall set forth the detailed terms and conditions for award of the Work to the Successful Bidder, including the scope of the Successful Bidder's services and obligations.

1.2.9 The EPC Tender Document shall form a part of the Contract document., The Successful Bidder shall submit the Performance Security within 21 days from the date of issue of Letter of Acceptance (LOA) and shall sign the Contract Agreement within 28 days from the date of issue of LOA. The Contract Agreement shall consist of all documents stipulated in 1.3.2 forming the e-tender as issued at the time of invitation of tender and acceptance thereof together with any correspondence leading thereto including amendments, Addenda, Corrigenda, etc., if any.

1.2.10 Completion Period: The total duration allocated for the completion of the works shall be as specified in Clause 1.2 of the Key Information Table (KIT).

1.2.11 Labour

- The Selected Bidder shall be responsible for providing a labour camp at their own expense, ensuring it is equipped with all necessary amenities and sanitation facilities in accordance with applicable regulations. The labour camp shall not be permitted within the Project area.
- The Contractor shall be solely responsible for the resolution of any labor disputes that may arise during the execution of the Project / Works.

1.2.12 The scope of work envisages a number of specialized Civil / Electrical/ Mechanical / Plumbing/ MGPS/ MOT/ Electronics Components as required etc. to be executed as integral part of this Contract. The Bidder is expected to have In-house design capabilities to provide the required services as per the scope of work.

1.2.13 Canvassing, whether directly or indirectly, in connection with tenders is strictly prohibited and the tenders submitted by the Bidders, who resort to canvassing will be liable to be rejected.

1.2.14 The Employer does not bind itself to accept the lowest or any other tender and reserves to itself the authority to reject any or all the tenders received without the assignment of any reason. All tenders in which any of the prescribed condition is not fulfilled or any condition including that of conditional rebate is put forth by the Bidder shall be summarily rejected.

1.2.15 The Tender Document consists of:

- Volume I – Request for Bid (Tender Document)- Notice Inviting E-Tenders (NIT) & Instructions to Bidders (ITB): This Tender Document comprises the Disclaimer set forth herein above, the contents as listed below, and will additionally include any addenda issued in accordance with Clause
  - Section I: Introduction
  - Section II: Instruction to Bidders (ITB)
  - Section III: Evaluation of Bids
  - Section IV: Fraud and corrupt practices

- Section V: Miscellaneous
- Annexure – I: Check List of Documents
    - **Form "A"** Format for Form of bid
    - ADDON to **Form A**
    - **Form "T-1"** (Financial Information)
    - **Form T-1-B** (Format for Solvency Certificate)
    - **Form T-1-B-1** (Form for Certificate of Net Worth)
    - **Form "T-2"** (Details of Eligible Similar Nature of Works Completed in Last Seven Years Ending Previous Day of Last Date of Submission of Bid)
    - **Form "T-3"** {ADDON to Form "T-2"} Performance Report of Works Referred to in Form "T-2"
    - **Form "T-4"** (Structure & Organization)
    - **Form "T-5"** (GST Registration Details)
    - **Form "T-6"** List of Key Personnel
    - **Form "T-7"** {ADDON to Form "T-6"} Format for CVs of Key Personnel
    - **Form "T-8"** Successful Bidder's Equipment
    - **Form "T-9"** Project Under Execution or Awarded
    - **Form "F-1"** (Information Required to calculate the Bid Capacity)
    - **Form "B"** Format for Performance Security
    - **Form "C"** Draft Agreement for EPC Tender
    - **Form "D"** Power of Attorney for Signing of Bid for Authorized Signatory
    - **Form "E"** Affidavit duly notarized on non-judicial of appropriate value-stamp paper
    - **Form "F"** Undertaking
    - **Form "G"** Format for Advance Bank Guarantee for Mobilization Advance
    - **Form -"H**" Format for No-Conviction Certificate
    - **Form- "I"** Format for understanding the project site
    - **Form- "J"** Format for No Deviation Certificate
    - **Form- "K"** Undertaking as per Clause 46 (Rule 144 (XI) in General Financial Rules (GFRs) 2017)
    - **Form-"L"** Format for Joint Venture Agreement
    - **Form "M"** Format for Undertaking Specialized Works
    - **Form "N"** Format for MOU
    - **Form "O"** Form of Integrity Pact
    - All Guiding Bid Documents (GBDs) along with corrigendum/ addendum (if any)/ pre-bid clarifications (if any) digitally signed by the authorized person of the bidder
- Volume II – General Conditions of Contract (GCC)
- Volume III – Particular Conditions of Contract (PCC)
    - **Part A**-Contract Data
    - **Part B**-Special Conditions
- Volume IV – Employer's Requirement
- Volume V – Tender Drawings
- Volume VI – Financial Bid
- All amendments (corrigenda/ addenda), if any.

SECTION II
INSTRUCTIONS TO BIDDERS

2.1 GENERAL TERMS OF BIDDING

2.1.1 The scope of work is for execution of the Project in “Engineering, Procurement and Construction” (EPC) mode, which shall include architectural design, structural design and design of all other required services, obtaining statutory clearances and approvals from local bodies/ authorities required for commencing the Work, execution of Work & Services and handing over the assets after completion in all respects to the satisfaction of the Employer. In addition to execution in EPC mode, the scope of Work includes rectification of defects during Defects Liability Period (DLP) covering electrical equipment, consumables, any spares. The details of scope of work are provided in Section VI of this document and Volume IV – Employer’s Requirements of the EPC Tender Document.

2.1.2 In case a Bidder firm/ company possesses the requisite experience and capabilities required for undertaking the required works it may participate in the Selection Process either individually (the “Sole Firm/ Company”) or as lead member of a Joint Venture (the “Lead Member”) in response to this invitation. The manner in which the Bid is required to be submitted, evaluated and accepted is explained in this Tender Document.

2.1.3 No Bidder shall submit more than one Bid for the Project. A Bidder bidding individually or as a member of a Joint Venture shall not be entitled to submit another Bid either individually or as a member of other Joint Venture, as the case may be.

2.1.4 The Employer may issue addenda / corrigenda to the Tender Document which will be deemed to form part of the Bidding Documents. The Bidders who have downloaded the Tender Document from website must visit the website and ensure that such addenda / corrigenda, if any, are also downloaded by them. It shall be the responsibility of the prospective registered Bidders to check the web site for any such corrigenda / addenda at the time of closing time of the Tender Document and ensure that the Bid submitted by them is in accordance with all the corrigenda / addenda. Suitable time extension (not less than 3 days beyond the date of last corrigenda / addenda) shall be granted or the prospective Bidder to prepare an informed bid for submission.

2.1.5 The Bidders are advised to submit their online Bid in the prescribed format well before the Bid Due Date specified in Key Information Table provided under Clause 1.1 of the Tender Document. Notwithstanding anything to the contrary contained herein on the Tender document, time being displayed on e-procurement portal of GoK / GoI (“Standard Time”) and website of WAPCOS Limited shall be final and binding on the Bidder. Bids are required to be submitted online by the Bidders only as per the Indian Standard Time (IST). The Employer shall not be responsible for any delay in submission of online Bid for any reason including server and technical problems.

2.1.6 The Bidders shall examine the Project in greater detail, and to carry out, at their cost, their own surveys, investigations and other detailed examination of the

Project before submitting their Bids for award of the contract including implementation of the Project specified in this Section of the EPC Tender Document. The Technical Bid shall be furnished in the formats exactly as defined in Annexure I and the Financial Bid as defined in the Volume VI: Financial Bid, and signed by the Bidder's authorized signatory. Upon selection, the Bidder shall be required to enter into an agreement with the Employer in the format as per **Form C** as specified in Volume I.

2.1.7 The Bid shall remain open for acceptance for a period of 120 (One Hundred and Twenty) days from the last date of submission of bid (Bid Due Date) or any extension thereto. If any bidder withdraws his bid before the said period or issue of Letter of Acceptance (LOA), whichever is earlier, or makes any modifications in the terms and conditions of the tender which are not acceptable to the Employer, the Bid Security amount will be forfeited.

2.1.8 E-Tender Fee and Bid Security: E-Tender Fee: Interested Bidder who wishes to participate in the Bid has to make online payment as specified in the Key Information Table, Clause 1.1 above, towards the E-tender Fee. E-tender Fee is non-refundable.
Bid Security: Interested Bidder who wishes to participate in the Bid has to make online payment as specified in the Key Information Table, Clause 1.1 above, towards Bid Security. No exemption for Bid Security is allowed. Bid Security is refundable after finalization of tender. The Bid security may be extended as mutually agreed between the Authority/ Employer and the Bidder from time to time. The Bid shall be summarily rejected if it is not accompanied by the Bid Security.

2.1.9 The Bidder, whose tender is accepted, will be required to furnish Performance Security as specified below:

The Performance Security shall be the sum equivalent to 5.0 % of the Contract Price. At least 50% of the Performance Security shall be in the form of Treasury fixed deposit as per G.O (P)No.429/15/Fin dated 28.09.2015. The Successful Bidder can submit balance of the Performance Security in the form of a Bank Guarantee issued by a Scheduled Bank in India. This Bank Guarantee shall be in favor of the Employer as per Form B of Annexure I.

Additional Performance Security/ Bank Guarantee is applicable in case of abnormally low Bids/ unbalanced Bids

2.1.10 The Bidder whose Bid is accepted will also be required to furnish either copy of applicable licenses/ registration or proof of having made application for obtaining labour licenses, registration with EPFO, ESIC and BOCW, Welfare Board including Provident Fund Code No., if applicable and also ensure the compliance of aforesaid provisions by the sub-agencies, if any engaged by the Contractor for the said work and Program Chart (time and progress) within the period specified in Clause 1.1 KIT, of this document.

2.1.11 The Bidders are advised that the selection shall be based on selection process specified in this Tender Document. Bidders shall be deemed to have understood and agreed that no explanation or justification for any aspect of the Selection

Process will be given and that the Employer's decisions are acceptable without any right of appeal whatsoever.

2.1.12 The total time allowed for completion of construction under the Agreement (the "Construction Period") and the period during which the Contractor shall be liable for maintenance and rectification of any defect or deficiency in the Project after completion of the Construction Period shall be pre-determined, and are specified in the draft Agreement forming part of the EPC Tender Document.

2.1.13 In the event that the Employer rejects or annuls all the Bids, it may in its discretion, invite all Bidders to submit fresh Bids hereunder.

2.1.14 Other details of the process to be followed under this bidding process and the terms thereof are spelt out in this Tender Document.

2.1.15 Any award of Project pursuant to this Tender Document shall be subject to the terms of Tender Document.

2.1.16 The Tender Document is not transferable.

2.1.17 Any entity, which has been barred by the Central/ State Government, or any entity controlled by it, from participating in any project, and the bar subsists as on the date of Application, would not be eligible to submit the Bid, either individually or as member of a Joint Venture. The Bidder shall provide an undertaking to that effect.

2.1.18 A Bidder shall be liable for disqualification if the Bidder, its Members or any Associate thereof engages any legal, financial or technical adviser of the Employer in relation to the Project, as the case may be, in any manner for matters related to or incidental to such Project during the Bidding Process. In the event any such adviser is engaged by the Selected Bidder or the Successful Bidder, as the case may be, after issue of the LOA or execution of the Contract Agreement for matters related or incidental to the Project, then not withstanding anything to the contrary contained herein or in the LOA or the Contract Agreement and without prejudice to any other right or remedy of the Employer, which may have there under or otherwise, the LOA or the Contract Agreement, as the case may be, shall be liable to be terminated without the Employer being liable in any manner whatsoever to the Contractor for the same. For the avoidance of doubt, this disqualification shall neither apply where adviser was engaged by the Bidder, its Member or Associate in the past but its assignment expired or was terminated 6 (six) months prior to the date of issue of the Tender Document for the Project nor will this disqualification apply where such adviser is engaged after a period of 3 (three) years from the date of commercial operation of the Project.

2.1.19 A Bidder, including any Member in case the Bidder is in Joint Venture, should, in the last 3 (three) years, have neither failed to perform on any Contract, as evidenced by imposition of a penalty by an arbitral or judicial Employer or a judicial pronouncement or arbitration award against the Bidder or Member, as the case may be, nor has been expelled from any project or contract by any public entity nor have had any contract terminated by any public entity for breach by such Bidder or Member.

2.1.20 The Bidder, including any Member of Joint Venture, should provide details of all their on-going projects along with stage of litigation, if so, against the Employer/ Governments.

2.1.21 The Bidder, including any Member of the Joint Venture, should also provide details of on-going process of blacklisting if so, under any contract with Employer/ Government.

2.1.22 In case the Bidder is a Joint Venture, it shall comply with the following additional requirements:

a. Number of members in a Joint Venture shall not exceed 3 (three);
b. Subject to the provisions of clause (a) above, the Bid should contain the information required for each Member of the Joint Venture;
c. Members of the Joint Venture shall nominate one member as the lead member (the "Lead Member"). The nomination(s) shall be supported by a Power of Attorney and agreement as per Form L of Annexure I.
d. Lead Member shall meet minimum 50% requirement of financial capacity required as per Clause 2.3 and 2.4. Each of the other Members shall individually meet the minimum 25% requirement of financial capacity required as per Clause 2.3 and 2.4.
e. the Bid should include a brief description of the roles and responsibilities of individual members, particularly with reference to financial, technical and defect Notification obligations;
f. An individual Bidder cannot at the same time be member of a Joint Venture applying for this Bid. Further, a member of a particular Joint Venture cannot be member of any other Joint Venture applying for this bid;
g. Member of the Joint Venture shall have entered into a binding Joint Bidding Agreement, substantially in the form specified at **Form "L"** of Annexure I ("Joint Venture Agreement"), for the purpose of making the Bid and submitting a Bid. The Joint Bidding Agreement, to be submitted along with the Application, shall, inter alia:
   (i) convey the intent to form a Joint Venture, which would enter into the Contract Agreement and subsequently carry out all the responsibilities as the "Successful Bidder" in terms of the Contract Agreement
   (ii) convey the commitment(s) of the Lead Member in accordance with this Tender Document, in case this Contract is awarded to the Joint Venture; and clearly outline the proposed roles & responsibilities, if any, of each member
   (iii) commit the approximate share of work to be undertaken by each member ;
   (iv) include a statement to the effect that all members of the Joint Venture shall be liable jointly and severally for all obligations of the Contractor in relation to the Project until the completion of the Project; and
h. The validity of Joint Venture shall be till completion of the DLP.
i. Except as provided under this Tender Document, there shall not be any amendment to the Joint Bidding Agreement.

2.1.23 Notwithstanding anything to the contrary contained herein, in the event that the Bid Due Date falls within three months of the closing of the latest financial year of

a Bidder, it shall ignore such financial year for the purposes of its Bid and furnish all its information and certification with reference to the 5 (five) years or 1 (one) year, as the case may be, preceding its latest financial year. For the avoidance of doubt, financial year shall, for the purposes of a Bid hereunder, mean the accounting year followed by the Bidder in the course of its normal business.

2.1.24 Notwithstanding anything to the contrary contained in this EPC Tender Document, the detailed terms specified in the draft Contract Agreement shall have overriding effect; provided, however, that any conditions or obligations imposed on the Bidder hereunder shall continue to have effect in addition to its obligations under the Contract Agreement.

2.1.25 The latest CPWD/ MoRD/ CPHEEO specifications/ PCB circulars and BIS/ IS codes and the relevant sections of the National Building Code, PWD Manual, PWD Quality Control Manual, PWD Quality Control Laboratory Manual etc. shall be followed for Demolition, Planning, detailed design and Engineering, Surveys & Investigation (Pre- Engineering, Pre-Construction and Post-Construction), Procurement, Fabrication, Transportation, Construction (Civil, Structural, Mechanical, Electrical, HVAC, Fire Fighting, STP and other related services) and Installation, Testing, Pre - commissioning, Commissioning and handing over as per the terms of the EPC Contract.

2.2 ELIGIBILITY CRITERIA

2.2.1 The intending bidder must read the terms and conditions of Notice Inviting e-tender and the Bid documents carefully. The prospective Bidder should submit the bid only if the Bidder assesses themselves to be eligible and they are in possession of all the documents required. Intending bidder is eligible to submit the Bid provided they have definite proof from the appropriate authority, which shall be to the satisfaction of the Employer, of having satisfactorily completed the works given in the Eligible Assignments specified in this Clause 2.3.

2.2.2 Bidders established in India and operating under the laws of India, who fulfill the following requirement shall be eligible to apply. Joint Venture is also permitted subject to the conditions set out in this tender document as per Clause 2.3.

a) The Bidder (individually or as a Joint Venture) shall be in active business for the last 5 (Five) years and shall submit relevant documentary evidence for the same as specified in Clause 2.4.

b) The Bidder should have the experience of having successfully completed the works, as defined in Clause 2.3 during the past 7 years ending last day of month previous to one in which tenders are invited. For this purpose, estimated cost of work shall mean gross value of the completed work including cost of material supplied by the respective / Employer but excluding those supplied by the Client /Employer free of cost:

c) The experience claimed by the Bidder in specific works should be in the name of the bidding entity and not in the name of a subsidiary / associate company / Group Entity, etc.

d) The Bidder should submit a declaration that eligible works(s) as mentioned in eligibility criteria has / have not been got executed through another

Contractor on back-to-back basis. Bidder shall submit duly notarized affidavit to this effect, as per prescribed format (**Form "E"**).

e) The Bidder should be an Indian Registered Company under Companies Act 2013/ Proprietorship Company/Co-operative Society/ Registered Contractors from State Government or Central Government/ Partnership Company/ Limited company private or public or corporation. Copy of Certificate of Incorporation/Registration/Partnership Deed or any other relevant document, as applicable, as issued by the Competent Authority should be submitted along with a copy of address proof.

f) The Bidder shall submit only one bid in the same bidding process, either individually as a Bidder or as a member in a Joint Venture. A Bidder (either as a firm or as an individual or as a member of a firm) who submits or participates in more than one bid, will cause all the Bids in which the Bidder has participated to be disqualified.

g) At the time of bidding, a Bidder shall not be blacklisted / debarred / penalized from bidding by any Central / State Government Department / Autonomous Government Body / Central or State PSU as on the last date of submission of the bid (including amendments if any).

h) The Bidder shall have a valid GST registration. The copy of GST registration shall be submitted. GST registration Certificate of the state in which the work is to be taken up, if already obtained by the bidder is also to be submitted. If the bidder has not obtained GST registration in the State in which the work is to be taken up or as required by GST authorities, then in such case the bidder shall scan and upload following undertaking in their letter head along with other bid documents. "If work is awarded to me, I/we shall obtain GST registration Certificate of the State, in which work is to be taken up within one month from the date of receipt of award letter or before release of any payment by Client / WAPCOS / Funding Agency, whichever is earlier, failing which I/We shall be responsible for any delay in payments which will be due towards me/us on a/c of the work executed and/or any action taken by Client / WAPCOS / Funding Agency or GST department in this regard."

i) The Bidder shall have valid ESI and EPF registration. The copy of the valid ESI and EPF registration shall be submitted.

j) The Bidder shall submit ITR details for the last five financial Years along with the bid.

2.2.3 For the purposes of satisfying the Conditions of Eligibility and for evaluating the Bids, experience of the Bidder for the following projects shall be deemed to be the "Eligible Assignments".

2.3 ELIGIBILE ASSIGNMENTS

a) Experience should be in construction sector and should have successfully completed / commissioned Projects in the name of the bidding company(s). In case of Joint Venture, experience of all members shall be considered.

b) Experience of having successfully completed the Similar Works** during the last 7 years ending last day of month previous to one in which tender is invited. For this purpose, cost of work shall mean gross value (excluding GST) of the completed work including cost of material supplied by the respective Client but excluding those supplied by the Client free of cost:

One similar completed work costing not less than the amount equal to 80% of Estimated Cost of this project.

OR

Two similar completed works costing not less than the amount equal to 50% of Estimated Cost of this project.

OR

Three similar completed works costing not less than the amount equal to 40% of Estimated Cost of this project.

*****Similar Works means,***

"Similar works" mean the Design and Construction of Hospital, encompassing all aspects such as Civil, MEP (Mechanical, Electrical, Plumbing), MGPS, Water Treatment Plant (WTP), Sewage Treatment Plant (STP), Effluent Treatment Plant (ETP), HVAC, Firefighting, Lifts, OTs, Solar Panels and other related systems, etc. satisfactorily completed for Central/State/PSU's (Copy of Completion certificate signed by an officer not below the rank of Executive Engineer or equivalent needs to be submitted).

For specialized works such as WTP, STP, ETP, HVAC, Firefighting, Lifts, OT, Solar Panels and MGPS the Bidder can associate with specialized agencies to fulfil the qualification criteria. The Bidder or the associated agency, as the case may be, should have installed and commissioned atleast one (1) hospital project in any Central/ State/ PSU's. MoU (Memorandums of Understanding) between bidder and the specialized agency as per **Form N** in this regard should be submitted along with an undertaking on Rs. 100 Non- Judicial Stamp Paper as per **Form M**. The validity of MOU shall be for 27 months or till completion of the work whichever is later.

Copy of Taking Over/Completion Certificate signed by an officer not below the rank of Executive Engineer or equivalent needs to be submitted for both (c) and (d) above.

The value of executed works shall be brought to current costing level by enhancing the actual executed value of work at simple interest rate of 7% per annum; calculated from the date of completion to previous day of last date of submission for Bids.

Own works/ work under the same management / own certification of the Bidder shall not be considered.

Experience for any activity relating to an Eligible Assignment shall not be claimed by two or more Members of the Joint Venture. In other words, no double counting by a Joint Venture in respect of the same experience shall be permitted in any manner whatsoever.

2.4 FINANCIAL ELIGIBILITY

a) **Turnover:** Average annual financial turnover from construction works should be at least 30% of Estimated Cost during the immediate past three consecutive financial years ending 31st March, 2024. Duly filled **Form T1** along with balance sheets, Statement of Profit & Loss Account and Notes to Accounts should be duly audited and certified by a Chartered Accountant/ Statutory Auditor with his seal and signatures along with registration number and UDIN. The year in which no turnover is shown, would also be considered for working out the average. The turnover should be of the Bidding entity and not for Group Company or subsidiary company etc. In case of a Joint Venture, the Lead Member shall meet minimum 50% requirement of turnover stated in this clause. Each of the other Members shall individually meet the minimum 25% requirement as per the turnover requirement in this clause.

b) . The above information pertaining to Financial Eligibility of the Bidder shall be provided as per the format (Form T-1) duly certified by a Statutory Auditor / Chartered Accountant.

- The Bidder shall provide audited financial reports for the last five financial years.
- Bids submitted without the certificate of Statutory Auditor / Chartered Accountant and the audited financial reports for the last five years shall not be considered for evaluation.

c) **Profit / Loss:** The Bidder should not have incurred any loss (profit after tax PAT, should be positive) in more than two years during the last five consecutive financial years ending 31st March, 2024, duly certified and audited by the Chartered Accountant/ Statutory Auditor. In case of a Joint Venture, all Members should individually meet this criterion.

d) **Solvency Certificate:** The Bidder should submit a minimum solvency of 40% of EC issued by Schedule bank as per latest RBI list for this project. The Bidder shall check the Technical Bid criteria in **Form T-1B** for solvency certificate before submission In case of a Joint Venture, the Lead Member shall meet minimum 50% requirement of solvency stated in this clause. Each of the other Members shall individually meet the minimum 25% requirement as per the solvency stated in this clause.

Solvency certificates (as prescribed in **Form T-1 B**) in the current financial year dated after publication of this NIT, should be issued on the letter head of the Bank, addressed to tender inviting authority clearly quoting the name of this project. The solvency should be issued between the publishing date of NIT for this work and last date of submission of Bids including extensions if any.

e) **Bid Capacity:** The Bidder who inter alia meet the minimum qualification criteria will be qualified only if their available Bid Capacity is more than the Total Tendered Value. The available Bid Capacity will be calculated as

outlined in the Bid Format for Bid Capacity, based on the information provided. In case of a Joint Venture, the Lead Member shall meet minimum 50% requirement of bid capacity stated in this clause. Each of the other Members shall individually meet the minimum 25% requirement as per the bid capacity stated in this clause.

Assessed available Bid Capacity = (A*N*1.5-B), Where

N = Number of years prescribed for completion of work for which Bid is invited

A= Maximum turnover (as per **Form T-1**) in construction works executed in any one year during the last five years (updated to the price level of the year indicated in table below under note) taking into account the completed as well as works in progress. The Projects include turnkey project/ EPC/ Item rate contract/ Construction works.

B = Value of existing commitments and ongoing works to be completed during the period of completion of work for which bid has been invited.

Year	Year 1	Year 2	Year 3	Year 4	Year 5
Updation Factor (UF)	1.00	1.05	1.10	1.15	1.20

The Bidder shall submit the value of existing commitments and ongoing works as above duly signed by a Chartered Accountant/ Statutory Auditor with his seal and signatures along with registration number.

The Bidder shall submit the bidding capacity '**Form-F1**' attached along with this tender. In case of a Joint Venture, the Lead Member shall meet minimum 50% requirement of bid capacity stated in this clause. Each of the other Members shall individually meet the minimum 25% requirement as per the bid capacity stated in this clause.

2.5 DISQUALIFICATION

Even if a bidder meets the eligibility criteria as per 2.2, 2.3 and 2.4, they shall be subject to disqualification if he or any of the constituent member is found to have:

a) Made misleading or false representations in the forms, statements, affidavits and attachments submitted in proof of the qualification requirements; and/ or
b) Records of poor performance during the last five years, as on the date of application, such as abandoning the work, rescission of the contract for reasons which are attributable to non-performance of the Contractor inordinate delays in completion, consistent history of litigation resulting in awards against the Contractor or any of the constituents, or financial failure due to bankruptcy, and so on. The rescission of a contract of Joint Venture on account of reasons other than non performance, such as the most experienced partner (Lead member) of Joint Venture member pulling out
c) On account of currency of debarment by any Government agency.

2.6 COST OF BIDDING

2.6.1 The overall Master Plan, scheme and Engineering designs are for guidance only and the Authority/ Employer does not own any liability in the Project. It is the entire responsibility of the Bidder to verify the scheme and design for the requirement based on the input and output quality parameters given in the Guiding Bidding Documents. It is therefore, responsibility of the Bidder to visit the site and assess the resources, in order to be more practical and competitive.

2.6.2 Not limiting to the Volume- IV: Employer's Requirement defined in the guiding bidding document, the Bidder has to ensure that they have considered all the items that are required for the execution of the Project to ensure the desired results within the quoted price.

2.6.3 The Bidders shall be responsible for all of the costs associated with the preparation of their Bids and their participation in the Bidding Process. The Employer will not be responsible or in any way liable for such costs, regardless of the conduct or outcome of the Bidding Process.

2.7 SITE VISIT AND VERIFICATION OF INFORMATION

2.7.1 The Bidder is solely responsible for the preparation, correctness and details of their Bid.

2.7.2 The Bidder is expected to examine carefully all the contents of Tender Document as mentioned and take them fully into account before submitting his bid. Bids, which do not satisfy all the requirements, as detailed in these documents, are liable to be rejected as being non - responsive.

2.7.3 The Bidder is to submit their respective Bids after visiting the Project site and ascertaining for themselves the site conditions, location, surroundings, climate, availability of power, water & other utilities for construction, access to site, handling and storage of materials, weather data, applicable laws and regulations and any other matter considered relevant by them.

2.7.4 The Bidder shall be deemed to have inspected the Site and its surroundings existing facilities, services & utilities and satisfy themselves before submitting their tenders as to the nature of the ground and sub-soil, the form and nature of the Site, the means of access to the Site, the accommodation they may require and in general shall themselves obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect their tender and taken into account all relevant factors pertaining to the Site, while preparing and submitting the Bid.

2.7.5 The Bidder shall be deemed to have full knowledge of the Site whether he inspects it or not and no extra charges consequent on any misunderstanding or otherwise shall be allowed. The Bidder shall be responsible for arranging and maintaining at its own cost all materials, tools & plants, water, electricity, access, facilities for workers and all other services required for executing the work unless

otherwise specifically provided for in the contract documents. Submission of a Bid by a Bidder implies that they have read this notice and all other contract documents and has made themselves aware of the scope and specifications of the work to be done and other conditions, factors etc. having a bearing on the execution of the Work.

2.7.6 It shall be deemed that by submitting a Bid, the Bidder has:

a) Made a complete and careful examination of the Bidding Documents;

b) Received all relevant information requested from the Employer;

c) Inspected the Site and its surroundings and taken into account all relevant factors pertaining to the Site, while preparing and submitting the Bid.

d) Accepted the risk of inadequacy, error or mistake in the information provided in the Guiding Bidding Documents (GBD) or furnished by or on behalf of the Employer relating to any of the matters referred in the Guiding Bidding Document (GBD). No claim shall be admissible at any stage on this account.

e) Satisfied itself about all matters, things and information including matters referred to in the Guiding Bidding Document (GBD) herein above necessary and required for submitting the bid, execution of the Project in accordance with the Guiding Bidding Document (GBD) and performance of all of its obligations there under;

f) Acknowledged and agreed that inadequacy, lack of completeness incorrectness of information provided in the Guiding Bidding Document (GBD) shall not be a basis for any claim for compensation, damages, extension of time for performance of its obligations, loss of profits etc. from the Employer, or a ground for termination of the Agreement by the Bidder;

g) Acknowledged that it does not have a Conflict of Interest that affects the Bidding Process. Any Bidder found to have Conflict of Interest shall be disqualified and liable for forfeiture of the Bid Security or the Performance Security, as the case may be. A Bidder shall be deemed to have a Conflict of Interest affecting the Bidding Process, if:

   i. The Bidder (or any constituent thereof) and any other Bidder, have common controlling shareholders or other ownership interest; provided that this disqualification shall not apply in cases where the direct or indirect shareholding of a Bidder, (or any shareholder thereof having a shareholding of more than 5% (five percent) of the paid up and subscribed share capital of such Bidder, in the other Bidder, is less than 5% (five percent) of the subscribed and paid up equity share capital thereof; provided further that this disqualification shall not apply to any ownership by a bank, insurance company, pension fund or a public financial institution referred to in section 4A of the Companies Act 2013. For the purposes of this Clause 2.7.2,

indirect shareholding held through one or more intermediate persons shall be computed as follows:

a. Where any intermediary is controlled by a person through management control or otherwise, the entire shareholding held by such controlled intermediary in any other person (the "Subject Person") shall be taken into account for computing the shareholding of such controlling person in the Subject Person; and

b. Subject always to sub- clause (aa) above, where a person does not exercise control over an intermediary, which has shareholding in the Subject Person, the computation of indirect shareholding of such person in the Subject Person shall be undertaken on a proportionate basis; provided, however, that no such shareholding shall be reckoned under this sub-clause (bb) if the shareholding of such person in the intermediary is less than 26% of the subscribed and paid up equity shareholding of such intermediary; or

ii. a constituent of such Bidder is also a constituent of another Bidder; or

iii. Such Bidder, or any of its Joint Venture Member thereof receives or has received any direct or indirect subsidy, grant, concessional loan or subordinated debt from any other Bidder, or any of its Joint Venture Member thereof or has provided any such subsidy, grant, concessional loan or subordinated debt to any other Bidder, its Member or any of its Joint Venture Member thereof; or

iv. Such Bidder has the same legal representative for purposes of this Application as any other Bidder; or

v. Such Bidder, or any of its Joint Venture Member thereof has a relationship with another Bidder, or any of its Joint Venture Member thereof, directly or through common third party/ parties, that puts either or both of them in a position to have access to each other's information about, or to influence the Application of either or each other; or

vi. Such Bidder or any of its Joint Venture Member thereof has participated as a consultant to the Authority/ Employer in the preparation of any documents, design or technical specifications of the Project.

vii. Agreed to be bound by the undertakings provided by it under and in terms hereof.

2.7.7 The Employer shall not be liable for any omission, mistake or error in respect of any of the above or on account of any matter or thing arising out of or concerning or relating to Tender Document, Guiding Bidding Document (GBD) or the Bidding Process, including any error or mistake therein or in any information or data given by the Employer.

2.8 VERIFICATION

2.8.1 The Employer reserves the right to verify all statements, information and documents submitted by the Bidder in response to the Tender Document and the Bidder shall, when so required by the Employer, make available all such information, evidence and documents as may be necessary for such verification. Any such verification or lack of such verification, by the Employer shall not relieve the Bidder of its obligations or liabilities hereunder nor will it affect any rights of the Employer there under.

2.8.2 The Employer reserves the right to reject any Bid and appropriate the Bid Security if:

a) At any time, a material misrepresentation is made or uncovered, or

b) The Bidder does not provide, within the time specified by the Employer, the supplemental information sought by the Employer for evaluation of the Bid.

2.8.3 Such misrepresentation/ improper response shall lead to the disqualification of the Bidder.

2.8.4 In case it is found during the evaluation or at any time before signing of the Agreement or during execution, subsistence thereof, the Bidder has made material misrepresentation or has given any materially incorrect or false information, the Bidder shall be disqualified forthwith if not yet appointed as the Contractor either by issue of the LOA or entering into of the Agreement, and if the Selected Bidder has already been issued the LOA or has entered into the Agreement, as the case may be, the same shall, notwithstanding anything to the contrary contained therein or in this Tender, be liable to be terminated, by a communication in writing by the Employer to the Selected Bidder or the Successful Bidder, as the case may be, without the Employer being liable in any manner whatsoever to the Selected Bidder or the Successful Bidder. In such an event, the Employer shall be entitled to forfeit and appropriate the Bid Security or Performance Security, as the case may be, as Damages, without prejudice to any other right or remedy that may be available to the Employer under the Bidding Documents and/ or the Agreement, or otherwise.

2.9 BID PRICE

2.9.1 The Lump sum price quoted by the Bidder for Bid Price in financial Bid shall include all the components mentioned in Volume-IV Employer's Requirements including, demolition, designing, supply & erection of civil, electrical, mechanical and miscellaneous items for completing all the works as defined Volume- IV Employer's Requirement, including remedying any defects therein up to the end of the Defects Liability Period (DLP).

2.9.2 The Bidder shall quote further breakdown of Lump sum costs, the Component Wise Breakup of the Volume- VI Financial Bid.

2.9.3 The lump sum offer shall provide for all superintendence, labour, material, plant, equipment and all other things required for work including all taxes duties, royalties, and such other charges except for the exemptions provided for in the Contract.

2.9.4 "Prices quoted by the Bidder shall be fixed during the Bidder's performance of the Contract and not subject to variation on any account, for goods and services except as provided in the Contract. For all goods and services covered in this Tender Document, prices shall be quoted in Indian Rupees only and payments shall be made in Indian currency only directly by the funding agency on the Employer's recommendation.

2.10 CLARIFICATION AND PRE-BID MEETING

2.10.1 A prospective Bidder requiring any clarification with regards to the Guiding Bidding Document (GBD) may submit their queries in accordance with the Clause 1.1

2.10.2 The Employer shall endeavor to respond to queries raised or clarifications sought by the Bidders within the stipulated time without identifying the source of queries. Only the communication/ clarification that are submitted up to 5 days after the pre- bid meeting will be considered.

2.10.3 However, the Employer reserves the right not to respond to any question or provide any clarification, in its sole discretion, and nothing in this Clause shall be taken or read as compelling or requiring the Employer to respond to any question or to provide any clarification.

2.10.4 The Employer may also on its own motion, if deemed necessary, issue interpretations and clarifications to all Bidders. All clarifications and interpretations issued by the Employer shall be deemed to be part of the Guiding Bidding Documents. Verbal clarifications and information given by the Employer or its employees or representatives shall not in any way or manner be binding on the Employer.

2.10.5 Only those authorized persons who have downloaded the online e-TENDER documents or their representatives shall be allowed to participate in the Pre-Bid Conferences. A maximum of two (2) representatives of each Bidder shall be allowed to participate on production of authorization letter from the original Bidder.

2.10.6 During the course of Pre-Bid meeting(s), the Bidders will be free to seek clarifications and make suggestions for consideration of the Employer. The Employer shall endeavor to provide clarifications and such further information as it may, in its sole discretion, consider appropriate for facilitating a fair, transparent and competitive Bidding Process.

2.11 CONFIDENTIALITY

The Bidders are to treat all information as strictly confidential and shall not use it for any purpose other than for preparation and submission of their Bid. The document including this Tender Document and all attached documents, provided by the Employer are and shall remain or becomes the property of the Employer and are transmitted to the Bidders solely for the purpose of preparation and the submission of a Bid in accordance herewith.

2.12 AMENDMENT OF TENDER

2.12.1 At any time prior to the Bid Due Date, the Employer may, for any reason, whether at its own initiative or in response to clarifications or queries requested by a prospective Bidder, modify the TENDER by the issuance of an Amendment(s) an Addendum(s) / Corrigendum(s).

2.12.2 The said amendments in the form of Addenda/ Corrigenda issued hereunder will be in writing and shall be uploaded to the website / e-portals. at least three (3) days prior to the last date of the original or extended deadline for the submission of the Bids. The uploading of the said amendment(s) ((addenda/ corrigenda) shall be binding on the Bidders. The Bidders are advised to regularly visit above mentioned website to ensure that they are aware of the amendment(s) (addenda/ corrigenda). The amendment(s) (addenda/ corrigenda issued will form part of the Bid documents.

2.12.3 In order to provide the prospective Bidders a reasonable time for taking such amendments (addenda/ corrigenda) into account, or for any other reason, the Employer may, in its sole discretion, extend the Bid Due Date.

2.13 PREPARATION AND SUBMISSION OF BID

2.13.1 Format and signing of Bid

The Bidder shall provide all the information sought under this Tender Document. The Employer will evaluate only those Bids that are received in the required formats and complete in all respects. The completed Bids shall be submitted by the scheduled time and date as provided in the Clause 1.1 by uploading on E-Procurement portal GoK in a single stage two-cover system as follows:

a) Technical Bid along with the documents/ information as provided in Annexure I

b) Financial Bid in the format as specified in Volume VI.

2.13.2 The Bid shall be submitted online strictly in accordance with the Instructions to Bidders, terms and conditions given in the Tender Document.

2.13.3 The Bidder may submit his Bid online following the instructions appearing on the screen. The detailed guidelines for e-procurement are also available on e-procurement portal.

2.13.4 The e-tender documents shall be uploaded online in two (2) covers:

a) Cover-1 shall contain Scanned copies of Technical Bid.

b) Cover -2 shall contain Financial Bid in the prescribed format.

2.13.5 Bidders are particularly advised to fill in the details asked for, strictly in the prescribed forms. Bidders are liable to be rejected if relevant details are not furnished as per enclosed formats and also which do not meet the pre-qualification requirement as specified in the tender notice. The Bidder may furnish along with his Bid any additional information that in his opinion will highlight his capability to successfully complete the envisaged work. He is, however advised not to furnish superfluous information. No information shall be entertained after submission of Bid unless it is called for by the Employer.

2.13.6 All information called for in the enclosed forms should be furnished against the relevant columns in the forms. If for any reason, information is furnished on a separate sheet, this fact should be mentioned against the relevant column. Even, if no information is to be provided in a column, a “Nil” or “no such case” entry should be made in that column. If any particulars/query is not applicable in case of the bidder, it should be stated as “Not applicable”. The Bidders are cautioned that not giving complete information called for in the application forms or not giving it in clear terms or making any change in the prescribed forms (or) deliberately suppressing the information may result in the bid being summarily disqualified. Bid submitted in any other mode than specified and those received later than the specified time will not be entertained.

2.13.7 Individual pages of the bid submission need not be physically signed, before being scanned and uploaded. While uploading the bid documents, the bidder’s Bidder’s Bid would be digitally signed and this would suffice.

2.13.8 Over writing should be avoided. Corrections if any should be made by neatly crossing out, initialing, dating and rewriting. Pages of the Bid are numbered. Additional Sheets if any added by the Bidder should also be numbered. They should be submitted as a package with signed letter of transmittal.

2.13.9 References, information and certificate from the respective clients certifying technical knowledge or capability of the bidder, etc. should be signed by an officer not below the rank of Executive Engineer or equivalent.

2.13.10 The Bidder should note the following procedure carefully:

a) The Bidder should quote his financial quote offer only in Financial Bid.
b) The Bidder should not indicate his cost offer anywhere directly or indirectly in Technical Bid.
c) The Bidder should quote for the Work as per Employer’s Requirement.
d) No delay on account of any cause will be entertained for the late receipt of Bid.

e) Bid offered or received after the stipulated time limit will either not be accepted and if inadvertently accepted, will not be opened and shall be returned to Bidder unopened.
f) No page shall be added or removed from the set of tender documents.

2.13.11 If the Bidder is already registered with e-tendering service provider of the Employer, and validity of registration is not expired the Bidder does not require a fresh registration.

2.13.12 On the date and time specified in the tender notice, following procedure will be adopted for opening of the Bid. Bidders are also requested to follow the online E-tendering procedure and contact details for submission of their Bids.

2.14 CONTENTS OF PACKAGES FOR ONLINE BID SUBMISSION

The Bid shall be submitted in two parts i.e. Technical Bid & Financial Bid through online mode only. Following documents/ certificates shall be submitted along with the Technical Bid, without which the Technical Eligibility as well as Financial Eligibility will not be evaluated.

A. Part 1: Technical Bid:

The Technical Bid shall contain the following:

I. Online Non – Refundable Tender Fee

Interested Bidder who wishes to participate in the Bid has to make online payment as specified in Clause 1.1 Key Information Table at Section I of this document towards the e- tender Fee. E-tender Fee is non–refundable.

II. Bid Security

a) The Bidder shall to make online payment as specified in Clause 1.1 Key Information Table of this document towards Bid Security .
b) Bids not accompanied by Bid Security, shall be treated as non-responsive and will be summarily rejected by the Employer.
c) The Bid Security of the Bidder shall be forfeited in case the Bidder withdraw/ modify their bid during the period of validity of their tender or fail to sign the Contract Agreement or failed to submit the Performance Security before the deadline as per the tender document.

III. Other documents/ forms shall be submitted as per ANNEXURE - I: CHECK LIST OF DOCUMENTS TO BE SUBMITTED WITH THE BID.

B. Part 2: Financial Bid

a) The financial bid (VOLUME VI – FINANCIAL BID) should be submitted ONLINE only. Physical submission of financial bid will not be accepted and e-tender shall be rejected in such case. The quoted rates should include all costs associated with the Project as per the scope of work till the end of the Defects Liability Period (DLP), including any out of pocket/ mobilization expenses. Quoted rates shall include all prevailing taxes, Building and other Construction Workers welfare cess and any other applicable statutory taxes, levies till the last stipulated date for the receipt of tender including extensions if any, but excluding Goods and

Services Tax (GST). In case Government levies/ modifies any tax subsequently, the same shall be considered mutually in consultation with the Employer and the Funding Agency.

b) The Bidder must ensure to fill up rate against each component of financial bid. If any cell is left blank then value of that cell shall be treated as "0" (ZERO). In event no rate has been quoted for any component(s), it will be presumed that the Contractor has included the cost of this/ these items(s) in other items and rate for such item(s) will be considered as zero and work will be required to be executed accordingly.

c) However, in respect of GST, where ever legally applicable the same shall be paid by the Contractor to the concerned Authorities as per the prevailing rules. The payment for any bills as per the Contract shall be made for the total value of the works at the Contract Price plus the GST @18% at the time of billing. Any variation in tax rate of GST (increase or decrease) after the last date of tender submission shall be adjusted at the time of settlement of bills. TDS and other deductions shall be made on payments excluding GST.

d) The quoted rates shall also include expenses towards all Quality Control tests prescribed in the IS codes/ PWD Manuals/CPHEEO Manual and Central/State Pollution Control Board Standards or as directed by the Employer and to be done at Government/ Aided Engineering Colleges or Polytechnic Colleges or NABL Accredited laboratories.

e) The quoted rates shall includes dismantling, if any, of the required services and utilities falling in the project area and supporting/ shifting & making functional existing utilities and services (sewerage, Electrical transmission & Distribution lines and water supply lines etc.)

2.15 LANGUAGE OF BID

The Bid and all related correspondence and documents relating to the Project shall be in English language only.

2.16 CURRENCY OF BID

The Bid prices shall quote in Indian Rupees only. The amount mentioned elsewhere in the Tender Document will also deemed to be in Indian Rupees unless otherwise mentioned.

2.17 FORMAT AND SIGNING OF BID

a) The Bid documents (Technical Bid and Financial Bid) shall be digitally signed by a person duly authorized to sign the Bid documents. The Bidder shall also submit a Power of Attorney authorizing the person signing the documents.

b) Entries to be filled in by the Bidder shall be typed or written in indelible ink.

c) All witnesses and sureties shall be persons of status and probity and their full names, occupations and addresses shall be written below their signatures.

2.18 SUBMISSION OF BIDS

The mode of submission of Technical Bid and Financial Bid is online. The last date for submission of completed Bids is given in Notice Inviting e-Tender. The Employer may at their discretion, extend this date, in which case all rights and obligations of the Employer and the Bidder shall thereafter be subjected to the new deadline as extended. If such nominated date for submission of Bid is subsequently declared as a public holiday, the next official working day shall be deemed as the date for submission of Bid. The Bidder may require to present Original documents as per the requirement of the Employer during the tendering process.

Employer shall not take any cognizance and shall not be responsible for delay/loss in transit or non-submission of said documents in time.

2.19 POWER OF ATTORNEY

The Bidders shall submit, along with Technical Bid, a Power of Attorney, on a stamp paper of appropriate value, in favor of the person signing the Bid documents authorizing him to sign the Bid documents, make corrections/ modifications thereto and interacting with Employer and act as the contact person. The format for the Power of Attorney shall be as per **Form D** of **Annexure- I**. In case Bids are signed by Managing Director/ Partner/ Proprietor himself, Power of Attorney is not required.
In the event of tender being submitted by a partnership firm, it must be signed separately by each partner thereof or in the event of the absence of any partner, it must be signed on his behalf by a person holding a Power of Attorney authorizing him to do so, such Power of Attorney to be produced with the tender, and it must disclose that the firm is duly registered under the Indian Partnership Act 1932.

In the event of tender being submitted by a Limited company or a corporation, it must be signed by a duly authorized person holding Power of Attorney for signing the application and certified copy of such Power of Attorney shall also be furnished. The Bidder should also furnish a copy of Articles and Memorandum of Association duly attested by a Public Notary.

2.20 MODIFICATION/ SUBSTITUTION/ WITHDRAWAL OF BIDS

2.20.1 No Bid shall be modified, substituted or withdrawn by the Bidder on or after the Bid Due Date & Time.

2.20.2 Only a single copy of the withdrawal notice shall be prepared and each page of the notice shall be signed and stamped by the authorized signatory. The notice shall be duly marked “WITHDRAWAL”. This withdrawal notice will be opened at the time of opening of bid and not earlier. The signature of General Power of Attorney (GPA) holder will be verified and withdrawal shall be considered only in case both are same.

2.20.3 Any alteration / modification in the Bid or additional information supplied subsequent to the Bid Due Date, unless the same has been expressly sought for by the Employer, shall be disregarded.

2.21 REJECTION OF BIDS

2.21.1 Notwithstanding anything contained in this Tender Document, the Employer reserves the right to reject any Bid and to annul the Bidding Process and reject all Bids at any time without any liability or any obligation for such acceptance, rejection or annulment, and without assigning any reasons therefore. In the event that the Employer rejects or annuls all the Bids, it may, in its discretion, invite all eligible Bidders to submit fresh Bids hereunder.

2.21.2 The Employer reserves the right not to proceed with the Bidding Process at any time, without notice or liability, and to reject any Bid without assigning any reasons.

2.21.3 The Employer reserves the right to reject any Bid if:

a) At any time, a material misrepresentation is made or uncovered;

Or

b) The Bidder does not respond within the stipulated time to requests for supplemental information/ clarifications required and sought by the Employer for the evaluation of the Bid;

Or

c) It is found that the information provided is not true or incorrect or facts/material for the evaluation have been suppressed.

Even if a Bidder meets the Eligibility Criteria (Please refer Clause 2.2 and 2.3), he shall be subject to disqualification if he or any of the constituent partners is found to have:

a) Made misleading or false representations in the forms, statements, affidavits and attachments submitted in proof of the qualification requirements; and/ or;
b) Records of poor performance during the last five years, as on the date of Bid such as abandoning the work, rescission of the contract for reasons which are attributable to non-performance of the Successful Bidder, inordinate delays in completion, consistent history of litigation resulting in awards against the Contractor or any of the constituents, or financial failure due to bankruptcy, and so on. The rescission of a contract of venture JV on account of reasons other than non-performance, such as the Lead Member of JV pulling out;
c) On account of currency of debarment by any Government agency.

The Employer reserves the right, without being liable for any damages or obligation to inform the bidder to:

a) Amend the scope and value of contract.
b) Reject any or all the Bids / Bids without assigning any reason.

2.22 CONFIDENTIALITY

Information relating to the examination, clarification, evaluation and recommendation for the Bidders shall not be disclosed to any person who is not officially concerned with the process or is not a retained professional advisor advising the Employer in relation to or

matters arising out of, or concerning the Bidding Process. The Employer will treat all information, submitted as part of the Bid, in confidence and will require all those who have access to such material to treat the same in confidence.

2.23 PROPRIETARY DATA

All documents and other information supplied by the Employer or submitted by a Bidder to the Employer shall remain or become the property of the Employer. The Bidders are to treat all information as strictly confidential and shall not use it for any purpose other than for preparation and submission of their Bid.

2.24 CORRESPONDENCE WITH THE BIDDER

Except as provided in the TENDER, the Employer shall not entertain any correspondence with any Bidder in relation to acceptance or rejection of any Bid.

2.25 BID SECURITY

2.25.1 Bidder shall furnish as part of its Bid, a Bid Security referred to in Clause 2.1.8.

2.25.2 Any Bid without the Bid Security shall be summarily rejected by the Employer as non- responsive.

2.25.3 The Employer will adjust the amount of Bid Security in the amount of Performance Security to be provided by the Successful Bidder in accordance with the provisions of the Agreement.

2.25.4 The Employer shall be entitled to forfeit and appropriate the Bid Security as Damages inter alia in any of the events specified in Clause 2.25.5 herein below. The Bidder, by submitting its Bid pursuant to this Tender Document, shall be deemed to have acknowledged and confirmed that the Employer will suffer loss and damage on account of withdrawal of its Bid or for any other default by the Bidder during the period of Bid validity as specified in this Tender Document. No relaxation of any kind on Bid Security shall be given to any Bidder.

2.25.5 The Bid Security shall be forfeited and appropriated by the Employer as damages payable to the Employer for, inter-alia, time cost and effort of the Employer without prejudice to any other right or remedy that may be available to the Employer under the bidding documents and/ or under the Agreement, or otherwise, under the following conditions:

a) If a Bidder submits a non-responsive Bid as defined in 2.21

b) If a Bidder engages in a corrupt practice, fraudulent practice, coercive practice, undesirable practice or restrictive practice as specified in Section of this Tender Document;

c) If a Bidder withdraws its Bid during the period of Bid validity as specified in this Tender Document and as extended by mutual consent of the respective Bidder(s) and the Employer;

d) In the case of Selected Bidder, if it fails within the specified time limit -

   (i) to sign and return the duplicate copy of LOA; or

   (ii) to sign the Agreement; or

   (iii) to furnish the Performance Security within the period prescribed therefore in the Contract; or

2.26 PERFORMANCE SECURITY

Within 21 days of issue of LOA, the Successful Bidder shall furnish to the Employer a Performance Security in accordance with the provisions of the Bid and in the format given in this Tender Document at **Form "B"** and **Form "P"** in Annexure I. The Successful Bidder can submit the Performance Security in the form of a Bank Guarantee issued by a Scheduled Bank in India in favor of the Employer. The Performance Security shall be sum equivalent to 5.00% of the Contract Price. At least 50% of these Guarantee shall be in the form of Treasury fixed deposit as per - G.O(P)No.429/15/Fin Dated 28.09.2015.

2.27 BID OPENING

2.27.1 Bid Opening

a) The Bids will be opened online in the presence of prospective Bidders or their authorized representatives who may choose to attend on date and time as mentioned in Notice Inviting e-Tender. However, the Bidders can view the status of bid opening online by logging on to the e-tender portal from anywhere.

b) If such nominated date for opening of Bid is subsequently declared as a public holiday, the next official working day shall be deemed as the date of opening of the Bid.

c) Bids for which an acceptable notice of withdrawal has been submitted shall not be opened.

d) Bids which have not complied with one or more of the foregoing instructions may not be considered.

e) On opening of the e-Bid, it will be checked if they contain Technical and Financial Bids and e-Tender Fees paid online, Bid Security as detailed above

f) Financial Bid of all Bidders whose Bids are found responsive after technical evaluation will be opened at a later date.

2.27.2 Determination of Responsiveness

i. Prior to evaluation of Bids, the Employer shall determine whether each Bid is responsive to the requirements of this Tender Document.

ii. For the purpose of this clause, a Bid may be considered responsive only if:

a) It is received as per the format at Annexure - I with scanned versions of the same digitally signed wherever required uploaded on the portal;
b) It is received by the Bid Due Date including any extension thereof pursuant to Clause 1.1 KIT.
c) It is accompanied by the Power(s) of Attorney,
d) It contains all the information as requested in the Tender Document
e) It contains information in formats same/ similar as those specified in this Tender Document

f) It mentions the validity period of the Bid
g) It is accompanied by the Bid Security declaration
h) It conforms to all the terms, conditions and specifications of Tender without material deviation or reservation. "Deviation" may include exceptions and exclusions. A material deviation or reservation is one which affects, in any substantial way, the scope, quality, performance or administration of the works to be undertaken by the Bidder under the Contract, or which limits in any substantial way, Employer rights or the Bidder's obligations under the Contract as provided in Bid and/or is of an essential condition, the rectification of which would affect unfairly the competitive position of other Bidders presenting substantially responsive Bids at reasonable price.

iii. Any condition or qualification or any other stipulation contained in the Bid shall render the Bid liable for rejection as a non-responsive Bid.

iv. The decision of the Employer in this regard shall be final and binding. The Financial Bid of non-responsive Bidders shall not be opened.

2.28 AWARD OF CONTRACT

2.28.1 Award Criteria

The Employer will declare the Bidder ranked L-1 as the Successful Bidder considering the total Bid as mentioned in the NIT. The Employer reserves the right to proceed and award the work as a whole for the entire scope of work or de-scoping any part of work and issue Letter of Acceptance (LOA) on these basis as per the procedure mentioned and terms and conditions set out in this Tender Document.

2.28.2 Notification of Award

Prior to the expiry of the period of Bid Validity, the Employer will issue the Letter of Acceptance (LOA) to the Successful Bidder, notifying him of being declared successful and the intent to sign the Contract Agreement with him. This letter (hereinafter and in the Conditions of Contract called 'the Letter of Acceptance) shall mention the amount which the Funding Agency, KIIFB, will pay to the Contractor on recommendation of the Employer in consideration of the completion and guarantee of the work to be performed by them, as prescribed therein (hereinafter and in the conditions of Contract called 'the Contract Price'). No correspondence will be entertained by the Employer from the unsuccessful Bidders.

The Letter of Acceptance shall constitute a part of the Contract.

2.28.3 Signing of Agreement

a) The Employer shall prepare the Contract Agreement in the Proforma (**Form C**) included in this document, duly incorporating all the terms of agreement between the two parties and within 28 (Twenty-Eight) days from the date of issue of the Letter of Acceptance (LOA) the Contractor will be required to execute the Contract Agreement.
b) Prior to the signing of the Contract Agreement, the Contractor shall submit Performance Security as per requirement of this tender.

c) The Contractor will also be required to furnish either copy of applicable licenses/ registrations or proof of applying for obtaining labour licenses, registration with EPFO, ESIC and BOCW Welfare Board and Programme Chart (Time and Progress) within the period specified in the PCC.
d) The Contract Agreement shall be duly signed by the Employer and the Contractor through their authorized signatories.
e) In case the Contractor does not sign the Contract Agreement, the Employer reserves the right to cancel the selection process, forfeit any Bid Security and/or Performance Security, as the case may be, submitted by the Contractor and either re-Bid or proceed in any manner that it may deem fit.

2.29 PREFERENCE TO MAKE IN INDIA

The order issued by Department of Industrial Policy and Promotion (DIPP) vide No. P-45021/2/2017-PP (BE-II) dated 16.09.2020 will form part of this tender. The Contractor shall ensure strict compliance to this order during the entire tenancy of Contract.

SECTION III
EVALUATION OF BIDS

3.1 EVALUATION PARAMETERS

3.1.1 The Employer shall start downloading/ opening the online Bids at scheduled time on the Bid Due Date, at the time and place specified in Clause 1.1 KIT and in the presence of the Bidders who choose to attend. The Bids for which Bidder has exercised withdrawal option on the e-procurement portal in accordance with Clause 2.14 shall not be downloaded/ opened.

3.1.2 The Employer will subsequently examine and evaluate the Bids in accordance with the provisions set out in this Section III.

3.1.3 To facilitate evaluation of Bids, the Employer may, at its sole discretion, seek clarifications in writing from any Bidder regarding its Bid.

3.1.4 Subject to the terms of this Tender Document and the LOA, the Project will be awarded to the Bidder, who submits a responsive Bid, meets the specified Technical Capacity, Financial Capacity criteria for undertaking the Project and is shortlisted for opening of Financial Bid and offers the lowest Bid Price.

3.1.5 In the Bid Evaluation stage, only those Bids that are found to be responsive to the requirements of the Tender Document as specified in Clause 2.21.2 above would be opened for assessing their qualification for Technical Capacity, Financial Capacity to undertake the Project as per the Evaluation Process detailed in Clause 3.2 hereunder.

3.2 EVALUATION PROCESS

For the purpose of evaluation of the Bids received against this Tender Document, a Bid Evaluation Committee (BEC) shall be constituted by the Employer. The BEC would subsequently examine and evaluate the Bids received, as per the criteria set out in this Tender Document.

The Bids will be evaluated in the following stages:

i. Stage 1- Preliminary & Technical Evaluation
ii. Stage 2- Financial Evaluation

Stage 1: Preliminary &Technical Evaluation

3.2.1 Preliminary Evaluation

In Preliminary Stage, e-Tender Fee and Bid Security will be checked online. E-Tender Fee and Bid Security will be checked for veracity of Amount as required by e-tender terms and conditions. If e-Tender Fee and/ or Bid Security submitted by any Bidder is not as per e- tender terms and conditions, his bid will be rejected and will not be considered for further stages of evaluation.

3.2.2 Technical Evaluation

A. Technical Bid – Eligibility Criteria

The Bidders qualifying in Stage 1 as per Clause 3.2.1 above will be considered for further evaluation and the Technical Bids shall be evaluated as per the eligibility criteria detailed in Clauses 2.2 and 2.3 and the Bidder's eligibility for the work shall be determined. If the Bidder is not meeting with the minimum eligibility criteria as

detailed in Clauses 2.2 and 2.3, his Bid will be rejected and will not be considered for further stages of evaluation.

3.3 SELECTION OF BIDDER

3.3.1 The Employer, however, reserve the rights to restrict the list of such technically qualified Bidders to any number deemed suitable by it.

i. The financial Bid of only those Bidders who are technically qualified shall be opened.
ii. The financial Bids of Bidders whose technical Bids are found unacceptable shall not be opened
iii. The Employer shall notify all the technically qualified Bidders of their technical qualification indicating the date, time and venue for opening of financial Bids.
iv. The Employer (Tender Inviting Agency) shall open the financial Bid of the technically qualified Bidders in the presence of the Bidders/ their authorized representative, who choose to attend, at the scheduled date and time.
v. On opening the financial Bids, the result shall be visible in the e-tender portal.
vi. If a Bidder quotes Nil rates against each item in the Financial Bid, it shall be treated as invalid and will not be considered.

3.3.2 The evaluation of the Financial Bids by the BEC will take into account, in addition to the tender amounts, the following factors:

i. Arithmetical errors corrected by BEC.
ii. Such other factors of administrative nature as the Employer may consider having a potentially significant impact on contract execution, price and payments, including the effect of items or rates that are unbalanced or unrealistically priced.

3.4 LETTER OF ACCEPTANCE

3.4.1 The Selected bidder would be notified in writing by the Employer by issuing the Letter of Acceptance (LOA) in favour of the L-1 Bidder.

3.4.2 The Letter of Acceptance (LOA) shall be issued, in duplicate, by the Employer to the Selected Bidder and the Selected Bidder shall, within 7(seven) days of the receipt of the LOA, sign and return the duplicate copy of the LOA in acknowledgement thereof. In the event the duplicate copy of the LOA duly signed by the Selected Bidder is not received by the stipulated date, the Employer may, unless it consents to extension of time for submission thereof, appropriate the Bid Security of such Bidder as Damages on account of failure of the Selected Bidder to acknowledge the LOA.

3.4.3 After acknowledgement of the LOA as aforesaid by the Selected Bidder, it shall cause the Bidder to submit Performance Security and Additional Performance Security (if any) within the period prescribed/extended by Authority / Employer and then execute the Agreement within the period prescribed in Clause 1.1. The Selected Bidder shall not be entitled to seek any deviation, modification or amendment in the Agreement.

3.4.4 The Employer reserves the right to evaluate / analyze the component wise quote of the Bidders and in the case of exorbitant / unbalance quote of components, the

Employer reserves the right to de-scope any component from the quote while awarding the work to the L-1 Bidder.

3.5 EXECUTION OF CONTRACT AGREEMENT

After acknowledgement of the LOA as aforesaid by the L-1 Bidder, it shall in accordance with the requirement set forth in Tender Document execute the Contract Agreement with the Employer within the period prescribed in Clause 1.3. The Selected Bidder shall not be entitled to seek any deviation, modification or amendment in the Contract Agreement. Notwithstanding anything contained in the LOA and the Tender, the rights of the Selected Bidder specified in the Contract Agreement shall not become effective until the Contract Agreement has been executed by the Selected Bidder with the Employer.

3.6 CONTACTS DURING BID EVALUATION

Bids shall be deemed to be under consideration immediately after they are opened and until such time the Employer makes official intimation of award/ rejection to the Bidders. While the Bids are under consideration, Bidders and/ or their representatives or other interested parties are advised to refrain, save and except as required under the Bidding Documents, from contacting by any means, the Employer and/ or their employees/ representatives on matters related to the Bids under consideration.

3.7 CORRESPONDENCE WITH BIDDER

Save and except as provided in this TENDER, the Employer shall not entertain any correspondence with any Bidder in relation to the acceptance or rejection of any Bid.

Any information contained in the Bid shall not in any way be construed as binding on the Employer, its agents, successors or assigns, but shall be binding against the Bidder if the Project is subsequently awarded to it on the basis of such information.

SECTION IV
MISCELLANEOUS

4.1. The Bidding Process shall be governed by and construed in accordance with the laws of India. The Courts in Kerala shall have exclusive jurisdiction over all disputes arising under, pursuant to, or in connection with the Bidding Process. Any dispute that is not resolved amicably through conciliation, as outlined in the relevant Clause of the Agreement on Settlement of Disputes, shall be subject to legal resolution.

Except where otherwise provided in the Contract, all questions and disputes relating to the meaning of the specifications, designs, drawings and instructions hereinbefore mentioned and as to the quality of workmanship or materials used on the work or as to any other question, claim, right, matter or thing whatsoever, in any way arising out of relating to the contracts, designs, drawings, specifications, estimates, instructions, orders or these conditions or otherwise concerning the works, or the executions or failure to execute the same, whether arising during the progress of the work, or after the completion or abandonment thereof shall be dealt with as mentioned hereinafter:

4.2. The Employer in its sole discretion and without incurring any obligation or liability, reserves the right, at any time, to;

a. Suspend and / or cancel the Bidding Process and / or amend and / or supplement the Bidding Process or modify the dates or other terms and conditions relating thereto;

b. Consult with any Bidder in order to receive clarification or further information;

c. Retain any information and/ or evidence submitted to the 'Authority' / Employer by, on behalf of, and/ or in relation to any Bidder; and/ or

d. 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.

4.3. It shall be deemed that by submitting the Bid, the Bidder agrees and releases the Employer, its employees, agents and advisers, irrevocably, unconditionally, fully and finally from any and all liability for claims, losses, damages, costs, expenses or liabilities in any way related to or arising from the exercise of any rights and/ or performance of any obligations hereunder, pursuant hereto and/ or in connection with the Bidding Process and waives, to the fullest extent permitted by applicable laws, any and all rights and/ or claims it may have in this respect, whether actual or contingent, whether present or in future.

4.4. The Contract and Tender are to be taken as mutually explanatory and, unless otherwise expressly provided elsewhere in this Tender, in the event of any conflict between them, the priority shall be in the following order:

a) the Contract;

b) the Tender.

i.e. the Contract at (a) above shall prevail over the Tender at (b) above.

ANNEXURE - I
CHECK LIST OF DOCUMENTS

TECHNICAL PACKAGE

S. No	Name of Document	Mode of Submission
1.	Non –refundable Online payment of Rs. 17,700/- as e-Tender Fee / Processing Fee	**Online**
2.	Bid Security of Rs. 5,00,000/-	
3.	**Form "A"** Format for Form of bid	
3.1	ADDON to **Form A**	
3.2	**Form "T-1"** (Financial Information)	
3.3	**Form T-1-B** (Format for Solvency Certificate)	
3.4	**Form T-1-B-1** (Form for Certificate of Net Worth)	
3.5	**Form "T-2"** (Details of Eligible Similar Nature of Works Completed in Last Seven Years Ending Previous Day of Last Date of Submission of Bid)	
3.6	**Form "T-3"** {ADDON To **Form "T-2"**} Performance Report of Works Referred to in **Form "T-2"**	
3.7	**Form "T-4"** (Structure & Organization)	
3.8	**Form "T-5"** (GST Registration Details)	
3.9	**Form "T-6"** List of Key Personnel	
3.10	**Form "T-7"** {ADDON to **Form "T-6**"} Format for CVs of Key Personnel	
3.11	**Form "T-8"** Successful Bidder's Equipment	
3.12	**Form "T-9"** Project Under Execution or Awarded	
3.13	**Form "F-1"** (Information Required to calculate the Bid Capacity)	
4.	**Form "B**" Format for Performance Security	
5.	**Form "C"** Draft Agreement for EPC Tender	
6.	**Form "D"** Power of Attorney for Signing of Bid for Authorized Signatory	
7.	**Form "E"** Affidavit duly notarized on non-judicial of appropriate value- stamp paper	
8.	**Form "F"** Undertaking	
9.	**Form "G"** Format for Advance Bank Guarantee for Mobilization Advance	
10.	**Form "H"** Format for No-Conviction Certificate	
11.	**Form "I"** Format for understanding the project site	
12.	**Form "J"** Format for No Deviation Certificate	
13.	**Form "K"** Undertaking as per Clause 46 (Rule 144 (XI) in General Financial Rules (GFRs) 2017)	
14.	**Form-"L"** Format for Joint Venture Agreement	
15.	**Form "M"** Format for Undertaking Specialized Works	
16.	**Form "N"** Format for MOU	
17.	**Form "O"** Form of Integrity Pact	
18.	All guiding bid documents along with corrigendum/ addendum (if any)/ pre bid clarifications (if any) digitally	

S. No	Name of Document	Mode of Submission
	signed by the authorized person of the bidder	
Note:- All the uploaded documents should be in readable, printable & legible form.		

FINANCIAL PACKAGE

S. No	Name of Document	Mode of Submission
1	Digitally signed Price Bid (Volume- VI: Financial Bids)	Online

FORM- "A"
FORMAT FOR FORM OF BID
(ON BIDDER'S LETTERHEAD)

From:

To,
The Project Director
1st Floor, JP Krishna Building,
Pallimukku, Pettah
Trivandrum – 695024

Subject: Submission of Bids for the work of "Development of General Hospital Trivandrum''

Sir,
Having visited the Site, ascertained the Site conditions and examined the General Conditions of Contract as well as Particular Conditions of Contract, Notice Inviting Bids, Instructions to Bidders etc. and addenda for the above project, we the undersigned, are pleased to submit our technical and financial Bid along with relevant documents.
We acknowledge that the Annexures shall be an integral part of the Bid.

1. I / We acknowledge that all information provided in the Bid are true and correct; nothing has been omitted which renders such information misleading; and all documents accompanying the BID are true copies of their respective originals.
2. I/We acknowledge that while preparing this Bid, we have gathered our own information after due site visits and conducted our own inquiry/survey to our satisfaction and we did not rely solely on the information provided in the tender documents. We shall not hold Employer responsible on any account in this regard. The Contract Price has been quoted by me / us after taking into consideration all the terms and conditions stated in the NIT, draft Agreement, our own estimates of costs and after a careful assessment of the site and all own the conditions that may affect the Project Cost and implementation of the Project.
3. We have furnished all information and details necessary for eligibility and have no further pertinent information to supply.
4. We hereby submit the required certified Solvency Certificate / Net Worth Certificate and authorize Employer to approach the Bank issuing the Solvency Certificate / Chartered Accountant issuing the Net Worth Certificate to confirm the correctness thereof. We also grant the Employer permission to contact individuals, employers, firms and corporations to verify our competence, work experience, and general reputation.
5. We undertake, if our Bid is accepted, to enter into an Agreement in accordance with the draft that has been provided to me/us prior to the Bid Due Date. We also agree not to seek any changes in the aforesaid draft and agree to abide by the same. We further agree not to request any changes to the aforementioned draft and to fully comply with its terms
6. We undertake to commence the work within the specified time and to complete the entire scope of work outlined in the Contract within the stipulated time frame, calculated from the commencement date.

7. If our Bid is accepted, we will furnish Performance Security as per NIT for the due performance of the Contract. The amount and form of such guarantee or bond will be in accordance with as given in the NIT.
8. We are aware that in the event of delay in execution of the Project, beyond the agreed timelines due to reasons attributable to us, liquidated damages shall be recovered from us.
9. Our Bid is valid for your acceptance for a period of ONE HUNDRED AND TWENTY DAYS from the last date of submission of the Bid as per the Bid Documents or any extension thereto.
10. We agree to the General Conditions of Contract and Particular Conditions of Contract and the terms and conditions mentioned in the Guiding Bidding Documents.
11. We declare that the submission of this Bid confirms that no agent, middleman or any intermediary has been, or will be engaged to provide any services, or any other item of work related to the award of this Contract. We further confirm and declare that no agency commission or any payment, which may be construed as an agency, commission has been, or will be, paid and that the Bid price does not include any such amount. We acknowledge the right of Employer, if it finds anything to the contrary, to declare our Bid to be non- compliant and if the Contract has been awarded to declare the Contract null and void.
12. We understand that you are not bound to accept the lowest or any Bid you may receive.
13. We understand that the project payments shall be directly released by the funding agency.
14. I/ We acknowledge the right of the Authority/Employer to reject our Bid without assigning any reason or otherwise and hereby waive, to the fullest extent permitted by applicable law, our right to challenge the same on any account whatsoever.
15. We submit the certificates in support of our suitability, technical knowledge and capability for having successfully completed the works.
16. We enclose;
    a. All documents as per the checklist
    b. Bid Security

Note:

i) The Annexures part of the Bid
ii) Bidders are required to fill up all the blank spaces in this form of Bid and Annexures.

Certificate:

It is certified that the information given in the enclosed in the bid are correct. It is also certified that I/we shall be liable to be debarred, disqualified/ cancellation of enlistment in case any information furnished by me/us found to be incorrect.

Enclosures:

Seal of bidder

Date of submission: Signature(s) of Bidder(s)

FORM 'T-1'
FINANCIAL INFORMATION

Financial Analysis: Details to be furnished duly supported by figures in Balance Sheet/ Profit & Loss account for the last FIVE years duly certified by the Chartered Accountant/ Statutory Auditor, as submitted by the Bidder to the Income Tax Department (Copies to be attached).

Years	Gross Annual turnover on Construction works	Profit/ Loss (After Tax)
2023-2024		
2022-2023		
2021-2022		
2020-2021		
2019-2020		

II. Financial arrangements for carrying out the project.

Signature of Statutory Auditor/ Chartered Accountant (with Seal and UDIN)

Signature of Bidder(s). (with Seal)

FORM "T-1-B"
FORMAT FOR SOLVENCY CERTIFICATE
[To be submitted on Bank's Original Letter Head]

SOLVENCY CERTIFICATE

To,
The Project Director
WAPCOS Limited, Regional Office, Kerala
1st Floor, JP Krishna Building,
Pallimukku, Pettah
Trivandrum - 695024

Name of the work: Tender for "[Insert name of the work/project here]"

This is to certify that to the best of our knowledge and information M/s _____having marginally noted address, a customer of our bank are/ is respectable and can be treated as good for any engagement up to a limit of Rs._____(Rupees_____).
This certificate is issued without any guarantee or responsibility on the Bank or any of the officers. This certificate is issued at specific request of the customer for tender purpose.

Date:
Place:

Signature of Authorized signatory of bank:
Name of Authorized signatory of bank:
E-mail id of Bank/Authorized signatory of bank:
Power of Attorney number of bank official:

Note:

- Solvency Certificate should be on letter head of the Bank
- Email ID of bank/ authorized signatory of bank should be clearly mentioned on the certificate so that Authenticity/genuineness of the certificate can be established via email.
- Solvency Certificate should have the Name of the work: Tender for "[Insert name of the work/project here]"

FORM 'T-1-B-1'
FORM FOR CERTIFICATE OF NET WORTH

To,
The Project Director
WAPCOS Limited, Regional Office, Kerala
1st Floor, JP Krishna Building,
Pallimukku, Pettah
Trivandrum - 695024

Name of the work: Tender for "[Insert name of the work/project here]"

It is to certify that as per the audited balance sheet and profit & loss account during the financial year 2023-24, the Net Worth of M/s …… (Name & Registered Address of the individual / firm / company) , as on…… (relevant date) is Rs…… after considering all liabilities. It is further certified that the Net Worth of the company has not eroded by more than 30% in the last three years ending on …….. (the relevant date).

Signature of the Chartered Accountant/ Statutory Auditor …….

Name of the Chartered Accountant/ Statutory Auditor ……..

Membership number of ICAI…….

Date & Seal.

FORM "T-2"

DETAILS OF ELIGIBLE SIMILAR NATURE OF WORKS COMPLETED IN LAST SEVEN YEARS ENDING PREVIOUS DAY OF LAST DATE OF SUBMISSION OF BID

Name of the Bidder…….

S. No	Details	Description
1.	Name of work / project and location	
2.	Owner/Client/Employer or sponsoring organization	
3.	Whether the work is carried out in Engineering, Procurement & Construction (EPC)/Turnkey basis	Yes/ No
4.	Type of work (with respect to the eligibility criteria of this bid)	
5.	Work Components	
6.	Cost of work on completion in Rs. Crores	
7.	Date of commencement as per contract	
8.	Stipulated date of completion	
9.	Actual date of completion	
10.	Date and No. of Taking Over certificate/Completion Certificate	
11.	*Litigation/ arbitration cases pending / in progress with details	
12.	Name and Address (Postal & E-mail) / telephone number of officer to whom reference may be made	
13.	Whether the work was done on back to back basis	
14.	Whether case of levy of compensation for delay has been decided or not	
	If decided, amount of compensation levied for delayed completion, if any.	

Certified that the above list of works is complete and no work has been left out and that the information given is correct to my / our knowledge and belief.

SIGNATURE OF BIDDER(S) WITH STAMP

*indicate gross amount claimed and amount awarded by the Arbitrator.

Note: - Copy of work Orders and Completion Certificates of the above works should also be submitted.

FORM "T-3"

{ADDON to FORM "T-2"}

PERFORMANCE REPORT OF WORKS REFERRED TO IN FORM-T-2

Sl. No	Details	Description
1.	Name of work / Project & Location	
2.	Agreement No.	
3.	Whether the work is carried out in Engineering, Procurement & Construction (EPC)/Turnkey basis	Yes/ No
4.	Name of Successful Bidder	
5.	Estimated Cost	
6.	Tendered Cost	
7.	Cost of Completed Work	
8.	Date of Start	
9.	Date of completion	
i)	Stipulated Date of Completion (as mentioned in work order)	
ii)	Actual Date of Completion	
10. (i)	Whether case of levy of compensation for delay has been decided or not	
(ii)	If decided, amount of compensation levied for delayed completion, if any.	
11.	Work Components	
12.	Performance Report	
i)	Quality of Work	Satisfactory
ii)	Financial Soundness	Satisfactory
iii)	Technical Proficiency	Satisfactory
iv)	Resourcefulness	Satisfactory
v)	General Behaviour	Satisfactory

Dated :
and above

Executive Engineer or Equivalent

(Name, Designation with Sign & seal)

FORM "T-4"
STRUCTURE & ORGANIZATION

S. No.	Particulars	Details Submitted by Bidder
1.	Name & address of the Bidder	
2.	Telephone no./Telex no./Fax no.	
3.	Legal status of the Bidder (attach copies of original document defining the legal status) (a) An Individual (b) A proprietary firm (c) A firm in partnership (d) A firm in Cooperative Sector (Cooperative Society) (e) A limited company or Corporation	
4.	Particulars of registration with various Government Bodies (attach attested photocopy)	
5.	Organization/Place of Registration 1. 2. 3.	Registration No.
6.	Names and titles of Directors & Officers with designation to be concerned with this work.	
7.	Designation of individuals authorized to act for the organization	
8.	Has the bidder, or any constituent partner in case of partnership firm Limited Company/ Joint Venture, ever been convicted by the court of law? If so, give details.	
9.	In which field of Civil Engineering construction the bidder has specialization and interest?	
10.	Any other information considered necessary but not included above.	

SIGNATURE OF BIDDER(S) WITH STAMP

FORM-"T-5"
GST REGISTRATION DETAILS

S. No.	Particulars	Details
1.	Entity Name	
2.	Address (As per registration with GST)	
3.	City	
4.	Postal code	
5.	Region/State (complete state name)	
6.	Permanent Account Number (PAN)	
7.	GSTN	
8.	Type of business (As per registration with GST	
9.	Service accounting code/HSN Code	
10.	Contract Person	
11.	Phone Number and Mobile Number	
12.	Email –ID	
13.	Compliance Rating (If updated by GSTN)	

SIGNATURE OF BIDDER(S) WITH STAMP

Note: Bidder should enclose copies of GST Registration and PAN

FORM "T-6"
LIST OF KEY PERSONNEL

Bidders should provide the names and details of the suitably qualified Successful Bidder's Representative and Key Personnel to perform the Contract. Information regarding their experience (including CVs as per **Form "T-6"** and supporting documents) should be supplied using the **Annexure - I** to **Form T-5** below for each candidate. Bidder should submit a comprehensive Key Personnel resource schedule for the entire contract implementation period. The resource schedule must include:

- The name and role for each Key Personnel position
- The duration of each Key Personnel appointment
- The level of effort (time) allocated to each Key Personnel position and its distribution throughout the contract implementation period.

S. No.	Key Personnel position	Qualification	Minimum No. of Experts required	Experience	Proposed Name
1.	Project Manager	B. Tech/ BE (Civil) with MBA (Construction Management	01	Should have 15 years of experience of which minimum 10 years shall be in Design and Development of Hospital, covering Civil, MEP and other hospital related works preferably for Central/ State/ PSU's Projects	

S. No.	Key Personnel position	Qualification	Minimum No. of Experts required	Experience	Proposed Name
2.	Deputy Project Manager	B. Tech/ BE (Civil)	01	Should have 12 years of experience of which minimum 6 years shall be in Design and Development of Hospital, covering Civil, MEP and other hospital related works preferably for Central/ State/ PSU' Projects	
3.	Deputy Project Manager	B. Tech/ BE (Electrical)	01	Should have 12 years of experience of which minimum 6 years shall be in Design and Development of Hospital, covering Civil, MEP and other hospital related works preferably for Central/ State/	
4.	Deputy Project Manager	B. Tech/ BE (Mechanical)	01	Should have 12 years of experience of which minimum 6 years shall be in Design and Development of Hospital, covering MEP and other hospital related works preferably for Central/ State/ PSU's Projects	

S. No.	Key Personnel position	Qualification	Minimum No. of Experts required	Experience	Proposed Name
5.	Procurement Specialist	Master's degree in civil engineering, or relevant fields	01	Should have minimum 10-15 years of experience in procurement for work contract	
6.	Environment Expert	B. Tech/ BE (Civil) with M. Tech in Environment Engineering	01	Should have 10 years experience in handling environmental aspects of hospital projects. This includes conducting Environmental Impact Assessments (EIA) and ensuring compliance with environmental regulations throughout the project lifecycle.	
7.	Project Engineer	B. Tech/ BE (Civil) Or Diploma (Civil)	01	Should have 5 years for B. Tech/ BE or 10 years for Diploma	
8.	MEP Engineer	B.Tech/BE (Electrical) or Diploma (Electrical)	01	Should have working experience of minimum 5 years for B. Tech/ BE or 10 years for Diploma	

S. No.	Key Personnel position	Qualification	Minimum No. of Experts required	Experience	Proposed Name
9.	Quality Engineer	B. Tech/ BE (Civil)	01	Should have minimum 8 years of experience out of which 5 years in Quality supervision	
10.	Structural Engineer	M. Tech in Structural Engineering with B. Tech/ BE (Civil)	02	Should 10 years of experience (post M. Tech) in designing of multi-storied RCC framed structure.	
11.	Hospital Planner	B. Arch.	01	Should have 10 years of experience of which minimum 6 years shall be in Design and Development of Multispecialty hospital	
12.	Bio Medical Engineer	Bachelor'sDegree in Bio-Medical Engineering or related fields	01	Should have 10 years of experience of which minimum 6 years shall be in Design and Development of Multispecialty hospital	
13.	IGBC Expert	Bachelor's Degree in architecture, engineering or environmental sciences Certified by the Indian Green Building Council (IGBC)	01	Should have 5 years of experience in sustainable design and development of various types of construction projects, of which minimum 3 years shall be in sustainable Design and Development of Multispecialty	

S. No.	Key Personnel position	Qualification	Minimum No. of Experts required	Experience	Proposed Name
				hospital	
14.	BIM Expert	Bachelor Degree in Architecture, Engineering, or a related field.	01	Should have 6 years of experience in BIM modelling in the field of Construction of buildings	
15.	Surveyor	Diploma	02	Should have 10 years of experience in survey works	
16.	Billing Engineer	B. Tech/BE	02	Should have 10 years of experience in relevant field	
17.	Health & Safety Engineer	B. Tech/BE	02	Should have 5 years of experience in relevant field	
18.	Site Engineers (Number as per requirement)	B. Tech/Diploma	02	Should have minimum 5 Years of experience	

FORM "T-7"
{ADDON to Form "T-6"}
FORMAT FOR CVs OF KEY PERSONNEL

1.	Proposed Position			
2.	Name of Firm			
3.	Name of Staff			
4.	Date of Birth			
5.	Nationality			
6.	Education			
7.	Membership in Professional Association			
8.	Other Trainings Received			
9.	Countries of Work Experience			
10.	Languages	Speaking	Reading	Writing
	English			
	Malayalam			
	Hindi			

11.	Employment Record	•

Sl no.	From	To	Employer	Position Held

12. Detailed Task Assigned on Consultants Team of Experts:

-
-

13.	Work/Assignments that Best Illustrates Capability to handle the Assigned Tasks	
I.	Project Name	
	Location	
	Year	
	Client	
	Position Held	
	Project features	•
	Actual Duties Performed	•

14. Certification:

I, the undersigned, certify to the best of my knowledge and belief, this CV correctly describes myself, my qualifications, and my experience. I understand that any wilful

misstatement described herein may lead to my disqualification or dismissal, if engaged.

(Signature of the Staff Member)

Date:

Place:

FORM "T-8"

THE SUCCESSFUL BIDDER'S EQUIPMENT

(LIST OF EQUIPMENT OWNED BY THE BIDDER AT THE TIME OF BIDDING

The Bidder shall provide its strategy for acquiring and maintaining the key equipment that may be needed to execute the Works in accordance with the Work Program. In the strategy, the Bidder shall specify the manufacturer, capacity, model, power rating, age and maintenance condition, and how it will ensure that the equipment is maintained in accordance with manufacturer's specifications for the duration of the Contract. The Bidder shall specify whether it will own, lease, rent or specially manufacture the key equipment.

S. No.	Equipment's
1.	Concrete Mixing Batching Plant
2.	Concrete Pump
3.	Transit Mixer
4.	Concrete Mixer
5.	Vibrator (Needle)
6.	Vibrator (Plant)
7.	Lime mixer
8.	Bar Bending Machine
9.	Bar Cutting Machine
10.	Formwork/ Shuttering
11.	Scaffolding
12.	Lift Tower Crane
13.	Vehicles (Truck, Water Tanker, JCB, Tractor with Loader, Jeep, Road roller)
14.	De watering machines
15.	Boom Pump Truck
16.	Wood related Machinery cutter
17.	Electrical motors
18.	Diesel Generator set
19.	Oil Engines

S. No.	Equipment's
20.	Laboratory set-up (Concrete cube testing machine, cube mould, Sieve test, dump level etc.)
21.	Granite/ Marble/ Tiles cutting machine
22.	Grander
23.	Compressor
24.	Pressure grunting pump machinery
25.	Drill
26.	Line Laser leveller
27.	Electric wielding plant
28.	Total station and other surveying equipment
29.	Laser distance measurer
30.	Sand/ Earth Compactor

A separate Form shall be prepared for each item of equipment proposed:

Item of equipment		
Equipment information	Name of manufacturer	Model and power rating
	Capacity	Year of manufacture
Current status	Current location	
	Details of current commitments	
Source	Indicate source of the equipment ☐ Owned ☐ Rented ☐ Leased ☐ Specially manufactured	

Omit the following information for equipment owned by the Bidder / Proposer.

Owner	Name of owner	
	Address of owner	
	Telephone	Contact name and title
	Fax	Telex

Agreements	Details of rental / lease / manufacture agreements specific to the project

(Signature, name and designation of the Authorized signatory)

Name and seal of Bidder

FORM "T-9"

PROJECT UNDER EXECUTION OR AWARDED

Sl. No	Name of Work/Project & Location	Owner of sponsoring Organization	Cost of Work in lakhs	Date of commencement as per contract	Stipulated date of completion	Actual date of completion	Litigation/ Arbitration pending/ in progress with details*	Name & address /Telephone No. of officer to whom reference may be made	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)

(Signature, name and designation of the Authorized signatory)

Name and seal of Bidder

FORM "F-1"
INFORMATION REQUIRED TO CALCULATE THE BID CAPACITY

1. To Calculate the Value of "A"

A table containing value of Civil Engineering Works in respect to Projects (Turnkey Projects/ Item rate contract/ Construction works) undertaken by the Bidder during the last 5 Years is as follows:

S. No.	Year	Value of Civil Engineering Works undertaken w.r.t projects (Rs. In Crores)
1.	2023-24	
2.	2022-23	
3.	2021-22	
4.	2020-21	
5.	2019-20	

Maximum Value of projects that have been undertaken during the F.Y……out of the last 5 Years and value thereof is Rs……. Crore (Rupees in words……). Further, value updated to the price level of the Year indicated in Annexure - I is as follows:

Rs. ……. Crores X …… (Updation Factor as per Annexure - I)
= Rs. …. Crores (Rupees ……..
)

…… ……..
…..... ……

Authorized Signatory

For and on behalf of ……..(Name Signatory) of the Bidder)

Name of the Statutory Auditor's Firm Seal of the audit firm: (Signature, name and designation and Membership No. of authorised Signatory).

2. To Calculate the value of "B"

A table containing value of all the existing commitments and on-going workings to be completed during the next Years is as follows:

S. No.	Name of project/ work	Percentage of participation of Bidder in the project	Dater of start / appointed date of project	Value of contract as per Agreement / LOA	Value of work completed	Balance value of work to be completed	Anticipated date of completion	Balance value of work at 2023-24 price level
				Rs. in	Rs. in	Rs. in		Rs. in

				Crore	Crore	Crore		Crore
1	2	3	4	5	6	7= (5-6)	8	9(3x7xuf)

Updation Factor as given below:

For Year	F.Y / Calendar Year	Updation Factor
1	2023-24	1.00
2	2022-23	1.05
3	2021-22	1.10
4	2020-21	1.15
5	2019-20	1.20

The Statement showing the value of all existing commitments and ongoing works as well as the stipulated period of completion remaining for each of the works mentioned above is verified from the certificate issued that has been countersigned by the Client not below the rank of Executive Engineer or equivalent in respect of projects or Concessionaire/ Authorized Signatory of Employer in respect of the project. No awarded/ ongoing works has been left in the aforesaid statement which has been awarded to M/s……. individually/ and other member M/s …….. and M/s ……, as on due date of this tender.

…… ……..

…..... ..……

Authorized Signatory

For and on behalf of ……..(Name Signatory) of the Bidder)

Name of the Statutory Auditor's Firm Seal of the audit firm: (Signature, name and designation and Membership No. of Authorized Signatory).

FORM-"B"

FORMAT FOR PERFORMANCE SECURITY

WAPCOS Limited,
76-C, Institutional Area,
Sector-18, Gurgaon,
Haryana-122015

In consideration of _____ (hereinafter referred to as "the Employer ") which expression shall, unless repugnant to the context or meaning thereof include its successors, administrators and assigns) having awarded to _____ (Successful Bidder's name & address) (hereinafter referred to as "the Contractor " which expression shall unless repugnant to the context or meaning thereof, include its successors, administrators, executors and assigns) a contract, by issue of Employer Notification of Award No. _____ dt. _____ and the same having been unequivocally accepted by the Successful Bidder, resulting into a contract valued at Rs. _____(Rupees _____only) for _____(name of work) (hereinafter called " the contract") and the Contractor having agreed to provide a Contract Performance Security for the faithful performance of the entire contract equivalent to Rs. _____ (Rupees _____only) (5.00% of the said value of the Contract Price to the Employer).

We, _____(name & address of bank) (hereinafter referred to as "the Bank" which expression shall, unless repugnant to the context or meaning thereof, include its successors, administrators, executors and assigns) do hereby guarantee and undertake to pay the Employer, on demand any or, all monies payable by the Contractor to the extent of Rs. _____(Rupees _____only) as aforesaid at any time up to _____without any demur, reservation, contest , recourse or protest and/or without any reference to the Successful Bidder. Any such demand made by the Employer on the bank shall be conclusive and binding notwithstanding any difference between the Employer and the Contractor or any dispute pending before any Court, Tribunal, Arbitrator or any other authority. The Bank undertakes not to revoke this guarantee during its currency without previous consent of the Employer and further agrees that the guarantee herein contained shall continue to be enforceable till the Employer discharges this guarantee.

We the said Bank further agree that the guarantee herein contained shall remain in full force and effect during the period that would be taken for the performance of the said Contract and that it shall continue to be enforceable till all the dues of the Employer under or by virtue of the said contract have been fully paid and its claims satisfied or discharged or till the Employer certifies that the terms and conditions of the said Contract have been fully and properly carried out by the said Contractor and accordingly discharges the guarantee.

The Employer shall have the fullest liberty without affecting in any way the liability of the Bank under this guarantee, from, time to time to extend the time for performance of the Contract by the Successful Bidder. The Employer shall have the fullest liberty without affecting this guarantee, to postpone from time to time the exercise of any powers vested in them or of any right which they might have against the

Contractor and to exercise the same at any time in any manner and either to enforce or to forbear to enforce any covenants, contained or implied, in the Contract between the Employer and the Contractor or any other course or remedy or security available to the Employer. The bank shall not be released of its obligations under these presents by any exercise by the Employer of its liberty with reference to the matters aforesaid or any of them or by reason of any other act or forbearance or other acts of omission or commission on the part of the Employer or any other indulgence shown by the Employer or by any other matter or thing whatsoever which under law would but for this provision, have the effect of relieving the Bank. The guarantee shall not be affected by a change in the constitution of the bank or of the Employer.

The bank also agrees that the Employer at its option shall be entitled to enforce this Guarantee against the Bank as a principal debtor, in the first instance, without proceeding against the Contractor and notwithstanding any security or other guarantee that the Employer may have in relation to the Contractor 's liabilities.

We The Said Bank do hereby declare that we have absolute and unconditional power to issue this guarantee in your favour under the Memorandum and Articles of Association or such other constitutional documents of the Bank and the undersigned have full power to execute this guarantee under the Power of Attorney/ Post Approval Authorization dated_____ of the bank granted to him / us by the Bank. We the said bank do hereby declare and undertake that your claim under the guarantee shall not be affected by any deficiency or other defect in the powers of the bank or its officials and the guarantee shall be deemed to have been issued as if the bank and its officials have all the powers and authorization to give this guarantee on behalf of the bank.

We the said bank do hereby certify the genuineness and appropriateness of the Stamp paper and stamp value used for issuing the guarantee. We the said bank do hereby declare and undertake that your claim under the guarantee shall not be affected by any deficiency or other defect in the stamp paper or its stamp value.

We the said bank do hereby declare that our payments hereunder shall be made to you, free and clear of and without and deduction, reduction on account of any reasons including any and all present and future taxes, levies, charges of withholding whatsoever imposed or collected with respect thereto.

Notwithstanding anything contained hereinabove our liability under this guarantee is restricted to Rs. _____(Rupees _____ only) and it shall remain in force up to and including _____ and shall be extended from time to time for such period as may be desired by Employer on whose behalf this bank guarantee has been given.

Notwithstanding anything contained herein

i) our liability under this guarantee shall not exceed Rs. _____ (Rupees _____ only) ;

ii) This bank guarantee shall be valid up to _____; and

iii) our liability to make payment shall arise and we are liable to pay the guaranteed amount or any part thereof under this guarantee, only and only if you serve upon us a written claim or demand in terms of the guarantee on or before _____(indicate a date twelve months after validity of guarantee).

Dated this _____day of _____.

For & on behalf of Bidder

FORM-"C"
DRAFT AGREEMENT

Preliminary Agreement entered into on this …… …… day of…… Two thousand and …….. between WAPCOS LIMITED, hereinafter called the Employer of the one part and M/s……
……
…….. (here enter full name and address of the Bidder) hereinafter called the Bidder of the other part for the execution of the agreement as well as for the execution of the work ……
……
……
WHEREAS the Employer invited tenders for the work of……..……
……..
..……...……..……..……(here enter name of the work) by Notification No……Dated ……in the ……...……

I/We undersigned hereby offer to construct the proposed work in strict accordance with the Bid document.

I/We undertake to complete the whole of the works as per the contract price quoted from the date of issue of intimation that our tender has been accepted and upon being permitted to enter site. I/We further undertake that on failure, subject to the conditions of the contract relating to extension of time, I/We shall pay agreed `Liquidated Damages' for the period during which the work shall remain incomplete.

I/We hereby deposit with you as Bid Security Rs. _____ /- (Rupees _____) [carrying no interest] as mentioned in TENDER in favour of the Employer and I/We agree that this sum shall be forfeited in the event of the Employer accepting my/our tender and I/We fail to take up the contract when called upon to do so as per the bid document. I/We further agree for the applicable deduction from the `Interim Payment' towards the Performance Security, which will be returned as per the relevant clauses in the agreement.

I/We will furnish the Performance Security & Additional Performance Security (if applicable) as per the approved format, if our bid is accepted. Security deposit shall be treated as security for the proper fulfillment of the same and shall execute an agreement for the work in the prescribed form. If I/We fails to do this or maintain a specified rate of progress (as specified in the Milestone details of Contract data in the Bid Document), the Performance Security (both treasury fixed deposit and irrevocable bank Guarantee) and Security Deposit if any deducted from the payments shall be forfeited to the Employer and fresh tenders shall be called for or the matter otherwise

disposed off. If as a result of such measures due to the default of the Bidder to pay the requisite deposit, sign contract or take possession of the work any loss to the Employer due to the same will be recovered from me/us as arrears of revenue, but should it be a saving to Government. I/We shall have no claim whatever to the difference. Recoveries on this or any other account will be made from the sum that may be due to us on this or any or other subsisting contracts or under the Revenue Recovery act or otherwise the Government may decide.

NOW THEREFOR IN THE PRESENCE OF WITNESS it is mutually agreed as follows.

1) The terms and conditions for the said contract having been stipulated in the said Guiding Bidding Document and forms to which the I/We have agreed and a copy of which is here to be appended which forms the part of this agreement, it is agreed that the terms and conditions stipulated therein shall bind the parties to this agreement except to the extent to which they are abrogated or altered by express terms and conditions herein agreed to and in which respect the express provisions herein shall supersede those of said tender form.
2) I/We hereby agreed and undertake to perform and fulfill all the operations and obligations connected with the execution of the said contract work .....(hereinafter the name of the work) if awarded in favour of the me/us.)
3) If the Bidder does not come forward and to execute the original agreement after the said work is awarded and selection notice issued in his favour or commits breach of any of the conditions of the contract as stipulated in clause of the notice inviting tenders as quoted above, within the period stipulated then the Government may rearrange the work otherwise or get it done departmentally at the risk and the cost of the Bidder and the loss so sustained by the WAPCOS LIMITED can be realized from the Bidder under the Revenue recovery Act as if arrears of land revenue as assessed quantified and fixed by an adjudicating authority consisting of the Secretary, Department of Tourism, Government of Kerala or any other officer or officers authorized by Government in this behalf, taking into consideration the prevailing P.W.D rates and after giving due notice to the Bidder. The decision taken by such authority officer or officers shall be final and conclusive and shall be binding on the Bidder.
4) The Bidder further agrees that any amount found due to the Employer under or by virtue of this agreement shall be recoverable from the Bidder from his Bid Security and his properties movable and immovable as arrears of Land Revenue under the provision of the Revenue Recovery Act for the time being in force or in any other manner as the Government may deem fit in this regard.
5) The Bidder further assures that it is clearly understood that the settlement of claims either by part bills or by final bills will be made only according to the availability of budget provision and allotment of funds of the work under the respective heads of account in which the work is sanctioned and arranged and also subject to the seniority of such bills. No claims for interest or for damages whatsoever shall be made for the related settlement of claims of bills.

IN WITNESS THERE OF Sri…… ……
…… (here enter the name of the officers of the Department)

for on behalf of the Employer
and ……
……..……..……..
……..……
the Bidder have set their hand on the day and year first above written Signed by Sri……
In the presence of witnesses:

FORM-D

POWER OF ATTORNEY FOR SIGNING OF BID FOR AUTHORIZED SIGNATORY

Know all men by these presents, we …… (Name of the Bidder and address of their registered office) do hereby constitute, appoint and authorize Mr /Ms……(name and residential address of Power of Attorney holder) who is presently employed with us and holding the position of…… as our attorney, to do in our name and on our behalf, all such acts, deeds and things necessary in connection with or incidental to our Bid for the Project and submission of all documents and providing information / responses to _____, representing us in all matters before _____ _____, and generally dealing with _____ in all matters in connection with our Bid for the said Project.

We hereby agree to ratify all acts, deeds and things lawfully done by our said attorney pursuant to this Power of Attorney and that all acts, deeds and things done by our aforesaid attorney shall and shall always be deemed to have been done by us.

(Signature, name and designation of the Authorized signatory)
Name and seal of Bidder

FORM- "E"
AFFIDAVIT
(On a Rs 100/- non judicial stamp paper duly notarized)

I, the undersigned, do hereby certify that all the statements made in the required attachments are true and correct.

The undersigned also herby certifies that our firm M/s……. have neither abandoned any contract awarded to us nor such works have been rescinded, during the last five years prior to the date of this application.

The undersigned also herby confirm that M/s……. have not been under blacklisting/ debarred/ penalized from bidding by any Central/ State Government Department/Autonomous Body/ PSU as on the last date of submission of the bid.

I/We undertake and confirm that eligible works(s) as mentioned in eligibility criteria 1.4(b)(i) has/have not been got executed through another Contractor on back to back basis. Further that, if such a violation comes to the notice of Employer, then I/we shall be debarred for bidding in Employer in future forever. Also, if such a violation comes to the notice of Employer before date of start of work, the Employer's Representative shall be free to forfeit the entire amount of Performance Security.

I/ we undertake that we will provide required services during the Defects Notification Period and Operation & Maintenance period as per the terms conditions of the Contract.

The undersigned hereby authorize (s) and request (s) any bank, person, form or corporation to furnish pertinent information deemed necessary and requested by the Department to verify this statement or regarding my (our) competence and general reputation.

The undersigned understands and agrees that further qualifying information may be requested, and agrees to furnish any such information at the request of the Employer.

The undersigned undertake that "I/We have not altered/ modified the Financial Bid attached in the e-tender portal. If it is found during the tender stage, the Employer shall have the right to reject our Bid".

That ……(name of bidder) shall comply with the Make in India Policy as per the order issued by Govt. of India, Department of Industrial Policy and Promotion (DIPP) vide No. P- 45021/2/2017-PP (BE-II) dated 16.09.2020 and Rule 144(xi) of General Financial Rules (GFR) 2017 as per the order issued by Public

Procurement Division, Ministry of Finance, GOI F.No.6/18/2019-PPD dated 23.07.2020 or any revision thereof during the entire tenancy of contract. We shall submit necessary document / certificate to authenticate our claim as per the requirement of Employer's Representative.

(Signature, name and designation of the Authorized signatory)

Name and seal of Bidder

FORM- "F"

UNDERTAKING

(On a Rs 100/- non judicial stamp paper duly notarized)

Name of the Project:

We do hereby indemnify the Employer, against all penal action that may be levied/ effected by any concerned authority for default in any labour regulation/PF/ESI and other statutory requirements of the relevant Acts/Laws related to the work of the Contractor and will bear the legal charges, if any, and will pay the legal charges/dues directly to the concerned authority.

(Signature, name and designation of the Authorized signatory)

Name and seal of Bidder

FORM - "G"

FORMAT FOR ADVANCE BANK GUARANTEE FOR MOBILISATION ADVANCE

WAPCOS Limited,
76-C, Institutional Area,
Sector-18, Gurgaon,
Haryana-122015

Mobilization Advance Guarantee No.

Amount of Guarantee Rs. Guarantee cover from:

Last Date of Lodgment for Claim:

In consideration of WAPCOS Limited LTD. (hereinafter referred to as "the Employer") which expression shall, unless repugnant to the context or meaning thereof include its successors, administrators and assigns) having awarded to _____(Successful Bidder's name) with its Registered /Head Office at _____(hereinafter referred to as "the Contractor " which expression shall unless repugnant to the context or meaning thereof, include its successors, administrators, executors and assigns) a contract, by issue of Employer's Notification of Award No. _____dt. _____and the same having been unequivocally accepted by the Successful Bidder, resulting into a contract valued at
Rs._____(Rupees_____
_only) for _____ (hereinafter called " the contract") and the Employer having agreed to make an advance payment to the Contractor for performance of the above Contract amounting to Rs. _____(Rupees _____only) as an advance against bank guarantee to be furnished by the Successful Bidder.

We, _____(name & address of bank) having its Head Office at _____(hereinafter referred to as "the Bank" which expression shall, unless repugnant to the context or meaning thereof, include its successors, administrators, executors and assigns) do hereby guarantee and undertake to pay the Employer immediately on demand any or, all monies payable by the Contractor to the extent of Rs. _____ (Rupees _____only) as aforesaid at any time upto _____without any demur, reservation, contest , recourse or protest and/or without any reference to the Successful Bidder. Any such demand made by the Employer on the bank shall be conclusive and binding notwithstanding any difference between the Employer and the Contractor or any dispute pending before any Court, Tribunal, Arbitrator or any other authority. We agree that the Guarantee herein contained shall be irrevocable and shall continue to be enforceable till the Employer discharges this guarantee. We further agree that no change in the constitution of the Bank or of the Employer shall affect this guarantee.

The Employer shall have the fullest liberty without affecting in any way the liability of the Bank under this guarantee, from time to time, to vary the advance or to extend the time for performance of the Contract by the Successful Bidder. The Employer shall have the fullest liberty without affecting this guarantee, to postpone from time to time the exercise of any powers vested in them or of any right which they might have against the Contractor and to exercise the same at any time in any manner, and either to enforce or to forbear to enforce any covenants, contained or implied, in the Contract between the Employer and the Contractor or any other course or remedy or security available to the Employer. The bank shall not be released of its obligations under these presents by any exercise by the Employer of its liberty with reference to the matters aforesaid or any of them or by reason of any other act or forbearance or other acts of omission or commission on the part of the Employer or any other indulgence shown by the Employer or by any other matter or thing whatsoever which under law would but for this provision, have the effect of relieving the Bank.

The bank also agrees that the Employer at its option shall be entitled to enforce this Guarantee against the Bank as a principal debtor, in the first instance without proceeding against the Contractor and notwithstanding any security or other guarantee that the Employer may have in relation to the Contractor 's liabilities.

We The Said Bank do hereby declare that we have absolute and unconditional power to issue this guarantee in your favour under the Memorandum and Articles of Association or such other constitutional documents of the Bank and the undersigned have full power to execute this guarantee under the Power of Attorney/ Post Approval Authorization dated_____ of the bank granted to him / us by the Bank. We the said bank do hereby declare and undertake that your claim under the guarantee shall not be affected by any deficiency or other defect in the powers of the bank or its officials and the guarantee shall be deemed to have been issued as if the bank and its officials have all the powers and authorization to give this guarantee on behalf of the bank.

We the said bank does hereby certify the genuineness and appropriateness of the Stamp paper and stamp value used for issuing the guarantee. We the said bank does hereby declare and undertake that your claim under the guarantee shall not be affected by any deficiency or other defect in the stamp paper or its stamp value.

We the said bank do hereby declare that our payments hereunder shall be made to you , free and clear of and without and deduction, reduction on account of any reasons including any and all present and future taxes, levies, charges of withholding whatsoever imposed or collected with respect thereto.

Notwithstanding anything contained hereinabove our liability under this guarantee is limited to Rs._____(Rupees _____only) and it shall remain in force upto and including _____and shall be extended from time to time for

such period (not exceeding one year), as may be desired by M/S _____on whose behalf this bank guarantee has been given.

Notwithstanding anything contained herein
Our liability under this guarantee shall not exceed Rs._____(Rupees _____only);
This bank guarantee shall be valid upto _____ and
our liability to make payment shall arise and we are liable to pay the guaranteed amount or any part thereof under this guarantee, only and only if you serve upon us a written claim or demand in terms of the guarantee on or before _____(indicate a date twelve months after the validity of the guarantee).

Dated this _____day of _____at New Delhi.

WITNESS

_____ _____
(Signature) (Signature)

_____ _____
(Name) (Name)

_____ _____
(Official address) (Designation with bank stamp)

_____ Attorney as Power of Attorney
(Signature) No._____ dt._____

_____
(Name)

FORM-"H"
FORMAT FOR No-Conviction Certificate
[On the letterhead of the Organization]

Subject: No-Conviction Certificate for --- (Name of the work / project)

This is to certify that _____ (Name of the organization), having registered office at _____ (Address of the registered office) has never been blacklisted or restricted to apply for any such activities by any Central / State Government Department or Court of law anywhere in the country.

This is also to certify that M/s _____ (Name of Organization), is not involved in any form of Corrupt and Fraudulent practices in past and will never be involved in future.

Yours faithfully,

Date: (Signature, name and designation of the Authorized signatory)

Place: Name and seal of Bidder

FORM - "I"

FORMAT FOR UNDERSTANDING THE PROJECT SITE

(on Bidder's Letter Head)

To,
The Project Director
WAPCOS Limited, Regional Office Kerala,
1st Floor, JP Krishna Building,
Pallimukku, Pettah
Trivandrum - 695024

Subject: Undertaking of the Site Visit for --- (Name of the work / project)

Sir,

I/we hereby certify that I/we have examined & inspected the site & its surroundings satisfactorily, where the project is to be executed as per the scope of works. I/ We are well aware about the following

Location of the proposed building and its allied works.

Site clearance and no cutting off the matured trees.

Topography and contouring of the land where the project is to be executed to understand the cutting & filling during the construction and about depth of column/ foundation below the plinth beam.

Nature of the ground & sub-soil of the site and accessibility to the site.

Existing surrounding road level to finalize plinth beam level as per standard norms.

Location of Existing Sewer line & Water pipe line network to connect the proposed building and allied works to make the building functional.

Location of existing Electric Sub-Station to supply the electricity for the proposed building and allied works to make the building functional.

I / We hereby submit our BID considering above all facts gathered during site visit and each & every aspect have been considered in the Quoted cost of the project since it is EPC Contract. I / We hereby confirm that no extra/additional cost shall be claimed on above aspects

Yours faithfully,

Date:

Place:

(Signature, name and designation of the Authorized signatory)

Name and seal of Bidder

FORM "J"

FORMAT FOR NO DEVIATION CERTIFICATE

[To be submitted on Bidder's Letter Head]

To,
The Project Director
1st Floor, JP Krishna Building,
Pallimukku, Pettah
Trivandrum - 695024

Subject: No Deviation Certificate for ------(name of Work /Project)

Dear Sir,
With reference to above this is to confirm that as per Tender conditions we have visited site before submission of our Offer and noted the job content and site condition etc. We also confirm that we have not changed/ modified the above tender document and in case of observance of the same at any stage it shall be treated as null and void.

We hereby also confirm that we have not taken any deviation from Tender Clause together with other reference as enumerated in the above referred Notice Inviting Tender and we hereby convey our unconditional acceptance to all terms & conditions as stipulated in the Tender Document.

In the event of observance of any deviation in any part of our offer at a later date whether implicit or explicit, the deviations shall stand null and void.

Thanking you,
Yours faithfully,

Date: (Signature, name and designation of the Authorized signatory)

Place: Name and seal of Bidder
In the presence of witnesses:

IN WITNESS THERE OF SRI…… ……
…… (here enter the name of the officers of the Department)

for on behalf of the WAPCOS Limited
and ……
……..……..……..
……..……
the Bidder have set their hand on the day and year first above written Signed by Sri……

FORM "K"

UNDERTAKING

[Rule 144 (xi) in the General Financial Rules (GFRs), 2017]

Name of the Project:

I have read the clause regarding restrictions on procurement from a bidder of a country which shares a land border with India; I hereby certify that this bidder is not from such a country or, if from such a country, has been registered with the Competent Authority. I hereby certify that this bidder fulfills all requirements in this regard and is eligible to be considered.

Date:

Place:

(Signature, name and designation of the Authorized signatory)

Name and seal of Bidder

FORM "L"

FORMAT FOR Joint Venture Agreement

(To be executed on Stamp paper of appropriate value)

THIS MOU/ AGREEMENT is entered into on this the …… day of ……20… AMONGST

1. {…… Limited, and having its registered office at } (hereinafter referred to as the

"First Part" which expression shall, unless repugnant to the context include its successors and permitted assigns)

AND

2. {…… Limited, having its registered office at } and (hereinafter referred to as the

"Second Part" which expression shall, unless repugnant to the context include its successors and permitted assigns)

AND

3. {---, and having its registered office at } (hereinafter referred to as the "Third Part" which expression shall, unless repugnant to the context include its successors and permitted assigns)

The above mentioned parties of the FIRST, {SECOND and THIRD} PART are collectively referred to as the "Parties" and each is individually referred to as a "Party"

WHEREAS,

WAPCOS Limited (hereinafter referred to as the "EMPLOYER" which expression shall, unless repugnant to the context or meaning thereof, include its administrators, successors and assigns) has invited Bids (the Bids") for the Development of General Hospital Trivandrum, Kerala in EPC mode vide tender no. ----- dated……. (the "Project").

The Parties are interested in jointly bidding for the Project as members of a Joint Venture and in accordance with the terms and conditions of the BID document and other bid documents in respect of the Project, and

It is a necessary condition under the BID document that the members of the Joint Venture shall enter into a Joint Bidding Agreement and furnish a copy thereof with the Application.

NOW IT IS HEREBY AGREED as follows:

1. Definitions and Interpretations

In this Agreement, the capitalized terms shall, unless the context otherwise requires, have the meaning ascribed thereto under the Bid.

2. Joint Venture

2.1 The Parties do hereby irrevocably constitute a Joint Venture for the purposes of jointly participating in the Bidding Process for the Project.

2.2 The Parties hereby undertake to participate in the Bidding Process only through this Joint Venture and not individually and/ or through any other Joint Venture constituted for this Project, either directly or indirectly.

3. Covenants

The Parties hereby undertake that in the event the Joint Venture is declared the selected Bidder and awarded the Project, it shall enter into an EPC Contract with the Employer for performing all its obligations as the Contractor in terms of the EPC Contract for the Project.

4. Role of the Parties

The Parties hereby undertake to perform the roles and responsibilities as described below:

a) Party of the First Part shall be the Lead member of the Joint Venture and shall have the power of attorney from all Parties for conducting all business for and on behalf of the Joint Venture during the Bidding Process and for performing all its obligations as the Contractor in terms of the EPC Contract for the Project;
b) Party of the Second Part shall be {the Member of the Joint Venture; and}
c) Party of the Third Part shall be {the Member of the Joint Venture.}

5. Joint and Several Liability

The Parties do hereby undertake to be jointly and severally responsible for all obligations and liabilities relating to the Project and in accordance with the terms of the Bid and the EPC Contract, till such time as the completion of the Project is achieved under and in accordance with the EPC Contract.

6. Share of work in the Project

The Parties agree that the proportion of construction in the EPC Contract to be allocated among the members shall be as follows:

First Party:
Second Party:
{Third Party:}

7. Representation of the Parties

Each Party represents to the other Parties as of the date of this Agreement that:

- Such Party is duly organized, validly existing and in good standing under the laws of its incorporation and has all requisite power and authority to enter into this Agreement;
- The execution, delivery and performance by such Party of this Agreement has been authorized by all necessary and appropriate corporate or governmental action and a copy of the extract of the charter documents and board resolution/ power of attorney in favour of the person executing this Agreement for the delegation of power and authority to execute this Agreement on behalf of the Joint Venture member is annexed to this Agreement, and will not, to the best of its knowledge:
- Require any consent or approval not already obtained;

- Violate any Applicable Law presently in effect and having applicability to it;
- Violate the Memorandum and Articles of Association, by-laws or other applicable organizational documents thereof;
- Violate any clearance, permit, concession, grant, license or other governmental authorization, approval, judgment, order or decree or any mortgage agreement, indenture or any other instrument to which such Party is a party or by which such Party or any of its properties or assets are bound or that is otherwise applicable to such Party; or
- Create or impose any liens, mortgages, pledges, claims, security interests, charges or Encumbrances or obligations to create a lien, charge, pledge, security interest, encumbrances or mortgage in or on the property of such Party, except for encumbrances that would not, individually or in the aggregate, have a material adverse effect on the financial condition or prospects or business of such Party so as to prevent such Party from fulfilling its obligations under this Agreement;
- This MOU/ Agreement is the legal and binding obligation of such Party, enforceable in accordance with its terms against it; and
- There is no litigation pending or, to the best of such Party's knowledge, threatened to which it or any of its Affiliates is a party that presently affects or which would have a material adverse effect on the financial condition or prospects or business of such Party in the fulfillment of its obligations under this Agreement.

8. Termination

This MOU/ Agreement shall be effective from the date hereof and shall continue in full force and effect until Project completion (the “Defects Notification Period”) is achieved under and in accordance with the EPC Contract, in case the Project is awarded to the bidder/ Joint Venture. However, in case the Joint Venture is either not pre-qualified for the Project or does not get selected for award of the Project, the Agreement will stand terminated in case the bidder is not pre-qualified.

9. Miscellaneous

9.1 This MOU/ Agreement shall be governed by laws of {India}.

9.2 The Parties acknowledge and accept that this Agreement shall not be amended by the Parties without the prior written consent of the Employer.

IN WITNESS WHEREOF THE PARTIES ABOVE NAMED HAVE EXECUTED AND DELIVERED THIS AGREEMENT AS OF THE DATE FIRST ABOVE WRITTEN.SIGNED, SEALED AND DELIVERED

For and on behalf of:

LEAD MEMBER	SECOND PART	THIRD PART
Signature	Signature	Signature
(Name)	(Name)	(Name)
(Designation)	(Designation)	(Designation)
(Address)	(Address)	(Address)

In the presence of:
1…….

2.....

Notes:

1. The mode of the execution of the MOU/ Agreement should be in accordance with the procedure, if any, laid down by the Applicable Law and the charter documents of the executant(s) and when it is so required, the same should be under common seal affixed in accordance with the required procedure.
2. The Bidder should attach a copy of the extract of the charter documents and documents such as resolution / power of attorney in favour of the person executing this Agreement for the delegation of power and authority to execute this Agreement on behalf of the Joint Venture Member.
3. For a MOU/ Agreement executed and issued overseas, the document shall be notarized in the jurisdiction where the Power of Attorney has been executed.

FORM "M"
FORMAT FOR UNDERTAKING SPECIALIZED WORKS
(On a Rs 100/- non judicial stamp paper duly notarized)

Name of project: We, M/s _____ do hereby undertake to enter into a Joint Venture with specialized agency after approval of WAPCOS Limited for the execution of specialized works pertaining to _____ confirming:

We shall ensure DLP for 5 years for civil works and 3 years for Electrical, Plumbing and mechanical works

We shall execute Operation & Maintenance for Fifteen (15) years.

We shall ensure that the work is executed by specialized agency as per technical specifications as stipulated in the NIT. Any changes required shall be got approved by the Employer's Representative and the specialized agency shall abide by it.

We shall ensure that for all specialized works, for which intend to engage a specialized agency for execution of work, we shall take prior approval of the Employer's Representative before engaging such agency.

This undertaking with specialized agency does not absolve the Contractor M/s _____ from our contractual obligations

We shall be jointly and severely responsible for performance of the whole Contract.

FORM "N"

FORMAT FOR MOU

(To be executed on Stamp paper of appropriate value)

This Memorandum of Understanding (herein after referred to as "MoU") entered on this the …… day of ……2025 by and between

1. …… (Name of Bidder) having its registered office at …… (hereinafter referred to as the "Bidder" which expression shall, unless repugnant to the context include its successors and permitted assigns)

AND

2. …… (Name of Specialized Agency) having its registered office at …… (hereinafter referred to as the "Specialized Agency" which expression shall, unless repugnant to the context include its successors and permitted assigns)

Whereas M/s WAPCOS Ltd. invited a Tender No: WAP/INFRA/KERALA/2025/GHT/512 dated 18.06.2025 for the work of "……" (Name of Work)

Both parties have agreed to quote for the work jointly and work together strictly on back to back basis as per the tender documents, if the work is awarded to ……. (Name of Bidder)

…… (Name of Specialized Agency), is having vas experience in the field of installation and completion of ……. (Name of Specialized work) and have agreed to associate with …… (Name of Bidder) as per tender clause 2(g) (Qualifying Criteria) Section-II of Notice Inviting Tender of WAPCOS Ltd.

…… (Name of Specialized Agency) have successfully completed and commissioned the work of …… (Name of Specialized work) for …… (Name of Project and Client) as per attached Work order and Completion Certificate.

…… (Name of Specialized Agency) has agreed to provide their services until the successful completion and commissioning of the …… (Name of Specialized work) including Defects Liability Period as described in the tender document.

…… (Name of Specialized Agency) shall provide all required support to ……. (Name of Bidder) during the DLP for 5 years for civil works and 3 years for Electrical and Mechanical works wherever applicable, including AMC-related maintenance, repairs, and services at no additional cost. After the DLP, the Employer shall take over AMC responsibilities, and the Specialized Agency shall assist in the documentation and training for proper handover.

During the Defects Liability Period (DLP), …… (Name of Specialized Agency) shall provide necessary support, including preventive and corrective maintenance for the installed systems. At the end of DLP, all maintenance responsibilities shall be transferred to the University with the submission of as-built documentation, O&M manuals, and necessary training for operational staff.

IN WITNESS WHEREOF, the parties have caused this MoU to be executed by their respective authorized representatives with effect as of the effective date and shall be valid till completion of the work.

For and on behalf of
…… (Name of Specialized Agency
Authorized Signatory

For and on behalf of
…… (Name of Bidder)
Authorized Signatory

FORM "O"
FORM OF INTEGRITY PACT

To,
The Project Director
WAPCOS LIMITED
1st Floor, JP Krishna Building,
Pallimukh Junction, Petteah
Trivandrum- 695024

Sub: Submission of Tender for the work of "Development of General Hospital Trivandrum''

Ref: Tender No:

Dear Sir,
I/We acknowledge that WAPCOS Limited is committed to follow the principles thereof as enumerated in the Integrity Agreement enclosed with the tender/bid document.

I/We agree that the Notice Inviting Tender (NIT) is an invitation to offer made on the condition that I/We will sign the enclosed integrity Agreement, which is an integral part of tender documents, failing which I/We will stand disqualified from the tendering process. I/We acknowledge that the Making of the Bid shall be regarded as an Unconditional and absolute Acceptance of this condition of the NIT.

I/We confirm acceptance and compliance with the Integrity Agreement in letter and spirit and further agree that execution of the said Integrity Agreement shall be separate and distinct from the main Contract, which will come into existence when tender/bid is finally accepted by the Employer. I/We acknowledge and accept the duration of the Integrity Agreement, which shall be in the line with sections of the enclosed Integrity Agreement.

I/We acknowledge that in the event of my/our failure to sign and accept the Integrity Agreement, while submitting the tender/bid, the Employer shall have unqualified, absolute and unfettered right to disqualify the Bidder and reject the Bid is accordance with terms and conditions of the Bid.

Encl: Format for Integrity Pact

Yours faithfully

(Duly authorized signatory of the Bidder)

FORMAT FOR INTEGRITY PACT

This Integrity Agreement is made at ..... on this..... Day of..... 20.....

BETWEEN

WAPCOS Limited, New Delhi (Hereinafter referred as the 'Employer'**,** which expression shall unless repugnant to the meaning or context hereof include its successors and permitted assigns)

AND

.....
.....
.....
(Name and Address of the Individual/firm/Company)
through..... (Hereinafter referred to as the (Details of duly authorized signatory)

"Bidder/ Successful Bidder**"** and which expression shall unless repugnant to the meaning or context hereof include its successors and permitted assigns)

PREAMBLE

WHEREAS the Employer has floated the Tender (NIT No. .....) (Hereinafter referred to as "Tender/ Bid") and intends to award, under laid down organizational procedure, contract for..... (Name of work) hereinafter referred to as the "Contract".

AND WHEREAS the Employer values full compliance with all relevant laws of the land, rules, regulations, economic use of resources and of fairness/transparency in its relation with its Bidder(s) and Contractor (s).

AND WHEREAS to meet the purpose aforesaid both the parties have agreed to enter into this Integrity Agreement (hereinafter referred to as "Integrity Pact" or "Pact"), the terms and conditions of which shall also be read as integral part and parcel of the Tender/ Bid documents and Contract between the parties.

NOW, THEREFORE, in consideration of mutual covenants contained in this Pact, the parties hereby agree as follows and this Pact witnesses as under:

Article 1: Commitment of the Employer

1. The Employer commits itself to take all measures necessary to prevent corruption and to observe the following principles:
   a) No employee of the Employer , personally or through any of his/her family members, will in connection with the Tender, or the execution of the Contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to.
   b) The Employer will, during the Tender process, treat all Bidder(s) with equity and reason. The Employer will, in particular, before and during the Tender process, provide to all Bidder(s) the same information and will not provide to any Bidder(s)

confidential / additional information through which the Bidder(s) could obtain an advantage in relation to the Tender process or the Contract execution.

c) The Employer shall endeavour to exclude from the Tender process any person, whose conduct in the past has been of biased nature.

2. If the Employer obtains information on the conduct of any of its employees which is a criminal offence under the Indian Penal code (IPC)/ Prevention of Corruption Act, 1988 (PC Act) or is in violation of the principles herein mentioned or if there be a substantive suspicion in this regard, the Employer will inform the Chief Vigilance Officer and in addition can also initiate disciplinary actions as per its internal laid down policies and procedures.

Article 2: Commitment of the Bidder(s)/ Contractor **(s)**

1. It is required that each Bidder/ Contractor (including their respective officers, employees and agents) adhere to the highest ethical standards, and report to the Employer all suspected acts of fraud or corruption or Coercion or Collusion of which it has knowledge or becomes aware, during the tendering process and throughout the negotiation or award of a contract.
2. The Bidder(s)/ Contractor (s) commits himself to take all measures necessary to prevent corruption. He commits himself to observe the following principles during his participation in the Tender process and during the Contract execution:
   a) The Bidder(s)/ Contractor (s) will not, directly or through any other person or firm, offer, promise or give to any of the Employer's employees involved in the Tender process or execution of the Contract or to any third person any material or other benefit which he/she is not legally entitled to, in order to obtain in exchange any advantage of any kind whatsoever during the Tender process or during the execution of the Contract.
   b) The Bidder(s)/ Contractor (s) will not enter with other Bidder(s) into any undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of Bids or any other actions to restrict competitiveness or to cartelize in the bidding process.
   c) The Bidder(s)/ Contractor (s) will not commit any offence under the relevant IPC/PC Act. Further the Bidder(s)/ Contract(s) will not use improperly, (for the purpose of competition or personal gain), or pass on to others, any information or documents provided by the Employer as part of the business relationship, regarding plans, technical Bids and business details, including information contained or transmitted electronically.
   d) The Bidder(s)/ Contractor (s) of foreign origin shall disclose the names and addresses of agents/ representatives in India, if any. Similarly Bidder(s)/ Contractor (s) of Indian Nationality shall disclose names and addresses of foreign agents/representatives, if any. Either the Indian agent on behalf of the foreign principal or the foreign principal directly could bid in a tender but not both. Further, in cases where an agent participates in a tender on behalf of one manufacturer, he shall not be allowed to quote on behalf of another manufacturer along with the first manufacturer in a subsequent/ parallel tender for the same item.
   e) The Bidder(s)/ Contractor (s) will, when presenting his bid, disclose any and all payments he has made, is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the Contract.
3. The Bidder(s)/ Contractor (s) will not instigate third persons to commit offences outlined above or be an accessory to such offences.

4. The Bidder(s)/ Contractor (s) will not, directly or through any other person or firm indulge in fraudulent practice means a willful misrepresentation or omission of facts or submission of fake/forged documents in order to induce public official to act in reliance thereof, with the purpose of obtaining unjust advantage by or causing damage to justified interest of others and/or to influence the procurement process to the detriment of the Employer interests.
5. The Bidder(s)/ Contractor (s) will not, directly or through any other person or firm use Coercive Practices (means the act of obtaining something, compelling an action or influencing a decision through intimidation, threat or the use of force directly or indirectly, where potential or actual injury may befall upon a person, his/her reputation or property to influence their participation in the tendering process).

Article 3: Consequences of Breach

Without prejudice to any rights that may be available to the Employer under law or the Contract or its established policies and laid down procedures, the Employer shall have the following rights in case of breach of this Integrity Pact by the Bidder(s)/ Contractor (s) and the Bidder/ Contractor accepts and undertakes to respect and uphold the Employer's absolute right:

1. If the Bidder(s)/ Contractor (s), either before award or during execution of Contract has committed a transgression through a violation of Article 2 above or in any other form, such as to put his reliability or credibility in question, the Employer after giving 14 days' notice to the Contractor shall have powers to disqualify the Bidder(s)/ Contractor (s) from the Tender process or terminate/determine the Contract, if already executed or exclude the Bidder/ Contractor from future contract award processes. The imposition and duration of the exclusion will be determined by the severity of transgression and determined by the Employer. Such exclusion may be forever or for a limited period as decided by the Employer.
2. Forfeiture of Bid Security/ Performance Security/ Security Deposit: If the Employer has disqualified the Bidder(s) from the Tender process prior to the award of the Contract or terminated/ determined the Contract or has accrued the right to terminate/ determine the Contract according to Article 3(1), the Employer apart from exercising any legal rights that may have accrued to the Employer, may in its considered opinion forfeit the entire amount of Bid Security, Performance Security and Security Deposit of the Bidder/ Successful Bidder.
3. Criminal Liability: If the Employer obtains knowledge of conduct of a Bidder or Successful Bidder, or of an employee or a representative or an associate of a Bidder or Contractor which constitutes corruption within the meaning of IPC Act, or if the Employer has substantive suspicion in this regard, the Employer will inform the same to law enforcing agencies for further investigation.

Article 4: Previous Transgression

1. The Bidder declares that no previous transgressions occurred in the last 5 years with any other Company in any country confirming to the anticorruption approach or with Central Government or State Government or any other Central/State Public Sector Enterprises in India that could justify his exclusion from the Tender process.
2. If the Bidder makes incorrect statement on this subject, he can be disqualified from the Tender process or action can be taken for banning of business dealings/ holiday listing of the Bidder/ Contractor as deemed fit by the Employer.
3. If the Bidder/ Contractor can prove that he has resorted / recouped the damage caused by him and has installed a suitable corruption prevention system, the Employer may, at its own discretion, revoke the exclusion prematurely.

Article 5: Equal Treatment of all Bidders/ Contractor **/Subcontractors**

1. The Bidder(s)/ Contractor (s) undertake(s) to demand from all subcontractors a commitment in conformity with this Integrity Pact. The Contractor shall be responsible for any violation(s) of the principles laid down in this agreement/Pact by any of its Subcontractors/ sub-vendors.
2. The Employer will enter into Pacts on identical terms as this one with all Bidders and Successful Bidder.
3. The Employer will disqualify Bidders, who do not submit, the duly signed Pact between the Employer and the bidder, along with the Tender or violate its provisions at any stage of the Tender process, from the Tender process.

Article 6- Duration of the Pact

This Pact begins when both the parties have legally signed it. It expires for the Contractor / Vendor 12 months after the completion of work under the contract or till the continuation of Defects Liability Period, whichever is more and for all other Bidders, till the Contract has been awarded.

If any claim is made/lodged during the time, the same shall be binding and continue to be valid despite the lapse of this Pacts as specified above, unless it is discharged/determined by the Competent Authority of the Employer.

Article 7- Other Provisions

1. This Pact is subject to Indian Law, place of performance and jurisdiction is the Headquarters of the Employer, who has floated the Tender.
2. Changes and supplements need to be made in writing. Side agreements have not been made.
3. If the Contractor is a partnership or a Joint Venture, this Pact must be signed by all the partners or by one or more partner holding power of attorney signed by all partners and Joint Venture members. In case of a Company, the Pact must be signed by a representative duly authorized by board resolution.
4. Should one or several provisions of this Pact turn out to be invalid; the remainder of this Pact remains valid. In this case, the parties will strive to come to an agreement to their original intensions.
5. It is agreed term and condition that any dispute or difference arising between the parties with regard to the terms of this Integrity Agreement / Pact, any action taken by the Employer in accordance with this Integrity Agreement/ Pact or interpretation thereof shall not be subject to arbitration.
6. Independent External Monitor(s) appointed for Implementation of Integrity Pact in WAPCOS are:

Sr. No.	Name	Contact Details
1	Shri Akhilesh Kumar	3111, Osimo Tower Mahagun Mezzaria Sector 78, Noida Uttar Pradesh-201304 Email: er.akhilesh@yahoo.co.in
2	Shri Uppuluri Krishna Murty	Door No. 31-51-5/84, Green city, Near Apparels Export Promotion Park, Vadlapudi Gajuwaka Mandal SRO-Gajuwaka,

		PO Special Economic Zone, Andhra Pradesh-530046 Email: ukmirts86@gmail.com

Article 8- LEGAL AND PRIOR RIGHTS

All rights and remedies of the parties hereto shall be in addition to all the other legal rights and remedies belonging to such parties under the Contract and/or law and the same shall be deemed to be cumulative and not alternative to such legal rights and remedies aforesaid. For the sake of brevity, both the Parties agree that this Integrity Pact will have precedence over the Tender/Contact documents with regard any of the provisions covered under this Integrity Pact.

IN WITNESS WHEREOF the parties have signed and executed this Integrity Pact at the place and date first above mentioned in the presence of following witnesses:

.....
(For and on behalf of Employer)

.....
(For and on behalf of Successful Bidder)

WITNESSES:
1. .....
(Signature, name and address)

2. .....
(Signature, name and address)

Place:
Dated:

FORM "O"
Memorandum of Understanding

This Memorandum of Understanding (herein after referred to as "MoU") entered on this the …… day of ……2025 by and between

1. …… (Name of Bidder) having its registered office at …… (hereinafter referred to as the "Bidder" which expression shall, unless repugnant to the context include its successors and permitted assigns)

AND

2. …… (Name of Specialized Agency) having its registered office at …… (hereinafter referred to as the "Specialized Agency" which expression shall, unless repugnant to the context include its successors and permitted assigns)

Whereas M/s WAPCOS Ltd. invited a Tender No: WAP/INFRA/KERALA/2025/GHT/512 dated 18.06.2025 for the work of "……" (Name of Work)

Both parties have agreed to quote for the work jointly and work together strictly on back to back basis as per the tender documents, if the work is awarded to ……. (Name of Bidder)

…… (Name of Specialized Agency), is having vas experience in the field of installation and completion of ……. (Name of Specialized work) and have agreed to associate with …… (Name of Bidder) as per tender clause 2(g) (Qualifying Criteria) Section-II of Notice Inviting Tender of WAPCOS Ltd.

…… (Name of Specialized Agency) have successfully completed and commissioned the work of …… (Name of Specialized work) for …… (Name of Project and Client) as per attached Work order and Completion Certificate.

…… (Name of Specialized Agency) has agreed to provide their services until the successful completion and commissioning of the …… (Name of Specialized work) including Defects Liability Period as described in the tender document.

…… (Name of Specialized Agency) shall provide all required support to ……. (Name of Bidder) during the DLP for 5 years for civil works and 3 years for Electrical and Mechanical works wherever applicable.

…… (Name of Specialized Agency) shall provide all required support to ……. (Name of Bidder) during the 3 years Warranty period of eligible items.

IN WITNESS WHEREOF, the parties have caused this MoU to be executed by their respective authorized representatives with effect as of the effective date and shall be valid till completion of the work.

For and on behalf of	For and on behalf of
…… (Name of Specialized Agency)	…… (Name of Bidder)
Authorized Signatory	Authorized Signatory

Ministry of Jal Shakti
(A Government of India undertaking)

1st Floor, JP Krishna Building, Pallimukh Junction,
Pettah, Thiruvananthapuram, Kerala-695024

EPC TENDER DOCUMENT FOR

DEVELOPMENT OF GENERAL HOSPITAL TRIVANDRUM

WAP/INFRA/KERALA/2025/GHT/512

Date: 18.06.2025

Volume II

General Conditions of Contract (GCC)

CONTENTS

1. General Provisions

1.1 Definitions

In the Contract the following words and expressions shall have the meanings stated, except where the context requires otherwise

1.1.1 **"Accounting Year"** means the financial year commencing from the first day of April of any calendar year and ending on the thirty-first day of March of the next calendar year.

1.1.2 **"Act"** means Kerala Infrastructure Investment Fund Act (KIIF Act) 1999, as amended from time to time.

1.1.3 **"Affected Party"** shall have the meaning as set forth in Sub-Clause 18.2 [*Notice of a Force Majeure*].

1.1.4 **"Applicable Permits"** means all clearances, licences, permits, authorization, no objection certificates, consents, approvals, and exemptions required to be obtained or maintained under applicable Laws in connection with the implementation of the Project during the subsistence of this Contract.

1.1.5 **"Authority"** means the Administrative Department of the Government of Kerala, named as Authority in the Contract Agreement who owns the Project and to whom on completion, the Project will be finally handed over.

1.1.6 **"Authority's Engineer"** appointed by the Authority, who shall act on behalf of the Authority as set forth in Sub-Clause 2.3.

1.1.7 **"Bank"** means any Scheduled Bank as per the approved list of Reserve Bank of India.

1.1.8 **"Bank Rate"** means the rate of interest specified by the Reserve Bank of India from time to time in pursuance of section 49 of the Reserve Bank of India Act, 1934 or any replacement of such Bank Rate for the time being in effect;

1.1.9 **"Base Date"** means the date 28 days before the latest date for submission of the Tender.

1.1.10 **"Claim"** means a request or assertion by one Party to the other Party (excluding a matter to be agreed or determined under sub-paragraph (a) of Sub-Clause 3.5 [*Agreement or Determination*]) and third paragraph of Sub-Clause 2.4 [*Authority's Engineer and the Employer*] for an entitlement or relief under any Clause of these Conditions or otherwise in connection with, or arising out of, the Contract or the execution of the Works.

1.1.11 **"Commencement Date"** means the date as stated in the Employer's "Notice to Proceed" (NTP) issued under Sub-Clause 8.1 [*Commencement of Works*].

1.1.12 **"Completion Certificate"** means a certificate issued by the Employer, when all the Works as part of the Contract, including those listed in the Provisional Completion Certificate, are successfully completed and fit for operation.

1.1.13 **"Compliance Verification System"** means the compliance verification system to be prepared and implemented by the Contractor for the Works in accordance with Sub-Clause 4.9.2 [*Compliance Verification System*].

1.1.14 **"Conditions of Contract"** or **"these Conditions"** means these General Conditions of Contract and the Particular Conditions of Contract.

1.1.15 **"Construction Period"** means the period from the Commencement Date and ending on the date of the Completion Certificate.

1.1.16 **"Contract"** means the Contract Agreement, any addenda referred to in the Contract Agreement, these Conditions, the Employer's Requirements, the Schedules, the Tender, the JV Undertaking (if applicable) and the further documents (if any) which are listed in the Contract Agreement.

1.1.17 **"Contract Agreement"** means the agreement entered into by both Parties in accordance with Sub-Clause 1.6 [*Contract Agreement*], including any annexed memoranda.

1.1.18 **"Contract Data"** means the pages, entitled contract data which constitute Part A of the Particular Conditions of Contract.

1.1.19 **"Contract Price"** means the agreed amount stated in the Contract Agreement for the execution of Works and includes adjustments (if any) in accordance with the contract.

1.1.20 **"Contractor"** means the person(s) named as contractor in the Contract Agreement and the legal successors in title of such person(s) and the permitted assignees of such individual, firm or company.

1.1.21 **"Contractor's Documents"** means the documents prepared by the Contractor as described in Sub-Clause 5.2 [*Contractor's Documents*], including calculations, digital files, computer programs and other software, drawings, manuals, models, specifications, and other documents of a technical nature.

1.1.22 **"Contractor's Equipment"** means all apparatus, equipment, machinery, construction plant, vehicles and other items required by the Contractor for the execution of the Works. Contractor's Equipment excludes Temporary Works, Plant,

Materials and any other things intended to form or forming part of the Permanent Works.

1.1.23 **"Contractor's Personnel"** means the Contractor's Representative and all personnel whom the Contractor utilises on Site or other places where the Works are being carried out, including the staff, labour, and other employees of the Contractor and of each Subcontractor; and any other personnel assisting the Contractor in the execution of the Works.

1.1.24 **"Contractor's Representative"** means the natural person named by the Contractor in the Contract or appointed by the Contractor under Sub-Clause 4.3 [*Contractor's Representative*], who acts on behalf of the Contractor.

1.1.25 **"Cost"** means all expenditure reasonably incurred (or to be incurred) by the Contractor in performing the Contract, whether on or off the Site, including taxes, overheads and similar charges, but does not include profit. Where the Contractor is entitled under a Sub-Clause of these Conditions to payment of Cost, it shall be added to the Contract Price.

1.1.26 **"Cost Plus Profit"** means Cost plus the applicable percentage for profit stated in the Contract Data. Such percentage shall only be added to Cost, and Cost-Plus Profit shall only be added to the Contract Price, where the Contractor is entitled under a Sub-Clause of these Conditions to payment of Cost Plus Profit.

1.1.27 **"Country"** means the country in which the Site (or most of it) is located, where the Permanent Works are to be executed.

1.1.28 **"DAAB"** or **"Dispute Avoidance/Adjudication Board"** means the sole member or three members (as the case may be) so named in the Contract, or appointed under Sub-Clause 21.1 [*Constitution of the DAAB*] or Sub-Clause21.2 [*Failure to Appoint DAAB Member(s)*].

1.1.29 **"DAAB Agreement"** means the agreement signed or deemed to have been signed by both Parties and the sole member or each of the three members (as the case may be) of the DAAB in accordance with Sub-Clause 21.1 [*Constitution of the DAAB*] or Sub-Clause 21.2 [*Failure to Appoint DAAB Member(s)*], incorporating by reference the General Conditions of DAAB Agreement contained in the Appendix to these General Conditions with such amendments as are agreed.

1.1.30 **"Date of Completion"** means the date stated in the Completion Certificate issued by the Employer; or, if the last paragraph of Sub-Clause 10.1 [*Taking Over the Works and Sections*] applies, the date on which the Works or Section are deemed

to have been completed in accordance with the Contract; or, if taking over of part(s) of the Works is permitted under Sub-Clause 10.2 [*Taking Over of Parts of the Works*], the date on which such part(s) are taken over or used by the Employer.

1.1.31 **"day"** means a calendar day.

1.1.32 **"Day work Schedule"** means the document entitled daywork schedule (if any) included in the Contract, showing the amounts and manner of payments to be made to the Contractor for labour, materials and equipment used for daywork under Sub-Clause 13.5 [*Daywork*].

1.1.33 **"Defect"** means the non-fulfilment of a requirement related to an intended or specified use. Essentially, it's when something doesn't meet the standards or expectations that have been set in the Employer's Requirements.

1.1.34 **"Defects Liability Period"** or **"DLP"** means the period for notifying and curing the defects and/or damage in the Works or a Section (or a part of the Works, if Sub-Clause 10.2 [*Taking Over of Parts of the Works*] applies), except reasonable wear and tear in the Work or any Section thereof, as the case may be, under Sub-Clause 11.1 [*Completion of Outstanding Work and Remedying Defects*], as stated in the Contract Data, and as may be extended under Sub-Clause 11.3 [*Extension of Defects Liability Period*]. This period is calculated from the Date of Completion of the Works or Section (or part of the Works).

1.1.35 **"Dispute"** means any situation where:

(a) one Party has made a Claim, or there has been a matter to be agreed or determined under sub-paragraph (a) of Sub-Clause 3.5 [*Agreement or Determination*] and third paragraph of Sub-Clause 2.4 [*Authority's Engineer and the Employer*];

(b) the Authority's Engineer's determination under Sub-Clause 3.5.2 [Authority's Engineer's *determination*] was a rejection (in whole or in part) of:

(i) the Claim (or there was a deemed rejection under sub-paragraph (i) of Sub-Clause 3.5.3 [*Time limits*]);

(ii) a Party's assertion(s) in respect of the matter as the case may be; and

(c) either Party has given a NOD under Sub-Clause 3.5.5 [Dissatisfaction with Authority's Engineer's determination]; or

(d) either Party fails to comply with either an agreement of the Parties or a final and binding determination of the Authority's Engineer under the Sub-Clause

3.5,

provided however that a failure by the other Party to oppose or respond to the claim, in whole or in part, may constitute a rejection if, in the circumstances, the DAAB or the arbitrator(s), as the case may be, deem it reasonable for it to do so.

1.1.36 **"Employer"** means the person, named as the employer in the Contract Agreement and Contract Data, appointed by the Authority to manage the Project on behalf of the Authority, and the legal successors in title to this person.

1.1.37 **"Employer's Equipment"** means the apparatus, equipment, machinery, construction plant and/or vehicles (if any) to be made available by the Employer for the use of the Contractor under Sub-Clause 3.12 [*Employer- Supplied Materials and Employer's Equipment*]; but does not include Plant which has not been taken over under Clause 10 [*Employer's Taking Over*].

1.1.38 **"Employer's Other Contractors"** means the contractors other than the Contractor, as specified in the Employer's Requirements, deployed by the Employer on the Site for execution of any work other than the Work / Section specified as per the Contract.

1.1.39 **"Employer's Personnel"** means the Employer's Representative, the assistants described in Sub-Clause 3.2 [*Other Employer's Personnel*] and all other staff, labour and other employees of the Employer and of the Employer's Representative, engaged in fulfilling the Employer's obligations under the Contract; and any other personnel identified as Employer's Personnel, by a Notice from the Employer or the Employer's Representative to the Contractor.

1.1.40 **"Employer's Representative"** means the person named by the Employer in the Contract Data appointed by the Employer for the purposes of the Contract, or any replacement appointed under Sub-Clause 3.1 [*The Employer's Representative*].

1.1.41 **"Employer's Requirements"** means the document entitled employer's requirements, as included in the Contract, and any additions and modifications to such document in accordance with the Contract. Such document describes the purpose(s) for which the Works are intended, and specifies Key Personnel (if any), the scope, and/or design and/or other performance, technical and evaluation criteria, for the Works.

1.1.42 **"Employer-Supplied Materials"** means the materials (if any) to be supplied by the Employer to the Contractor under Sub-Clause 3.12 *[Employer-Supplied Materials and Employer's Equipment*].

1.1.43 **"Encumbrances"** means, in relation to the Project, any encumbrances such as mortgage, charge, pledge, lien, hypothecation, security interest, assignment, privilege or priority of any kind having the effect of security or other such obligations and shall include any designation of loss payees or beneficiaries or any similar arrangement under any insurance policy pertaining to the Project, where applicable herein.

1.1.44 **"EPC"** means Project Management by Engineering, Procurement and Construction mode.

1.1.45 **"Extension of Time"** or **"EOT"** means an extension of the Time for Completion under Sub-Clause 8.5 [*Extension of Time for Completion*].

1.1.46 **"Final Statement"** means the Statement defined in Sub-Clause 14.11.2 *[Agreed Final Statement*].

1.1.47 **"Force Majeure"** means an exceptional event or circumstance as defined in Sub-Clause 18.1 [*Force Majeure*].

1.1.48 **"Foreign Currency"** means any other currency other than that specified in the Local Currency.

1.1.49 **"Funding Agency"** means the agency who shall be responsible for the financial arrangements for the Project.

1.1.50 "**General Conditions of Contract**" or "**GCC"** means this document entitled "General Conditions of Contract".

1.1.51 **"Goods"** means Contractor's Equipment, Materials, Plant and Temporary Works, or any of them as appropriate.

1.1.52 **"Good Industry Practice"** means the practices, methods, techniques, designs, standards, skills, diligence, efficiency, reliability and prudence which are generally and reasonably expected from a reasonably skilled and experienced Contractor engaged in the same type of undertaking as envisaged under this Contract and which would be expected to result in the performance of its obligations by the Contractor in accordance with this Contract, applicable Laws and Applicable Permits in reliable, safe, economical and efficient manner.

1.1.53 **"Government"** means Government of Kerala (GoK)

1.1.54 **"Government Instrumentality"** means any department, division or sub-division of the Government of India or the Government of Kerala and includes any Commission, Board, Agency or municipal and other local authority or statutory body, including panchayat, under the control of the Government of India or the

Government of Kerala, as the case may be, and having jurisdiction over all or any part of the Project or the performance of all or any of the Services or obligations of the Contractor under or pursuant to this Contract.

1.1.55 **"Joint Venture" or "JV"** means a joint venture, association, consortium or other unincorporated grouping of two or more persons, whether in the form of a partnership or otherwise.

1.1.56 **"JV Undertaking"** means the letter provided to the Employer as part of the Tender setting out the legal undertaking between the two or more persons constituting the Contractor as a JV. This letter shall be signed by all the persons who are members of the JV, shall be addressed to the Employer and shall include:

(a) each such member's undertaking to be jointly and severally liable to the Employer for the performance of the Contractor's obligations under the Contract;

(b) identification and authorisation of the Lead Member of the JV; and

(c) identification of the separate scope or part of the Works (if any) to be carried out by each member of the JV.

1.1.57 **"Key Personnel"** means the positions (if any) of the Contractor's Personnel, other than the Contractor's Representative, that are stated in the Employer's Requirements.

1.1.58 **"KIIFB"** means Kerala Infrastructure Investment Fund Board which is a statutory body established under the Kerala Infrastructure Investment Fund Act, 1999 ("KIIF Act) as amended from time to time. KIIFB shall be the Funding Agency responsible for the financial arrangements for the Project and shall make payments in accordance with the Acts, Schemes or Government Orders, as the case may be, governing the same.

1.1.59 **"Laws"** means all national (or state or local bodies) legislation, statutes, acts, decrees, rules, ordinances, orders, treaties, regulations and by-laws of any legally constituted public authority within India.

1.1.60 **"Letter of Acceptance or "LOA"**: means the letter issued by the Employer to the successful Bidder inviting him/her to sign the Contract Agreement.

1.1.61 **"Lead Member"** in the case of a JV, means the member of such JV who shall have the authority to bind the Contractor and each member of the JV; and shall be deemed to be the Contractor for the purposes of this Contract and cannot be substituted.

1.1.62 **"Liquidated Delay Damages"** means the damages for which the Contractor shall be liable under Sub-Clause 8.8 [*Liquidated Delay Damages*] for failure to comply with Sub-Clause 8.2 [*Time for Completion*].

1.1.63 **"Local Currency"** means the lawful currency of the Republic of India **("Re."**, **"Rs."** or **"Rupees"** or **"Indian Rupees (INR)"**).

1.1.64 **"Materials"** means things of all kinds (other than Plant), whether on the Site or otherwise allocated to the Contract and intended to form or forming part of the Permanent Works, including the supply-only materials (if any) to be supplied by the Contractor under the Contract.

1.1.65 **"Material Adverse Effect"** means a material adverse effect of any act or event on the ability of either Party to perform any of its obligations under and in accordance with the provisions of this Contract and which act or event causes a material financial burden or loss to either Party.

1.1.66 **"Milestone"** means targets to be achieved in the Project specified as a part of the Plant and/or a part of the Works stated in the Contract Data (if any), and described in detail in the Employer's Requirements as a Milestone, which is to be completed by the time for completion stated in Sub-Clause 4.24 [*Milestones*].

1.1.67 **"Milestone Certificate"** means the certificate issued by the Employer's Representative under Sub-Clause 4.24 [*Milestones*].

1.1.68 **"Mobilisation Advance Bank Guarantee"** means the bank guarantee under Sub-Clause 14.2.1[*Mobilisation Advance Bank Guarantee*].

1.1.69 **"month"** is a calendar month (according to the Gregorian calendar).

1.1.70 **"No-objection"** means that the Employer has no objection to the Contractor's Documents, or other documents submitted by the Contractor under these Conditions, and such Contractor's Documents or other documents may be used for the Works.

1.1.71 **"Notice"** means a written communication identified as a Notice and issued in accordance with Sub-Clause 1.3 [*Notices and Other Communications*].

1.1.72 **"Notice of Dissatisfaction"** or **"NOD"** means the Notice one Party may give to the other Party if it is dissatisfied, either with an Authority's Engineer's determination under Sub-Clause 3.5 [*Agreement or Determination*] or with a DAAB's decision under Sub-Clause 21.4 [*Obtaining DAAB's Decision*].

1.1.73 **"Notice to Proceed"** or **"NTP"** means the Notice issued for starting the work as stated in Sub-Clause 8.1[*Commencement of Works*].

1.1.74 **"Oversight"** means to the act of actively monitoring and supervising a project to ensure it is being built according to the design specifications, budget, timeline, and safety standards, essentially acting as a quality control mechanism to identify and address any potential issues throughout the construction process.

1.1.75 **"Particular Conditions of Contract" or "PCC"** means the document entitled particular conditions of contract included in the Contract, which consists of Part A - Contract Data and Part B – Special Provisions.

1.1.76 **"Parties"** means the parties (Employer or Contractor) to this Contract collectively and **"Party"** shall mean any of the parties to this Contract individually, as the context requires.

1.1.77 **"Performance Certificate"** means the certificate issued by the Employer (or deemed to be issued) under Sub-Clause 11.9 [*Performance Certificate*].

1.1.78 **"Performance Damages"** means the damages to be paid by the Contractor to the Employer for the failure to achieve the guaranteed performance of the Plant and/or the Works or any part of the Works (as the case may be), as set out in the Schedule of Performance Guarantees.

1.1.79 **"Performance Security"** means the security under Sub-Clause 4.2 [*Performance Security*].

1.1.80 **"Permanent Works"** means the works of a permanent nature which are to be executed by the Contractor under the Contract.

1.1.81 **"Plant"** means the apparatus, equipment, machinery and vehicles (including any components) whether on the Site or otherwise allocated to the Contract and intended to form or forming part of the Permanent Works.

1.1.82 **"Programme"** means a detailed time programme prepared and submitted by the Contractor to which the Employer has given (or is deemed to have given) a Notice of No-objection under Sub-Clause 8.3 [*Programme*].

1.1.83 **"Project"** means the execution of the Works in accordance with the provisions of this Contract, encompassing all Goods, Services, and Plant (if applicable) related to the scope of Work as detailed in the Employer's Requirements. The term includes all elements essential to the successful completion of the Works, covering not only the physical construction but also peripheral elements such as planning, legal compliance, permits, environmental considerations, and any required post-completion operations.

1.1.84 **"Provisional Completion Certificate"** means a temporary certificate issued by

the Employer, prior to the issue of Completion Certificate, where minor outstanding works and defects exist which will not substantially affect the safe operation of the Works or Section of Works for their intended use.

1.1.85 **"Provisional Sum"** means a sum (if any) which is specified in the Contract by the Employer as a provisional sum, for the execution of any part of the Works or for the supply of Plant, Materials, or Services under Sub-Clause 13.4 [*Provisional Sums*].

1.1.86 **"Quality Assurance Plan"** or **"QAP"** means a document specifying the quality practices, resources, and sequence of activities relevant to the Project and/or Contract. Its purpose is to provide clear guidelines for maintaining and controlling quality, ensuring that all outputs meet predetermined standards and customer expectations.

1.1.87 **"QM System"** means the Contractor's quality management system (as may be updated and/or revised from time to time) in accordance with Sub-Clause 4.9.1 [*Quality Management System*].

1.1.88 **"Retention Money"** means the accumulated retention moneys which the Employer retains under Sub-Clause 14.3 [*Application for Interim Payment*] and pays under Sub-Clause 14.9 [*Release of Retention Money*].

1.1.89 **"Review"** means examination and consideration by the Employer of a Contractor's submission in order to assess whether (and to what extent) it complies with the Contract and/or with the Contractor's obligations under or in connection with the Contract.

1.1.90 **"Schedules"** means the document(s) entitled schedules prepared by the Employer and completed by the Contractor, as attached to the Tender and included in the Contract. Such document(s) may include data, lists and schedules of payments and/or rates and prices, and guarantees.

1.1.91 **"Schedule of Payments"** means the document(s) entitled schedule of payments (if any) in the Schedules showing the amounts and manner of payments to be made to the Contractor.

1.1.92 **"Schedule of Performance Guarantees"** means the document(s) entitled schedule of performance guarantees (if any) in the Schedules showing the guarantees required by the Employer for performance of the Works and/ or the Plant or any part of the Works (as the case may be), and stating the applicable Performance Damages payable in the event of failure to attain any of the

guaranteed performance(s).

1.1.93 **"Schedule of Rates and Prices"** means the document(s) entitled schedule of rates and prices (if any) in the Schedules.

1.1.94 **"Section"** means a part of the Works specified in the Contract Data as a Section (if any).

1.1.95 **"Service(s)"** means the non-tangible aspects of the Project which include professional expertise, consultancy, design, engineering, project management, supervision, and other intellectual contributions for necessary execution of the Works to ensure the successful completion of the Project.

1.1.96 **"Site"** means the places where the Permanent Works are to be executed and to which Plant and Materials are to be delivered, and any other places specified in the Contract as forming part of the Site.

1.1.97 **"Special Provisions"** means the document (if any), entitled special provisions which constitutes Part B of the Particular Conditions of Contract.

1.1.98 **"Specifications and Standards"** means the specifications and standards relating to the quality, quantity, capacity and other requirements for the Project, as set forth in Employer's Requirements, and any modifications thereof, or additions thereto, as included in the design and engineering for the Project submitted by the Contractor and reviewed by the Employer as per Sub-Clause 5.2.2[*Review by Employer*].

1.1.99 **"Statement"** means a statement submitted by the Contractor as part of an application for payment under Sub-Clause 14.2.1 [*Mobilisation Advance Bank Guarantee*] (if applicable), Sub-Clause 14.3 [*Application for Interim Payment*], Sub-Clause 14.10 [*Statement at Completion*] or Sub-Clause 14.11 [*Final Statement*].

1.1.100 **"Subcontractor"** means any person named in the Contract as a subcontractor, or any person appointed by the Contractor as a subcontractor or designer, for a part of the Works; and the legal successors in title to each of these persons but not assignees to such person.

1.1.101 **"Temporary Works"** means all temporary works of every kind (other than Contractor's Equipment) required on Site for the execution of the Works.

1.1.102 **"Tender"** means the Contractor's signed offer for the Works, the JV Undertaking (if applicable) and all other documents, which the Contractor submitted with the Tender (other than the Conditions of Contract, the Schedules and the Employer's

Requirements, if so submitted), as included in the Contract.

1.1.103 **"Tests after Completion"** means the tests (if any) which are stated in the Employer's Requirements and which are carried out under Clause 12 [*Tests after Completion*] after the Works or a Section (as the case may be) are taken over under Clause 10 [*Employer's Taking Over*].

1.1.104 **"Tests on Completion"** means the tests which are specified in the Contract or agreed by both Parties or instructed as a Variation, and which are carried out under Clause 9 [*Tests on Completion*] before the Works or a Section (as the case may be) are taken over under Clause 10 [*Employer's Taking Over*].

1.1.105 **"Time for Completion"** means the time for completing the Works or a Section (as the case may be) under Sub-Clause 8.2 [*Time for Completion*], as stated in the Contract Data as may be extended under Sub-Clause 8.5 [*Extension of Time for Completion*], calculated from the Commencement Date.

1.1.106 **"Unforeseeable"** means not reasonably foreseeable by an experienced contractor by the Base Date.

1.1.107 **"Variation"** means any change to the Employer's Requirements or the Works, which is instructed as a variation under Clause 13 [*Variations and Adjustments*].

1.1.108 **"Works"** means the deliverables and activities to be carried out by the Contractor under the Contract Agreement to fulfil the Project objectives specified in the Contract. The term includes all Permanent Works (including but not limited to survey and investigation, design, engineering, procurement, construction, Plant, Materials), as well as Temporary Works and any other elements necessary to complete the Project in accordance with this Contract.

1.1.109 **"year"** means 365 days.

1.2 Interpretation

In the Contract, except where the context requires otherwise:

(a) words indicating one gender include all genders (including neutral gender); and "he", "his" and "himself" shall be read as "he/she", "his/her" and "himself/herself" respectively;

(b) words indicating the singular also include the plural and words indicating the plural also include the singular;

(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;

(e) "may" means that the Party or person referred to has the choice of whether to act or not in the matter referred to;

(f) "shall" means that the Party or person referred to has an obligation under the Contract to perform the duty referred to;

(g) "consent" means that the Authority/Employer or the Contractor (as the case may be) agrees to, or gives permission for, the requested matter;

(h) "including", "include" and "includes" shall be interpreted as not being limited to, or qualified by, the stated items that follow;

(i) words indicating persons or parties shall be interpreted as referring to natural and legal persons (including Firms, Corporations, JVs, Consortia and other legal entities);

(j) "execute the Works" or "execution of the Works" means the design, construction and completion of the Works (survey and investigation, design, developing, engineering, procurement, supply of plant, materials, equipment, labour, delivery, transportation, installation, processing, fabrication, testing, and commissioning of the Project, including maintenance during the Construction Period) and the remedying of any defects and other activities incidental to the construction shall be construed accordingly;

(k) references to any legislation or any provision thereof shall include amendment or re-enactment or consolidation of such legislation or any provision thereof so far as such amendment or re-enactment or consolidation applies or is capable of applying to any transaction entered into hereunder;

(l) references to laws of India or Indian law or regulation having the force of law shall include the laws, acts, ordinances, rules, regulations, bye laws or notifications which have the force of law in the territory of India and as from time to time may be amended, modified, supplemented, extended or re-enacted;

(m) any reference to any period of time shall mean a reference to that according to Indian Standard Time (IST); and

(n) reference to a "business day" shall be construed as a reference to a day when the State Government institutions are open for business, and excludes any public holidays including state, national and religious holidays, recognized and published in the Kerala Government Gazette by the General Administration

(Co-ordination) Department. In addition to this, officially recognized regional holidays not published in the Gazette, shall not be considered business days.

In any list in these Conditions, where the second-last item of the list is followed by "and" or "or" or "and/or" then all of the list items going before this item shall also be read as if they are followed by "and" or "or" or "and/ or" (as the case may be).

The marginal words and other headings shall not be taken into consideration in the interpretation of these Conditions.

1.3 Notices and Other Communications

Wherever these Conditions provide for the giving of a Notice (including a Notice to Proceed, Notice of Dissatisfaction) or the issuing, providing, sending, submitting or transmitting of another type of communication (including acceptance, acknowledgement, advising, agreement, approval, certificate, Claim, consent, decision, determination, disagreement, discharge, instruction, No-objection, record(s) of meeting, permission, proposal, record, reply, report, request, Review, Statement, statement, submission or any other similar type of communication), the Notice or other communication shall be in writing and:

(a) shall be:

(i) a paper-original signed by the Contractor's Representative, or the Employer's Representative/Authority's Engineer (as the case may be); or

(ii) an electronic original generated from any of the systems of electronic transmission stated in the Contract Data (if not stated, system(s) acceptable to the Employer), where the electronic original is transmitted by the electronic address uniquely assigned to each of such authorised representatives, or both, as stated in these Conditions; and

(b) if it is a Notice, it shall be identified as a Notice. If it is another form of communication, it shall be identified as such and include reference to the provision(s) of the Contract under which it is issued where appropriate;

(c) delivered by hand (against receipt), or sent by mail or courier (against receipt), or transmitted using any of the systems of electronic transmission under sub-paragraph (a)(ii) above; and

(d) delivered, sent or transmitted to the address for the recipient's communications as stated in the Contract Data. However, if the recipient gives a Notice of another address, all Notices and other communications shall

be delivered accordingly after the sender receives such Notice.

Where these Conditions state that a Notice, Notice to Proceed or NOD or other communication is to be delivered, given, issued, provided, sent, submitted or transmitted, it shall have effect when it is received (or deemed to have been received) at the recipient's current address under sub-paragraph (d) above. An electronically transmitted Notice or other communication is deemed to have been received on the day after transmission, provided no non-delivery notification was received by the sender.

All Notices, and all other types of communication referred to above, shall not be unreasonably withheld or delayed.

When a Notice, Notice to Proceed or NOD is issued by a Party or the Employer's Representative/Authority's Engineer, the paper and/or electronic original shall be sent to the intended recipient and a copy shall be sent to the Employer's Representative or the other Party, as the case may be. In case, when a Notice, Notice to Proceed or NOD is issued by the Authority's Engineer, it shall be sent to the Employer's Representative for further action. All other communications shall be copied to the Parties and/or the Employer's Representative as stated under these Conditions or elsewhere in the Contract.

1.4 Law and Language

The Contract shall be governed by the Law - national (or state or local bodies) legislation, statutes, acts, decrees, rules, ordinances, orders, treaties, regulations and by-laws of any legally constituted public authority within India.

The ruling language of the Contract shall be that stated in the Contract Data (if not stated, the language of these Conditions). If there are versions of any part of the Contract which are written in more than one language, the version which is in the ruling language shall prevail.

The language for communications shall be that stated in the Contract Data. If no language is stated there, the language for communications shall be the ruling language of the Contract.

1.5 Priority of Documents

The documents forming the Contract are to be taken as mutually explanatory of one another. If there is any conflict, ambiguity or discrepancy in the documents, the priority of the documents shall be in accordance with the following sequence:

(a) the Contract Agreement;
(b) the Particular Conditions of Contract Part A – Contract Data;
(c) the Particular Conditions of Contract Part B – Special Provisions;
(d) these General Conditions;
(e) the Employer's Requirements;
(f) the Schedules;
(g) the Tender;
(h) the JV Undertaking (if the Contractor is a JV); and
(i) any other documents forming part of the Contract.

If a Party finds a conflict, ambiguity or discrepancy in the documents, that Party shall promptly give a Notice to the other Party, describing the conflict, ambiguity or discrepancy. After giving or receiving such Notice, the Employer shall issue the necessary clarification or instruction within the period specified in Contract Data.

1.6 Contract Agreement

Upon receiving the Letter of Acceptance (LOA), the Contractor shall immediately submit a signed duplicate copy of the LOA as a token of his acceptance of the LOA and provide the Performance Security within the period specified in the Contract Data. Subsequently, the Parties shall sign the Contract Agreement within the period specified in the Contract Data. The Contract shall come into full force and effect on the date stated in the Contract Agreement. The costs of stamp duties and similar charges (if any) imposed by law in connection with entry into the Contract Agreement shall be borne by the Contractor.

If the Contractor is a JV, the authorised representative of the Lead Member of the JV shall sign the Contract Agreement under Sub-Clause 1.13 [*Joint and Several Liability*].

1.7 Assignment

Neither Party shall assign the whole or any part of the Contract or any benefit or

interest in or under the Contract. However, either Party with express consent of the Authority:

(a) may assign the whole or any part of the Contract with the prior agreement of the other Party, at the sole discretion of such other Party; and
(b) may, as security in favour of a Bank or financial institution, assign the Party's right to any moneys due, or to become due, under the Contract with the prior agreement of the other Party.

1.8 Care and Supply of Documents

Each of the Contractor's Documents shall be in the custody and care of the Contractor, unless and until submitted to the Employer. The Contractor shall supply to the Employer one paper-original, one electronic copy (in the form as specified in the Employer's Requirements or, if not stated, a form acceptable to the Employer) and additional paper copies (if any) as stated in the Contract Data of each of the Contractor's Documents.

The Contractor shall keep at all times, on the Site, a copy of:

(a) the Contract;
(b) the records under Sub-Clause 6.10 [*Contractor's Records*] and Sub-Clause 20.2.3 [*Contemporary records*];
(c) the QM System & Compliance Verification System under Sub-Clause 4.9 [Quality Management and Compliance Verification Systems];
(d) the publications (if any) named in the Employer's Requirements;
(e) the Contractor's Documents under Sub-Clause 5.2 [*Contractor's Document*]; and
(f) Variations, Notices and other communications given under the Contract.

The authorised representatives of Authority/ Employer shall have right of access to all these documents during all normal working hours, or as otherwise agreed with the Contractor.

If a Party becomes aware of an error or defect (whether of a technical nature or otherwise) in a document which was prepared by (or on behalf of) the Contractor for use in the execution of the Works, the Party shall promptly give a Notice of such error or defect to the other Party. The Contractor shall then promptly rectify the error or

defect at the Contractor's risk and cost, within the period specified in the Contract Data.

1.9 Use of Contractor's Documents

As between the Parties, the Contractor shall retain the copyright and other intellectual property rights in the Contractor's Documents and other design documents made by (or on behalf of) the Contractor.

The Contractor shall be deemed (by signing the Contract Agreement) to give to the Authority a non-terminable transferable non-exclusive royalty-free licence to copy, use and communicate the Contractor's Documents and such other design documents, including making and using modifications of them. This licence shall:

(a) apply throughout the actual or intended operational life (whichever is longer) of the relevant parts of the Works;

(b) entitle any person in proper possession of the relevant part of the Works to copy, use and communicate the Contractor's Documents and such other design documents for the purposes of completing, operating, maintaining, altering, adjusting, repairing and demolishing the Works;

(c) in the case of Contractor's Documents and such other design documents which are in the form of electronic or digital files, computer programs and other software, permit their use on any computer on the Site and/or at the locations of the Employer and the Employer's Representative and/or at other places as envisaged by the Contract; and

(d) in the event of termination of the Contract:

(i) under Sub-Clause 15.2 [*Termination for Contractor's Default*], entitle the Authority to copy, use and communicate the Contractor's Documents and the other design documents made by or for the Contractor; or

(ii) under Sub-Clause 15.5 [*Termination for Employer's Convenience*], Sub-Clause 16.2 [*Termination by Contractor*] or Sub-Clause 18.5 [*Optional Termination*], entitle the Authority to copy, use and communicate the Contractor's Documents for which the Contractor has received payment

for the purpose of completing the Works and/or arranging for any other entities to do so.

The Contractor's Documents and other design documents made by (or on behalf of) the Contractor shall not, without the Contractor's prior consent, be used, copied or communicated to a third party by (or on behalf of) the Employer for purposes other than those permitted under this Sub-Clause.

1.10 Contractor's Use of Employer's Documents

As between the Parties, the Employer shall retain the copyright and other intellectual property rights in the Employer's Requirements and other documents made by (or on behalf of) the Employer. The Contractor may, at the Contractor's cost, copy, use and communicate these documents for the purposes of the Contract.

These documents (in whole or in part) shall not, without the Employer's prior consent, be copied, used or communicated to a third-party by the Contractor, except as necessary for the purposes of the Contract.

1.11 Confidentiality

The Contractor shall disclose all such confidential and other information as the Employer may reasonably require in order to verify the Contractor's compliance with the Contract.

The Contractor shall treat all documents forming the Contract as confidential, except to the extent necessary to carry out the Contractor's obligations under the Contract. The Contractor shall not publish, permit to be published, or disclose any particulars of the Contract in any trade or technical paper or elsewhere without the Employer's prior consent.

The Authority, the Authority's Engineer, the Employer and the Employer's Personnel shall treat all information provided by the Contractor and marked "confidential", as confidential. The Authority, the Authority's Engineer, the Employer and the Employer's Personnel shall not disclose or permit to be disclosed any such information to third parties, except as may be necessary when exercising the Employer's rights under Sub-Clause 15.2 [*Termination for Contractor's Default*].

A Party's obligation of confidentiality under this Sub-Clause shall not apply where the information:

(a) was already in that Party's possession without an obligation of confidentiality

before receipt from the other Party;

(b) becomes generally available to the public through no breach of these Conditions; or

(c) is lawfully obtained by the Party from a third party which is not bound by an obligation of confidentiality.

1.12 Compliance with laws

The Contractor and the Employer shall, in performing the Contract, comply with all applicable Laws. Unless otherwise stated in the Employer's Requirements:

(a) the Employer shall have obtained (or shall obtain), the planning, zoning permit or similar permits, and any other permits, permissions, licenses and/or approvals for the Permanent Works described in the Employer's Requirements as having been (or being) obtained by the Employer. The Employer shall indemnify and hold the Contractor harmless against and from the consequences of any delay or failure to do so, unless the failure is caused by the Contractor's failure to comply with sub-paragraph (c) below;

(b) the Contractor shall give all notices, pay all taxes, duties and fees, and obtain all Applicable Permits, including other permits, permissions, licences and/or approvals, as required by the Laws in relation to the execution of the Works. The Contractor shall indemnify and hold the Employer harmless against and from the consequences of any failure to do so unless the failure is caused by the Employer's failure to comply with Sub-Clause 3.8 [*Assistance*];

(c) within the time(s) stated in the Employer's Requirements the Contractor shall provide such assistance and all documentation, as described in the Employer's Requirements or otherwise reasonably required by the Employer, so as to allow the Employer to obtain any permit, permission, licence or approval under sub-paragraph (a) above; and

(d) the Contractor shall comply with all Applicable Permits, including, permits, permissions, licences and/or approvals obtained by the Employer under sub-paragraph (a) above.

If, having complied with sub-paragraph (c) above, the Contractor suffers delay and/or incurs Cost as a result of the Employer's delay or failure to obtain any Applicable Permits, including, permit, permission, licence or approval under sub-paragraph (a)

above, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to EOT and/or payment of such Cost Plus Profit.

If the Employer incurs additional costs as a result of the Contractor's failure to comply with:

(i) sub-paragraph (c) above; or

(ii) sub-paragraph (b) or (d) above, provided that the Employer shall have complied with Sub-Clause 3.8 [*Assistance*],

the Employer shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment of these costs by the Contractor.

1.13 Joint and Several Liability

If the Contractor is a Joint Venture:

(a) the members of the JV shall be jointly and severally liable to the Employer for the performance of the Contractor's obligations under the Contract;

(b) the Lead Member shall have authority to bind the Contractor and each member of the JV; and

(c) neither the members nor (if known) the scope and parts of the Works to be carried out by each member nor the legal status of the JV shall be altered without the prior consent of the Employer (but such consent shall not relieve the altered JV from any liability under sub-paragraph (a) above).

1.14 Limitation of Liability

Neither Party shall be liable to the other Party for loss of use of any Works, loss of profit, loss of any contract or for any indirect or consequential loss or damage which may be suffered by the other Party in connection with the Contract, other than under:

i. Sub-Clause 4.15.2 [Utilities]
ii. Sub-Clause 4.15.3 [Felling of trees]
iii. Sub-Clause 8.8 [*Liquidated Delay Damages*];
iv. sub-paragraph (c) of Sub-Clause 13.3.1 [*Variation by Instruction*];
v. Sub-Clause 15.7 [*Payment after Termination for Employer's Convenience*];
vi. Sub-Clause 16.4 [*Payment after Termination by Contractor*];
vii. Sub-Clause 17.3 [*Intellectual and Industrial Property Rights*];
viii. the first paragraph of Sub-Clause 17.4 [*Indemnities by Contractor*]; and

ix. Sub-Clause 17.5 [*Indemnities by Employer*].

The total liability of the Contractor to the Employer under or in connection with the Contract, other than:

(i) under Sub-Clause 3.12 *[Employer-Supplied Materials and Employer's Equipment*];

(ii) under Sub-Clause 4.19 [*Temporary Utilities*];

(iii) under Sub-Clause 17.3 [*Intellectual and Industrial Property Rights*]; and

(iv) under the first paragraph of Sub-Clause 17.4 [*Indemnities by Contractor*],

shall not exceed the sum stated in the Contract Data or (if a sum is not so stated) the Contract Price stated in the Contract Agreement.

This Sub-Clause shall not limit liability in any case of fraud, gross negligence, deliberate default or reckless misconduct by the defaulting Party.

1.15 Contract Termination

Subject to any mandatory requirements under the governing law of the Contract, termination of the Contract under any Sub-Clause of these Conditions shall require no action of whatsoever kind by either Party other than as stated in such Sub-Clause.

2. The Authority

2.1 Authority's Administration

2.1.1 Appointment of Employer

The Authority shall appoint the Employer who shall be deemed to act and manage the Project on behalf of the Authority under the Contract, except in respect of the matters specified in (a) to (h) of Sub-Clause 2.3 [*Authority's Engineer*].

2.1.2 Appointment of Authority's Engineer

The Authority shall appoint the Authority's Engineer, who shall be a consulting engineering firm, in accordance with the selection procedure as detailed in the document mentioned in Part A -Contract Data of the Particular Conditions of Contract, who shall perform its duties and discharge its functions on behalf of

the Authority, in accordance with the provisions of these conditions and shall have the full authority in respect of the matters specified in (a) to (j) of Sub-Clause 2.3 [*Authority's Engineer*].

2.2 Obligations of Authority

The Authority shall facilitate, whenever necessary, the Employer and the Authority's Engineer in fulfilling their duties and responsibilities in accordance with the provisions of this Contract and applicable Laws.

2.2.1 Procurement of the Site

The Authority shall be responsible:

(a) for acquiring and providing right of access to the Site in compliance with the Sub-Clause 3.7 *[Right of Access to the Site]*, and in accordance with the Site layout finalised by the Employer, free from all encroachments and Encumbrances, and free access thereto for the execution of this Contract;

and for facilitating the Employer:

(b) to obtain licences and permits for environment clearance and forest clearance for the Project; and

(c) to ensure that no barriers that would have a Material Adverse Effect on Works are erected or placed on or about the Project by any Government Instrumentality or persons claiming through or under it, except for reasons of emergency, national security or law and order.

2.2.2 Support by the Authority

If requested by the Employer, the Authority shall promptly provide reasonable support, so as to enable the Employer to provide required assistance to the Contractor in respect of Sub-Clauses 3.7 [*Right of Access to the Site*], 3.8 [*Assistance*] ,3.11 [*Site data and reference*].

2.2.3 Financial Arrangement

The Authority's financial arrangements for the Employer's obligations under the Contract shall be met by the Funding Agency, as per the format

mentioned in the Contract Data.

The Employer shall not bear financial liability for payment delays or funding shortfalls. In case of payment disputes or funding changes, Funding Agency shall be responsible for resolution and indemnification.

If the Funding Agency intends to make any material change (affecting the ability to pay the part of the Contract Price remaining to be paid at that time as estimated by the Employer) to these financial arrangements or has to do so because of changes in the Funding Agency's financial situation, it shall immediately give a Notice to the Employer with detailed supporting particulars.

2.3 Authority's Engineer

The Authority's Engineer shall be vested with, and shall be deemed to have, the full authority of the Authority under the Contract in the following:

(a) any Extension of Time [EOT];
(b) any variation in Contract Price;
(c) termination of the Contract;
(d) decision with respect to curing of major defects and damages which will affect the functioning of the Project;
(e) Oversight of the Design Review by Employer
(f) Oversight of Test on Completion and Test after Completion;
(g) determination of delays on the part of the Employer due to which damages are to be paid to the Contractor;
(h) determination in matters of disagreement between the Employer and the Contractor;
(i) Final Scrutiny and recommendation for Payment of the Statement approved by the Employer; or
(j) any other matter, which falls beyond the power of the Employer.

2.4 Authority's Engineer and The Employer

Whenever the role of Authority's Engineer is warranted, the Employer shall

refer the matter with all supporting data to the Authority's Engineer. The Authority's Engineer shall give his /her decision/response within the time specified in the Contract data.

If there is any conflict regarding contractual obligations, claims, approvals, or variations, the Employer shall refer any disagreement or contract interpretation issues to the Authority's Engineer for final determination. The Authority's Engineer's decision shall be final unless escalated under the dispute resolution process.

In case of any matter to be agreed or determined under these conditions, the Employer's Representative shall proceed under sub-clause 3.5.1 [*Consultation to Reach an Agreement*] to achieve an agreement between the Parties on the matter referred. If the Parties fail to reach an agreement, then the Employer's Representative shall inform the matter to the Employer and the Employer shall refer the matter to the Authority's Engineer, who shall proceed under Sub-Clause 3.5.2 [*Authority's Engineer's Determination*].

However, in case of Sub-Clauses 13.3.1[*Variation by Instruction*], 13.3.2 [*Variation by Request for Proposal*], 15.3 [*Valuation after Termination for Contractor's Default*], 15.6 [*Valuation after Termination for Employer's Convenience*], 18.5[*Optional Termination*], 20.1[*Claims*], 20.2.5[*Agreement or Determination of Claims*] the Authority's Engineer shall follow the procedure under Sub-Clause 3.5.1[*Consultation to reach an agreement*], in addition to the role under Sub-Clause 3.5.2 [*Authority's Engineer's Determination*].

3. The Employer and the Employer's Administration

3.1 Employer's Representative

The Employer shall appoint the Employer's Representative who, except as otherwise stated in these Conditions, shall be deemed to act on the Employer's behalf under the Contract.

The Employer's Representative shall be vested with, and (unless and until the Employer notifies the Contractor otherwise) shall be deemed to have, the full authority

of the Employer under the Contract.

The Employer's Representative (or, if a legal entity, the natural person appointed to act on its behalf) shall:

(a) carry out the duties assigned to him/her, and exercise the authority delegated to him/her, by the Employer;
(b) be competent to carry out these duties and exercise this authority;
(c) act as a skilled experienced professional engineer; and
(d) be fluent in the ruling language defined in Sub-Clause 1.4 [*Law and Language*].

Where the Employer's Representative is a legal entity, the Employer's Representative shall give a Notice of delegation to the Parties of the natural person (or any replacement) appointed and authorised to act on its behalf. The authority shall not take effect until this Notice of delegation has been received by both Parties. The Employers' Representative shall similarly give a Notice of any revocation of such authority.

If the Employer wishes to replace any person appointed as the Employer's Representative, the Employer shall, not less than 14 days before the intended date of replacement, give a Notice to the Authority and the Contractor of the replacement's name, address, duties and authority, and of the date of appointment.

The Employer shall not replace the Employer's Representative with a person (whether a legal entity or a natural person) against whom the Contractor has raised reasonable objection by a Notice under this Sub-Clause.

3.2 Other Employer's Personnel

The Employer or the Employer's Representative may from time to time assign duties and delegate authority to assistants, and may also revoke such assignment or delegation, by giving a Notice of delegation to the Contractor of the name, assigned duties and delegated authority of the assistant. The assignment, delegation or revocation shall not take effect until this Notice of delegation has been received by the Contractor.

Assistants shall be suitably qualified natural persons, who are competent to carry out these duties and exercise this authority, and who are fluent in the language for communications defined in Sub-Clause 1.4 [*Law and Language*].

3.3 Delegated Persons

All persons, including the Employer's Representative and assistants, to whom duties have been assigned or authority has been delegated by a Notice of delegation given under Sub-Clause 3.1 [*The Employer's Representative*] or Sub-Clause 3.2 [*Other Employer's Personnel*] (as the case may be), shall only be authorised to issue instructions and communications and/or to give Notices to the Contractor to the extent defined by the Notice of delegation. Any acceptance, agreement, approval, check, certificate, comment, consent, disapproval, examination, inspection, instruction, Notice, No-objection, record(s) of meeting, permission, proposal, record, reply, report, request, Review, test, valuation, or similar act (including the absence of any such act) by a delegated person, in accordance with the Notice of delegation, shall have the same effect as though the act had been an act of the Employer.

However:

(a) unless otherwise stated in the delegated person's communication relating to such act, it shall not relieve the Contractor from any duty, obligation or responsibility the Contractor has under or in connection with the Contract; and

(b) if the Contractor questions any instruction, communication or Notice given by a delegated person, the Contractor may by giving a Notice refer the matter to the Employer. Unless the Employer reverses or varies the delegated person's instruction, communication or Notice within 7 days after receiving the Contractor's Notice, the Employer shall be deemed to have confirmed such instruction, communication or Notice.

3.4 Instructions

The Employer may, through the Employer's Representative or an assistant as stated below, issue to the Contractor (at any time) instructions which may be necessary for the execution of the Works, all in accordance with the Contract. Each instruction shall state the obligation(s) to which it relates and the Sub-Clause (or other term of the Contract) in which the obligation(s) are specified.

The Contractor shall only take instructions from the Employer's Representative or an assistant to whom the appropriate authority to give instruction has been delegated by a Notice given under Sub-Clause 3.2 [*Other Employer's Personnel*].

Subject to the following provisions of this Sub-Clause, the Contractor shall comply with the instructions given by the Employer's Representative or delegated assistant, on any matter related to the Contract.

If an instruction states that it constitutes a Variation, Sub-Clause 13.3.1 [*Variation by Instruction*] shall apply.

If not so stated, and the Contractor considers that the instruction:

(a) constitutes a Variation (or involves work that is already part of an existing Variation); or
(b) does not comply with applicable Laws or will reduce the safety of the Works or is technically impossible.

the Contractor shall immediately, and before commencing any work related to the instruction, give a Notice to the Employer with reasons. If the Employer does not respond within 14 days (or such other time as may be agreed between the Parties) after receiving this Notice, by giving a Notice confirming, reversing or varying the instruction, the Employer shall be deemed to have revoked the instruction. Otherwise, the Contractor shall comply with and be bound by the terms of the Employer's response.

3.5 Agreement or Determination

When carrying out his/her duties under this Sub-Clause, the Employer's Representative shall not be deemed to act for the Employer.

Whenever these Conditions provide that the Employer's Representative/Authority's Engineer shall proceed under this Sub-Clause 3.5 to agree or determine

(a) any matter, as provided for in the relevant Sub-Clauses 11.2 [*Cost of Remedying Defects*], 13.5 [*Daywork*], 14.4 [*Schedule of Payments*], 14.5 [*Plant and Materials intended for the Works*] and 14.6.3[*Correction or modification*] identifying in the same Sub-Clause the date of commencement of the corresponding time limit for agreement under Sub-Clause 3.5.3 [*Time limits*]

the following procedure shall apply.

3.5.1 Consultation to reach agreement

The Employer's Representative shall consult with both Parties jointly and/or separately, and shall encourage discussion between the Parties in an endeavour to reach agreement. The Employer's Representative shall commence such consultation promptly to allow adequate time to comply with the time limit for agreement under Sub-Clause 3.5.3 [*Time limits*]. Unless otherwise proposed by the Employer's Representative and agreed by the Parties, the Employer's Representative shall provide both Parties with a record of the consultation.

If agreement is achieved within the time limit for agreement under Sub-Clause 3.5.3 [*Time limits*], the Employer's Representative shall give a Notice to both Parties of the agreement, which agreement shall be signed by both Parties. This Notice shall state that it is a "Notice of the Parties' Agreement" and shall include a copy of the agreement.

If:

(a) no agreement is achieved within the time limit for agreement under Sub-Clause 3.5.3 [*Time limits*]; or

(b) both Parties advise the Employer's Representative that no agreement can be achieved within this time limit

whichever is the earlier, the Employer's Representative shall give a Notice to the Parties accordingly and shall immediately proceed under Sub-Clause 3.5.2 [*Authority's Engineer's determination*]

3.5.2 Authority's Engineer's determination

The Authority's Engineer shall make a fair determination of the matter or Claim, in accordance with the Contract, taking due regard of all relevant circumstances.

Within the time limit for determination under Sub-Clause 3.5.3 [*Time limits*], the Authority's Engineer shall give the Notice to both Parties of determination by the Authority's Engineer. This Notice shall state that it is a "Notice of the Authority's Engineer's Determination", and shall describe the determination in detail with reasons and detailed supporting particulars.

3.5.3 Time limits

The Employer's Representative/Authority's Engineer shall give the Notice of agreement, if agreement is achieved, within 42 days, or within such other time limit as may be proposed by the Employer's Representative and agreed by both Parties (the "time limit for agreement" in these Conditions), after:

(a) in the case of a matter to be agreed or determined under, sub-paragraph (a) of Sub-Clause 3.5 [*Agreement or Determination*] and third paragraph of Sub-Clause 2.4 [*Authority's Engineer and the Employer*], the date of commencement of the time limit for agreement as stated in the applicable Sub-Clause of these Conditions;

(b) in the case of a Claim under sub-paragraph (c) of Sub-Clause 20.1[*Claims*], the date the Employer's Representative receives a Notice under Sub-Clause 20.1 from the claiming Party; or

(c) in the case of a Claim under sub-paragraph (a) or (b) of Sub-Clause 20.1 [*Claims*], the date the Employer's Representative receives:

(i) a fully detailed Claim under Sub-Clause 20.2.4 [*Fully Detailed Claim*]; or

(ii) in the case of a Claim under Sub-Clause 20.2.6 [*Claims of continuing effect*], an interim or final fully detailed Claim (as the case may be).

The Authority's Engineer shall give the Notice of his/her determination within 42 days, or within such other time limit as may be proposed by the Employer's Representative and agreed by both Parties, (the "time limit for determination" in these Conditions), after the date corresponding to his/ her obligation to proceed under the last paragraph of Sub-Clause 3.5.1 [*Consultation to reach agreement*].

If the Authority's Engineer does not give the Notice of determination within the relevant time limit,

(i) in the case of a Claim, the Authority's Engineer shall be deemed to have given a determination rejecting the Claim; or

(ii) in the case of a matter to be agreed or determined under, sub-paragraph (a) of Sub-Clause 3.5 [*Agreement or Determinations*] and third paragraph of Sub-Clause 2.4 [*Authority's Engineer and the Employer*], the matter shall be deemed to be a Dispute which may be referred by either Party to the DAAB for its decision under Sub-Clause 21.4 [*Obtaining DAAB's Decision*] without the

need for a NOD (and Sub-Clause 3.5.5 [*Dissatisfaction with Authority's Engineer's determination*] and sub-paragraph (a) of Sub-Clause 21.4.1 [*Reference of a Dispute to the DAAB*] shall not apply).

3.5.4 Effect of the agreement or determination

Each agreement or determination shall be binding on both Parties unless and until corrected under this Sub-Clause or, in the case of a determination, it is revised under Clause 21 [*Disputes and Arbitration*].

If an agreement or determination concerns the payment of an amount from one Party to the other Party, the Contractor shall include such an amount in the next Statement and the Employer shall include such amount in the next payment under Sub-Clause 14.7 [*Interim Payment*] or 14.13 [*Final Payment*] (as the case may be) that follows that Statement.

If, within 14 days after giving or receiving the Notice of agreement or determination, any error of a typographical or clerical or arithmetical nature is found:

(a) by the Employer's Representative: then he/she shall immediately advise the Parties accordingly; or

(b) by a Party: then that Party shall give a Notice to the Employer's Representative stating that it is given under this Sub-Clause 3.5.4 and clearly identifying the error. If the Employer's Representative does not agree there was an error, he/she shall immediately advise the Parties accordingly.

The Employer's Representative shall within 7 days after finding the error, or after receiving a Notice under sub-paragraph (b) above (as the case may be), give a Notice to both Parties of the corrected agreement or in the case of the corrected determination (in consultation with the Authority's Engineer). Thereafter, the corrected agreement or determination shall be treated as the agreement or determination for the purpose of these Conditions.

3.5.5 Dissatisfaction with Authority's Engineer's determination

If either Party is dissatisfied with a determination of the Authority's Engineer:

(a) the dissatisfied Party may give a NOD to the other Party, with a copy to both the Employer's Representative and Authority's Engineer;

(b) this NOD shall state that it is a "Notice of Dissatisfaction with the Authority's Engineer's Determination" and shall set out the reason(s) for dissatisfaction;

(c) this NOD shall be given within 28 days after receiving the Notice of the determination under Sub-Clause 3.5.2 [*Authority's Engineer's Determination*] or, if applicable, his/ her Notice of the corrected determination under Sub-Clause 3.5.4 [*Effect of the agreement or determination*] (or, in the case of a deemed determination rejecting the Claim, within 28 days after the time limit for determination under Sub-Clause 3.5.3 [*Time limits*] has expired); and

(d) thereafter, either Party may proceed under Sub-Clause 21.4 [*Obtaining DAAB's Decision*].

If no NOD is given by either Party within the period of 28 days stated in sub-paragraph (c) above, the determination of the Authority's Engineer shall be deemed to have been accepted by both Parties and be final and binding on them.

If the dissatisfied Party is dissatisfied with only part(s) of the Authority's Engineer's determination:

(i) this part(s) shall be clearly identified in the NOD and follow the procedure detailed in (a) to (c) of this subclause;

(ii) this part(s), and any other parts of the determination that are affected by such part(s) or rely on such part(s) for completeness, shall be deemed to be severable from the remainder of the determination; and

(iii) the remainder of the determination shall become final and binding on both Parties as if the NOD had not been given.

In the event that a Party fails to comply with an agreement of the Parties under this Sub-Clause 3.5 or a final and binding determination of the Authority's Engineer, the other Party may proceed under Sub-Clause 21.4 [*Obtaining DAAB's Decision*].

3.6 Meetings

Either Party may require the other Party to attend a management meeting to review the progress of Work, discuss arrangements for future work and/or other matters in connection with execution of the Works at least once every month.

The Employer's other contractors, the personnel of legally constituted public

authorities and/or private utility companies, and/or Subcontractors may attend any such meeting, if requested by either Party.

The Employer shall keep a record of each management meeting and supply copies of the record to those attending. At any such meeting, and in the record, responsibilities for any actions to be taken shall be in accordance with the Contract.

3.7 Right of Access to the Site

The Employer shall give the Contractor right of access to, and possession of, all parts of the Site within the time (or times) stated in the Contract Data, in compliance with Sub-Clause 2.2.1[Procurement of the Site]. The right and possession may not be exclusive to the Contractor. If, under the Contract, the Employer is required to give (to the Contractor) possession of any foundation, structure, plant or means of access, the Employer shall do so in the time and manner stated in the Employer's Requirements. However, the Employer may withhold any such right or possession until the Performance Security has been received.

If no such time is stated in the Contract Data, the Employer shall give the Contractor right of access to, and possession of, the Site with effect from the Commencement Date.

If the Contractor suffers delay and/or incurs Cost as a result of a failure by the Employer to give any such right or possession within such time, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to EOT. and/or payment of such Cost Plus Profit.

However, if and to the extent that the Employer's failure was caused by any error or delay by the Contractor, including an error in, or delay in the submission of, any of the applicable Contractor's Documents, the Contractor shall not be entitled to such EOT. and/or Cost Plus Profit.

If, under the Contract, the Employer is required to give to the Contractor possession of any foundation, structure, plant or means of access in accordance with Contractor's Documents, the Contractor shall submit such Contractor's Documents to the Employer in the time and manner stated in the Employer's Requirements.

3.8 Assistance

The word "assist" and/or "assistance" with reference to the Sub-Clauses 3.8 [Assistance] and 4.15 [Access Route and Facilities] shall be interpreted as providing

procedural and documentary support, wherever applicable.

If requested by the Contractor, the Employer shall promptly provide reasonable assistance to the Contractor so as to allow the Contractor to obtain:

(a) any permits, permissions, licences or approvals required by the Laws of the Country (including information required to be submitted by the Contractor in order to obtain such permits, permissions, licences or approvals):
   (i) which the Contractor is required to obtain under Sub-Clause 1.12 [*Compliance with Laws*];
   (ii) for the delivery of Goods, including clearance through customs.

3.9 Employer's Personnel and Other Contractors

The Employer shall be responsible for ensuring that the Employer's Personnel and the Employer's other contractors (if any) on or near the Site:

(a) co-operate with the Contractor's efforts under Sub-Clause 4.6 [*Co-operation*]; and
(b) comply with the same obligations which the Contractor is required to comply with under sub-paragraphs (a) to (e) of Sub-Clause 4.8 [*Health and Safety Obligations*] and under Sub-Clause 4.18 [*Protection of the Environment*].

The Employer may remove (or cause to be removed) any person of the Employer's Personnel or of the Employer's other contractors (if any) who is found, based on reasonable evidence, to have engaged in corrupt, fraudulent, collusive or coercive practice.

3.10 Change in Financial Arrangements

The Contractor may request the Employer to provide reasonable evidence for financial arrangements, if the Contractor:

(a) becomes aware of a material change in the financial arrangements;
(b) receives an instruction to execute a Variation with a price greater than the percentage of the Contract Price specified in the Contract Data, or if the total of Variations accumulates beyond the percentage of the Contract Price specified in the Contract Data; or
(c) does not receive payment in accordance with Sub-Clause 14.7 [Payment],

The Employer shall refer the request to the Funding Agency for resolution. The Funding Agency shall provide necessary financial evidence within 28 days, demonstrating that financial arrangements have been made and are being maintained to enable the Employer to pay the remaining Contract Price (as estimated by the Employer).

3.11 Site Data and Items of Reference

The Employer shall have made available to the Contractor for information, before the Base Date, all relevant data in the Employer's possession on the topography of the Site and on sub-surface, hydrological, climatic and environmental conditions at the Site. The Employer shall promptly make available to the Contractor all such data which comes into the Employer's possession after the Base Date.

The original survey control points, lines and levels of reference (the "items of reference" in these Conditions) shall be specified in the Employer's Requirements.

The Employer shall have no responsibility for the accuracy, sufficiency or completeness of such data and/or items of reference, except as stated in Sub-Clause 5.1 [*General Design Obligations*].

3.12 Employer-Supplied Materials and Employer's Equipment

If Employer-Supplied Materials and/or Employer's Equipment are listed in the Employer's Requirements for the Contractor's use in the execution of the Works, the Employer shall make such materials and/or equipment available to the Contractor in accordance with the details, times, arrangements, rates and prices stated in the Employer's Requirements.

The Contractor shall be responsible for each item of Employer's Equipment whilst any of the Contractor's Personnel is operating it, driving it, directing it, using it, or in control of it.

4. The Contractor

4.1 Contractor's General Obligations

The Contractor shall execute the Works in accordance with the Contract. When completed, the Works (or Section or major item of Plant, if any) shall be fit for the

purpose(s) for which they are intended, as defined and described in the Employer's Requirements or, where no purpose(s) are so defined and described, fit for their ordinary purpose(s).

The Contractor shall provide the Plant (and spare parts, if any) and Contractor's Documents specified in the Employer's Requirements, and all Contractor's Personnel, Goods, consumables and other things and Services, whether of a temporary or permanent nature, required to fulfil the Contractor's obligations under the Contract.

The Works shall include any work which is necessary to satisfy the Employer's Requirements and Schedules, or is implied by the Contract, and all works which (although not mentioned in the Contract) are necessary for stability or for the completion, or safe and proper operation, of the Works.

The Contractor shall be responsible for the adequacy, stability and safety of all the Contractor's operations and activities, including design, planning, engineering, procurement, methods of construction and the overall execution of the Works. The Contractor shall, whenever required by the Employer, submit details of the arrangements and methods which the Contractor proposes to adopt for the execution of the Works. No significant alteration to these arrangements and methods shall be made without this alteration having been submitted to the Employer.

4.2 Performance Security

The Contractor shall obtain (at the Contractor's cost) a Performance Security to secure the Contractor's proper performance of the Contract, in the amount stated in the Contract Data. If no amount is stated in the Contract Data, this Sub-Clause shall not apply.

4.2.1 Contractor's obligations

The Contractor shall deliver the Performance Security to the Employer prior to signing the Contract Agreement as stated in the Sub-Clause 1.6 [*Contract Agreement*]. The Performance Security shall be issued by a Bank to which the Employer gives his/her consent and shall be in the form annexed to the Particular Conditions of Contract, or in another form agreed by the Employer (but such consent and/or agreement shall not relieve the Contractor from any obligation under this Sub-Clause).

The Contractor shall ensure that the Performance Security remains valid and enforceable until the issue of the Performance Certificate and the Contractor has complied with Sub-Clause 11.11 [*Clearance of Site*]. If the terms of the Performance Security specify an expiry date, and the Contractor has not become entitled to receive the Performance Certificate by the date 28 days before the expiry date, the Contractor shall extend the validity of the Performance Security until the issue of the Performance Certificate and the Contractor has complied with Sub-Clause 11.11 [*Clearance of Site*].

Whenever Variations and/or adjustments under Clause 13 [*Variations and Adjustments*] result in an accumulative increase or decrease of the Contract Price by more than twenty percent (20%) of the Contract Price stated in the Contract Agreement:

(a) in the case of such an increase at the Employer's request, the Contractor shall promptly increase the amount of the Performance Security by a percentage equal to the accumulative increase. If the Contractor incurs costs as a result of the Employer's request, Sub-Clause 13.3.1 [*Variation by Instruction*] shall apply as if the increase in the Contract Price resulting from Variations and/or adjustments had been instructed by the Employer; or

(b) in the case of such a decrease, subject to the Employer's prior consent the Contractor may decrease the amount of the Performance Security by a percentage equal to the accumulative decrease.

4.2.2 Claims under the Performance Security

The Employer shall not make a claim under the Performance Security, except for amounts to which the Employer is entitled under the Contract in the event of:

(a) failure by the Contractor to extend the validity of the Performance Security, as described in this Sub-Clause, in which event the Employer may claim the full amount (or, in the case of previous reduction(s), the full remaining amount) of the Performance Security;

(b) failure by the Contractor to pay the Employer an amount due, as agreed or determined under Sub-Clause 3.5 [*Agreement or Determination*] or

agreed or decided under Clause 21 [*Disputes and Arbitration*], within 42 days after the date of the agreement or determination or decision or arbitral award (as the case may be);

(c) failure by the Contractor to remedy a default stated in a Notice given under Sub-Clause 15.1 [*Notice to Correct*] within 42 days or other time (if any) stated in the Notice;

(d) circumstances which entitle the Employer to terminate the Contract under Sub-Clause 15.2 [*Termination for Contractor's Default*], irrespective of whether a Notice of termination has been given; or

(e) if under Sub-Clause 11.5 [*Remedying of Defective Work off Site*] the Contractor removes any defective or damaged Plant from the Site, failure by the Contractor to repair such Plant, return it to the Site, reinstall it and retest it by the date of expiry of the relevant duration stated in the Contractor's Notice (or other date agreed by the Employer).

The Funding Agency shall indemnify and hold the Contractor harmless against and from all damages, losses and expenses (including legal fees and expenses) resulting from a claim under the Performance Security to the extent that the Employer was not entitled to make the claim.

Any amount which is received by the Employer under the Performance Security shall be taken into account:

(i) in the final payment to the Contractor under Sub-Clause 14.13 [*Final Payment*]; or

(ii) if the Contract is terminated, in payment due to the Contractor under Sub-Clause 15.4 [*Payment after Termination for Contractor's Default*], Sub-Clause 15.7 [*Payment after Termination for Employer's Convenience*], Sub-Clause 16.4 [*Payment after Termination by Contractor*], Sub-Clause 18.5 [O*ptional Termination*], or Sub-Clause 18.6 [*Release from Performance under the Law*] (as the case may be).

4.2.3 Release of the Performance Security

The Employer shall release the Performance Security to the Contractor:

(a) within 21 days after the issue of the Performance Certificate and the Contractor has complied with Sub-Clause 11.11 [*Clearance of Site*]; or

(b) within 42 days after the date of termination if the Contract is terminated in accordance with Sub-Clause 15.5 [*Termination for Employer's*

Convenience], Sub-Clause 16.2 [*Termination by Contractor*], Sub-Clause 18.5 [*Optional Termination*] or Sub-Clause 18.6 [*Release from Performance under the Law*].

4.3 Contractor's Representative

The Contractor shall appoint the Contractor's Representative and shall give him/her all authority necessary to act on the Contractor's behalf under the Contract, except to replace the Contractor's Representative.

The Contractor's Representative shall be qualified, experienced and competent in the main engineering discipline applicable to the Works and fluent in the language for communications defined in Sub-Clause 1.4 [*Law and Language*].

Unless the Contractor's Representative is named in the Contract, the Contractor shall, before the Commencement Date, submit to the Employer for consent, the name and particulars of the person the Contractor proposes to appoint as Contractor's Representative. If consent is withheld or subsequently revoked, or if the appointed person fails to act as Contractor's Representative, the Contractor shall similarly submit the name and particulars of another suitable replacement for such appointment. If the Employer does not respond within 28 days after receiving this submission, by giving a Notice to the Contractor objecting to the proposed person or replacement, the Employer shall be deemed to have given the Employer's consent.

The Contractor shall not, without the Employer's prior consent, revoke the appointment of the Contractor's Representative or appoint a replacement (unless the Contractor's Representative is unable to act as a result of death, illness, disability or resignation without notice, in which case his/her appointment shall be deemed to have been revoked with immediate effect and the appointment of a replacement shall be treated as a temporary appointment until the Employer gives his/her consent to this replacement, or another replacement is appointed, under this Sub-Clause).

Unless otherwise agreed by the Employer, the whole time of the Contractor's Representative shall be given to directing the Contractor's performance of the Contract. The Contractor's Representative shall act for and on behalf of the Contractor at all times during the performance of the Contract, including issuing and receiving all Notices and other communications under Sub-Clause 1.3 [*Notices and Other Communications*] and for receiving instructions under Sub-Clause 3.4 [*Instructions*].

Unless otherwise agreed by the Employer, the Contractor's Representative shall be

based at the Site for the whole time that the Works are being executed at the Site. If the Contractor's Representative is to be temporarily absent from the Site during the execution of the Works, a suitable replacement shall be temporarily appointed, subject to the Employer's prior consent. The Contractor's Representative may delegate any powers, functions and authority except:

(a) the authority to issue and to receive Notices and other communications under Sub-Clause 1.3 *[Notices and Other Communications*]; and

(b) the authority to receive instructions under Sub-Clause 3.4 [*Instructions*]),

to any suitably competent and experienced person and may at any time revoke the delegation. Any delegation or revocation shall not take effect until the Employer has received a Notice from the Contractor's Representative, naming the person, specifying the powers, functions and authority being delegated or revoked, and stating the timing of the delegation or revocation.

All these persons shall be fluent in the language for communications defined in Sub-Clause 1.4 [*Law and Language*].

4.4 Subcontractors

The Contractor shall not subcontract:

(a) works with a total accumulated value greater than the percentage stated in the Contract Data of the Contract Price stated in the Contract Agreement (if no such percentage is stated, the whole of the Works); or

(b) any part of the Works for which subcontracting is not permitted as stated in the Contract Data.

The Contractor shall be responsible for the work of all Subcontractors, for managing and coordinating all the Subcontractors' works, and for the acts or defaults of any Subcontractor, any Subcontractor's agents or employees, as if they were the acts or defaults of the Contractor.

Where specified in the Contract Data, the Contractor shall give a Notice to the Employer not less than 28 days before:

(i) the intended appointment of a Subcontractor, with detailed particulars which shall include the Subcontractor's relevant experience,

(ii) the intended commencement of the Subcontractor's work, and

(iii) the intended commencement of the Subcontractor's work on the Site.

4.5 Nominated Subcontractors

In this Sub-Clause, "nominated Subcontractor" means a Subcontractor named as such in the Employer's Requirements or whom the Employer, under Sub-Clause 13.4 [*Provisional Sums*], instructs the Contractor to employ as a Subcontractor.

4.5.1. Objection to Nomination

The Contractor shall not be under any obligation to employ a nominated Subcontractor whom the Employer instructs and against whom the Contractor raises reasonable objection by giving a Notice to the Employer, with detailed supporting particulars, no later than 14 days after receiving the Employer's instruction. An objection shall be deemed reasonable if it arises from (among other things) any of the following matters, unless the Employer agrees to indemnify the Contractor against and from the consequences of the matter:

(a) there are reasons to believe that the nominated Subcontractor does not have sufficient competence, resources or financial strength;

(b) the subcontract does not specify that the nominated Subcontractor shall indemnify the Contractor against and from any negligence or misuse of Goods by the nominated Subcontractor, the nominated Subcontractor's agents and employees; or

(c) the subcontract does not specify that, for the subcontracted work (including design, if any), the nominated Subcontractor shall:

(i) undertake to the Contractor such obligations and liabilities as will enable the Contractor to discharge the Contractor's corresponding obligations and liabilities under the Contract; and

(ii) indemnify the Contractor against and from all obligations and liabilities arising under or in connection with the Contract and from the consequences of any failure by the Subcontractor to perform these obligations or to fulfil these liabilities.

4.5.2. Payments to nominated Subcontractors

The Contractor shall pay to the nominated Subcontractor the amounts due in accordance with the subcontract. These amounts plus other charges shall be included in the Contract Price in accordance with sub-paragraph (b) of Sub-Clause 13.4 [*Provisional Sums*], except as stated in Sub-Clause 4.5.3 [*Evidence of Payments*].

4.5.3. Evidence of Payments

Before making an interim payment under Sub-Clause 14.7 [*Interim Payment*] which includes an amount payable to a nominated Subcontractor, the Employer may request the Contractor to supply reasonable evidence that the nominated Subcontractor has received all amounts due in accordance with previous interim payments by the Employer, less applicable deductions for retention or otherwise. Unless the Contractor:

(a) submits this reasonable evidence, or

(b)

(i) satisfies the Employer in writing that the Contractor is reasonably entitled to withhold or refuse to pay these amounts, and

(ii) submits to the Employer reasonable evidence that the nominated Subcontractor has been notified of the Contractor's entitlement,

then the Employer may (at the Employer's sole discretion) pay, directly to the nominated Subcontractor, part or all of such amounts included in previous payments (less applicable deductions) as are due to the nominated Subcontractor and for which the Contractor has failed to submit the evidence described in sub-paragraphs (a) or (b) above.

Thereafter, the Employer shall give a Notice to the Contractor stating the amount paid directly to the nominated Subcontractor by the Employer and, in the next interim payment after this Notice, shall include this amount as a deduction under sub-paragraph (b) of Sub-Clause 14.6.1 [*Notice of Interim Payment*].

4.6 Co-operation

The Contractor shall, as specified in the Employer's Requirements or as instructed by the Employer, co-operate with and allow appropriate opportunities for carrying out work by:

(a) the Employer's Personnel;

(b) any other contractors employed by the Employer; and

(c) the personnel of any legally constituted public authorities and private utility companies,

who may be employed in the carrying out, on or near the Site, of any work not included in the Contract. Such appropriate opportunities may include the use of

the Contractor's Equipment, Temporary Works, access arrangements which are the responsibility of the Contractor, and/or other Contractor's facilities or Services on the Site.

The Contractor shall be responsible for the Contractor's construction activities on the Site, and shall use all reasonable endeavours to co-ordinate these activities with those of other contractors to the extent (if any) specified in the Employer's Requirements or as instructed by the Employer.

If in the opinion of the Employer, the Contractor suffers delay and/or incurs Cost as a result of an instruction under this Sub-Clause, to the extent (if any) that co-operation, allowance of opportunities and coordination was Unforeseeable having regard to that specified in the Employer's Requirements, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to EOT and/ or payment of such Cost Plus Profit.

4.7 Setting Out

The Contractor shall set out the Works in relation to the items of reference under Sub-Clause 3.11 [*Site Data and Items of Reference*].

The Contractor shall:

(a) verify the accuracy of all these items of reference before they are used for the Works;

(b) rectify any error in the items of reference, positions, levels, dimensions or alignment of the Works; and

(a) be responsible for the correct positioning of all parts of the Works.

4.8 Health and Safety Obligations

The Contractor shall:

(a) comply with all applicable health and safety regulations and Laws;

(b) comply with all applicable health and safety obligations specified in the Contract;

(c) comply with all directives issued by the Contractor's health and safety officer (appointed under Sub-Clause 6.7 [*Health and Safety of Personnel]*

(d) take care of the health and safety of all persons entitled to be on the Site and other places (if any) where the Works are being executed;

(e) keep the Site, Works (and the other places (if any) where the Works are being executed) clear of unnecessary obstruction so as to avoid danger to these persons;

(f) provide fencing, lighting, safe access, guarding and watching of:

(i) the Works, until the Works are taken over under Clause 10 [*Employer's Taking Over*]; and

(ii) any part of the Works where the Contractor is executing outstanding works or remedying any defects during the DLP; and

(iii) provide any Temporary Works (including roadways, footways, guards and fences) which may be necessary, because of the execution of the Works, for the use and protection of the public and of owners and occupiers of adjacent land and property.

Within 21 days of the Commencement Date and before commencing any construction on the Site, the Contractor shall submit to the Employer for information a health and safety manual which has been specifically prepared for the Works, the Site and other places (if any) where the Contractor intends to execute the Works. This manual shall be in addition to any other similar document required under applicable health and safety regulations and Laws.

The health and safety manual shall set out all the health and safety requirements:

(i) specified in the Employer's Requirements;

(ii) that comply with all the Contractor's health and safety obligations under the Contract; and

(iii) that are necessary to effect and maintain a healthy and safe working environment for all persons entitled to be on the Site and other places (if any) where the Works are being executed.

This manual shall be revised as necessary by the Contractor or the Contractor's health and safety officer, or at the reasonable request of the Employer. Each revision of the manual shall be submitted promptly to the Employer.

In addition to the reporting requirement of sub-paragraph (g) of Sub-Clause 4.20 *[Progress Reports*], the Contractor shall submit to the Employer details of any accident within 24 hours after its occurrence and, in the case of an accident causing serious injury or death, shall inform the Employer immediately.

The Contractor shall, as specified in the Employer's Requirements and as the Employer may reasonably require, maintain records and make reports (in compliance with the applicable health and safety regulations and Laws) concerning the health and safety of persons and any damage to property.

4.9 Quality Management and Compliance Verification Systems

4.9.1. Quality Management System

The Contractor shall prepare and implement a QM System to demonstrate compliance with the requirements of the Contract. The QM System shall be specifically prepared for the Works and submitted to the Employer within 28 days of the Commencement Date. The QM System shall also include a Quality Assurance Plan (QAP) to establish a quality control mechanism and the Contractor shall, within 28 days of the Commencement Date along with the QM system, submit to the Employer's Representative its Quality Assurance Plan which shall include the following:

(a) organisation chart, duties and responsibilities, procedures, inspections and documentation;

(b) quality control mechanism including sampling and testing of Materials, test frequencies, standards, acceptance criteria, testing facilities, reporting, recording and interpretation of test results, approvals, check list for site activities, and proforma for testing and calibration in accordance with the Employer's Requirements and Good Industry Practice; and

(c) internal quality audit system.

The Employer's Representative shall convey its comments to the Contractor within a period of 21 days of receipt of the QAP stating the modifications, if any, required, and the Contractor shall incorporate those in the QAP to the extent required for conforming with the provisions of this Sub-Clause. Thereafter, whenever the QM System is updated or revised, a copy shall promptly be submitted to the Employer. The QM System shall be in accordance with the details stated in the Employer's Requirements (if any) and shall include the Contractor's procedures:

(a) to ensure that all Notices and other communications under Sub-Clause 1.3 [*Notices and Other Communications*], Contractor's Documents, as-built records, O&M Manuals, and contemporary records can be traced, with full certainty, to the Works, Goods, Services, work, workmanship or test to which they relate;

(b) to ensure proper coordination and management of interfaces between the stages of execution of the Works, and between Subcontractors; and

(c) for the submission of Contractor's Documents to the Employer for Review.

The Contractor shall carry out internal audits of the QM System regularly, and at

least once every 6 months. The Contractor shall submit to the Employer a report listing the results of each internal audit within 7 days of completion. Each report shall include, where appropriate, the proposed measures to improve and/or rectify the QM System and/or its implementation.

If the Contractor is required by the Contractor's quality assurance certification to be subject to external audit, the Contractor shall immediately give a Notice to the Employer describing any failing(s) identified in any external audit. If the Contractor is a JV, this obligation shall apply to each member of the JV.

4.9.2. Compliance Verification System

The Contractor shall prepare and implement a Compliance Verification System to demonstrate that the design, Materials, Employer-Supplied Materials (if any), Plant, work and workmanship comply in all respects with the Contract.

The Compliance Verification System shall be in accordance with the details stated in the Employer's Requirements (if any) and shall include a method for reporting the results of all inspections and tests carried out by the Contractor. In the event that any inspection or test identifies a non-compliance with the Contract, Sub-Clause 7.5 [*Defects and Rejection*] shall apply.

4.9.3. General provision

Compliance with the QM System and/or Compliance Verification System shall not relieve the Contractor from any duty, obligation or responsibility under or in connection with the Contract.

4.10 Use of Site Data

The Contractor shall be responsible for verifying and interpreting all data made available by the Employer under Sub-Clause 3.11 [*Site Data and Items of Reference*].

4.11 Sufficiency of the Contract Price

The Contractor shall be deemed to have satisfied himself/herself as to the correctness and sufficiency of the Contract Price stated in the Contract Agreement.

Unless otherwise stated in the Contract, the Contract Price stated in the Contract Agreement shall be deemed to cover all the Contractor's obligations under the Contract and all things necessary for the proper execution of the Works in accordance with the Contract.

4.12 Unforeseeable Difficulties

Except as otherwise stated in the Particular Conditions of Contract:

(a) the Contractor shall be deemed to have obtained all necessary information as to risks, contingencies and other circumstances which may influence or affect the Works;

(b) by signing the Contract Agreement, the Contractor accepts total responsibility for having foreseen all difficulties and costs of successfully completing the Works; and

(c) the Contract Price shall not be adjusted to take account of any Unforeseeable or unforeseen difficulties or costs.

For the purposes of this Sub-Clause, Unforeseeable difficulties include man-made or natural physical conditions including sub-surface and hydrological conditions which the Contractor encounters at the Site during execution of the Works.

4.13 Rights of Way and Facilities

The Contractor shall bear all costs and charges for special and/or temporary rights of way which may be required for the purposes of the Works, including those for access to the Site.

The Contractor shall also obtain, at the Contractor's risk and cost, any additional facilities outside the Site which may be required for the purposes of the Works and the performance of its obligations under this Contract.

4.14 Avoidance of Interference

The Contractor shall not interfere unnecessarily or improperly with:

(a) the convenience of the public; or

(b) the access to and use and occupation of all roads and footpaths, irrespective of whether they are public or in the possession of the Employer or of others.

The Contractor shall indemnify and hold the Authority/ Employer harmless against and from all damages, losses and expenses (including legal fees and expenses) resulting from any such unnecessary or improper interference.

4.15 Access Route and Utilities

4.15.1 Access Route

The Contractor shall be deemed to have been satisfied, at the Base Date, as to the suitability and availability of the access routes to the Site. The Contractor shall take

all necessary measures to prevent any road or bridge from being damaged by the Contractor's traffic or by the Contractor's Personnel. These measures shall include the proper use of appropriate vehicles (conforming to legal load and width limits (if any) and any other restrictions) and routes.

Except as otherwise stated in these Conditions:

(a) the Contractor shall (as between the Parties) be responsible for repair of any damage caused to, and any maintenance which may be required for the Contractor's use of, access routes;

(b) the Contractor shall provide all necessary signs or directions along access routes, and shall obtain any permissions or permits which may be required from the relevant authorities, for the Contractor's use of routes, signs and directions;

(c) the Employer shall not be responsible for any third-party claims which may arise from the Contractor's use or otherwise of any access route;

(d) the Employer does not guarantee the suitability or availability of particular access routes; and

(e) all Costs due to non-suitability or non-availability, for the use required by the Contractor, of access routes shall be borne by the Contractor.

(f) in case for creating the access, any existing route/road has to be blocked causing any inconvenience to the user/public, the Contractor shall provide the alternate route/road in consultation with the local police/traffic authority. He/she shall also be responsible for adequate signage as well as traffic personnel at his/her cost.

To the extent that non-suitability or non-availability of an access route arises as a result of changes to that access route by the Employer or a third party after the Base Date and as a result the Contractor suffers delay and/or incurs Cost, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to EOT and/or payment of such Cost.

4.15.2 Utilities

The Contractor shall, in accordance with applicable Laws and with assistance of the Employer, cause shifting of any utility (including electric lines, water pipes and telephone cables) to an appropriate location, if such utility or obstruction adversely affects the execution of Works in accordance with this Contract. The actual cost of such shifting, as approved and communicated by the entity owning the utility, shall be paid by the Contractor and reimbursed by the Employer to the Contractor. In the

event of any delay in such shifting by the entity owning the utility beyond a period specified in the Contract Data, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to EOT and/or payment by the Employer of all costs arising from this delay.

In the event the construction of any Works is affected by a new utility or works undertaken in accordance with this Sub-Clause, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to EOT and/or such payment as determined by the Employer.

4.15.3 Felling of Trees

The Employer shall facilitate the Contractor in obtaining the Applicable Permits for felling of trees to be identified by the Employer for this purpose if and only if such trees cause a Material Adverse Effect on the execution of the Works. The cost of such felling and of the compensatory plantation of trees, if any, shall be borne by the Employer. In the event of any delay in felling thereof for reasons beyond the control of the Contractor; it shall be excused for failure to perform any of its obligations hereunder if such failure is a direct consequence of delay in the felling of trees. The Parties hereto agree that the felled trees shall be deemed to be owned by the Authority and shall be disposed in such manner and subject to such conditions as the Authority may in its sole discretion deem appropriate. If any felling of trees hereunder is in a forest area, the Applicable Permit thereof shall be procured by the Employer, facilitated by the Authority within the time specified in the Contract Data; and for any period of delay in providing the Applicable Permits, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to EOT and/or payment.

In the event the construction of any Works is affected by delay in felling of trees undertaken in accordance with this Sub-Clause, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to EOT and/or such payment as determined by the Employer.

4.16 Transport of Goods

The Contractor shall:

(a) give a Notice to the Employer not less than 21 days before the date on which any Plant, or a major item of other Goods (as specified in the Employer's Requirements), will be delivered to the Site;

(b) be responsible for packing, loading, transporting, receiving, unloading, storing

and protecting all Goods and other things required for the Works;

(c) be responsible for customs clearance, permits, fees and charges related to the import, transport and handling of all Goods, including all obligations necessary for their delivery to the Site; and

(d) indemnify and hold the Employer harmless against and from all damages, losses and expenses (including legal fees and expenses) resulting from the import, transport and handling of all Goods, and shall negotiate and pay all third-party claims arising from their import, transport and handling.

4.17 Contractor's Equipment

The Contractor shall be responsible for all Contractor's Equipment. When brought on to the Site, Contractor's Equipment shall be deemed to be exclusively intended for the execution of the Works. The Contractor shall not remove from the Site any major items of Contractor's Equipment without the Employer's consent. However, consent shall not be required for vehicles transporting Goods or Contractor's Personnel off Site.

In addition to any Notice given under Sub-Clause 4.16 [*Transport of Goods*], the Contractor shall give a Notice to the Employer of the date on which any major item of Contractor's Equipment has been delivered to the Site. This Notice shall be given within 7 days of the delivery date, shall identify whether the item of Contractor's Equipment is owned by the Contractor or a Subcontractor or another person and, if rented or leased, shall identify the rental or leasing entity.

4.18 Protection of the Environment

The Contractor shall take all necessary measures to:

(a) protect the environment (both on and off the Site);

(b) comply with the environmental impact statement for the Works (if any); and

(c) limit damage and nuisance to people and property resulting from pollution, noise and other results of the Contractor's operations and/ or activities.

The Contractor shall ensure that emissions, surface discharges, effluent and any other pollutants from the Contractor's activities shall exceed neither the values indicated in the Employer's Requirements, nor those prescribed by applicable Laws.

The Contractor shall within 28 days of the Commencement Date, submit to the Employer's Representative, its Environment Management System including Environment Management Plan, which shall include the following:

(a) organisation, duties and responsibilities, procedures, inspections and documentation;

(b) quality control mechanism including sampling and testing of Materials, test frequencies, standards, acceptance criteria, testing facilities, reporting, recording and interpretation of test results, approvals, check list for site activities, and proforma for testing and calibration in accordance with the Employer's Requirements and Good Industry Practice; and

(c) internal environmental quality audit system.

4.19 Temporary Utilities

The Contractor shall, except as stated below, be responsible for the provision of all temporary utilities, including electricity, gas, telecommunications, water and any other services the Contractor may require for the execution of the Works.

The following provisions of this Sub-Clause shall only apply if, as stated in the Employer's Requirements, the Employer is to provide utilities for the Contractor's use. The Contractor shall be entitled to use, for the purposes of the Works, the utilities on the Site for which details and prices are given in the Employer's Requirements. The Contractor shall, at the Contractor's risk and cost, provide any apparatus necessary for the Contractor's use of these services and for measuring the quantities consumed. The apparatus provided for measuring quantities consumed shall be subject to the Employer's consent. The quantities consumed (if any) during each period of payment stated in the Contract Data (if not stated, each month) shall be measured by the Contractor, and the amount to be paid by the Contractor for such quantities (at the prices stated in the Employer's Requirements) shall be included in the relevant Statement.

4.20 Progress Reports

Monthly progress reports, in the format stated in the Employer's Requirements (if not stated, in a format acceptable to the Employer) shall be prepared by the Contractor and submitted to the Employer. Each progress report shall be submitted in one paper-original, one electronic copy and additional paper copies (if any) as stated in the Contract Data. The first report shall cover the period up to the end of the first month following the Commencement Date. Reports shall be submitted monthly thereafter, each within 7 days after the last day of the month to which it relates.

Reporting shall continue until the Date of Completion of the Works or, if outstanding

work is listed in the Provisional Completion Certificate, the date on which such outstanding work is completed. Unless otherwise stated in the Employer's Requirements, each progress report shall include:

(a) charts, diagrams and detailed descriptions of progress, including each stage of design, Contractor's Documents, procurement, manufacture, delivery to Site, construction, erection, testing, commissioning and trial operation;

(b) photographs and/or video recordings showing the status of manufacture and of progress on and off the Site;

(c) for the manufacture of each main item of Plant and Materials, the name of the manufacturer, manufacture location, percentage progress, and the actual or expected dates of:

(i) commencement of manufacture,

(ii) Contractor's inspections,

(iii) tests, and

(iv) shipment and arrival at the Site;

(d) the details described in Sub-Clause 6.10 [*Contractor's Records*];

(e) copies of quality management documents, inspection reports, test results, and compliance verification documentation (including certificates of Materials);

(f) a list of Variations, and any Notices given (by either Party) under Sub-Clause 20.2.1 [*Notice of Claim*];

(g) Health, safety and environmental statistics, including details of any hazardous incidents and activities relating to environmental aspects and public relations;

(h) comparisons of actual and planned progress, with details of any events or circumstances which may adversely affect the completion of the Works in accordance with the Programme and the Time for Completion, and the measures being (or to be) adopted to overcome delays; and

In case provided for in the Employer's Requirements, the contractor shall provide a Weekly Progress Report (WPR) in the format provided for. In addition, the Contractor is also required to provide a Daily Progress Report (DyPR) indicating the photographs of any major events.

However, nothing stated in any progress report shall constitute a Notice under a Sub-Clause of these Conditions.

4.21 Security of the Site

The Contractor shall be responsible for the security of the Site, and:

(a) for keeping unauthorised persons off the Site; and

(b) authorised persons shall be limited to the Contractor's Personnel, the Authority's Personnel, the Employer's Personnel, and to any other personnel identified as authorised personnel (including the Employer's other contractors on the Site), by a Notice from the Employer to the Contractor.

The Contractor shall maintain a round-the-clock vigil over the Site and shall ensure and procure that no encroachment thereon takes place. During the Construction Period, the Contractor shall protect the Site from any and all occupations, encroachments or Encumbrances.

In the event of any encroachment or occupation on any part of the Site, the Contractor shall report such encroachment or occupation forthwith to the Employer and undertake its removal at its own cost and expenses.

4.22 Contractor's Operations and House - Keeping on Site

The Contractor shall confine the Contractor's operations to the Site, and to any additional areas which may be obtained by the Contractor and acknowledged by the Employer as working areas. The Contractor shall take all necessary precautions to keep Contractor's Equipment and Contractor's Personnel within the Site and these additional areas, and to keep them off adjacent land.

At all times, the Contractor shall keep the Site free from all unnecessary obstruction, and shall properly store or remove from the Site any Contractor's Equipment (subject to Sub-Clause 4.17 [*Contractor's Equipment*]) and/or surplus materials. The Contractor shall promptly clear away and remove from the Site any wreckage, rubbish, hazardous waste and Temporary Works which are no longer required.

The Contractor shall keep the Site neat and clean through employing requisite house-keeping staff. The Contractor shall also submit a house - keeping plan with appropriate timelines and outcome as specified in Particular Conditions of Contract.

Promptly after the issue of a Completion Certificate, the Contractor shall clear away and remove, from that part of the Site and Works to which the Completion Certificate refers, all Contractor's Equipment, surplus material, wreckage, rubbish, hazardous waste and Temporary Works. The Contractor shall leave that part of the Site and the Works in a clean and safe condition. However, the Contractor may retain at locations on the Site agreed with the Employer, during the DLP, such Goods as are required for the Contractor to fulfil obligations under the Contract.

4.23 Archaeological and Geological Findings

All fossils, coins, articles of value or antiquity, and structures and other remains or items of geological or archaeological interest found on the Site shall be placed under the care and authority of the Authority. The Contractor shall take all reasonable precautions to prevent Contractor's Personnel or other persons from removing or damaging any of these findings.

The Contractor shall, as soon as practicable after discovery of any such finding, promptly give a Notice to the Employer. The Employer shall in turn keep the Authority informed of the finding to give both the Authority and the Employer opportunity to jointly inspect and/or investigate the finding before it is disturbed. This Notice shall describe the finding, and the Employer shall issue instructions for dealing with it in consultation with the Authority/Government Instrumentality.

If the Contractor suffers delay and/or incurs Cost from complying with the Employer's instructions, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to EOT and/or payment of such Cost.

4.24 Milestones

If no Milestones are specified in the Contract Data, this Sub-Clause shall not apply.

If certain parts of the Works are to be completed within certain times but the Employer shall not take over such parts when completed (as distinct from the parts of the Works which the Employer shall take over after completion and defined as Sections in the Contract Data) such parts of Works shall be clearly described in the Employer's Requirements as 'Milestones'.

The Contractor shall complete the works of each Milestone (including all work which is stated in the Employer's Requirements as being required for the Milestone to be considered complete) within the time for completion of the Milestone, as stated in the Contract Data, calculated from the Commencement Date. The Contractor shall include, in the initial programme and each revised programme, under sub-paragraph (a) of Sub-Clause 8.3 [*Programme*], the time for completion for each Milestone. Sub-paragraph (d) of Sub-Clause 8.4 [*Advance Warning*] and Sub-Clause 8.5 [*Extension of the Time for Completion*] shall apply to each Milestone, such that "Time for Completion" under Sub-Clause 8.5 shall be read as the time for completion of a Milestone under this Sub-Clause.

The Contractor may apply, by Notice to the Employer's Representative, for a Milestone Certificate not earlier than 14 days before the works of a Milestone will, in the Contractor's opinion, be complete. The Employer's Representative shall, within 28 days after receiving the Contractor's Notice:

(a) issue the Milestone Certificate to the Contractor, stating the date on which the works of the Milestone were completed in accordance with the Contract, except for any minor outstanding work and defects (as shall be listed in the Milestone Certificate); or

(b) reject the application, giving reasons and specifying the work required to be done and defects required to be remedied by the Contractor to enable the Milestone Certificate to be issued.

The Contractor shall then complete the work referred to in sub-paragraph (b) of this Sub-Clause before issuing a further Notice of application under this Sub-Clause. If the Employer's Representative fails either to issue the Milestone Certificate or to reject the Contractor's application within the above period of 28 days, and if the works of a Milestone are complete in accordance with the Contract, the Milestone Certificate shall be deemed to have been issued on the date which is 14 days after the date stated in the Contractor's Notice of application.

If Liquidated Delay Damages for a Milestone are stated in the Contract Data, and if the Contractor fails to complete the works of the Milestone within the time for completion of the Milestone (with any extension under this Sub-Clause):

(i) the Contractor shall, subject to Sub-Clause 20.1 [*Claims*], pay Liquidated Delay Damages to the Employer for this default;

(ii) such Liquidated Delay Damages shall be the amount stated in the Contract Data, for every day which shall elapse between the time for completion for the Milestone (with any extension under this Sub-Clause) and the date stated in the Milestone Certificate;

(iii) these Liquidated Delay Damages shall be the only damages due from the Contractor for such default;

(iv) the Liquidated Delay Damages thus received by the Employer may be reimbursed to the Contractor in case where the Contractor is able to achieve the delayed Milestone along with the subsequent Milestone on time; and

(v) the total amount of Liquidated Delay Damages for all Milestones shall not exceed the maximum amount stated in the Contract Data (this shall not limit the Contractor's liability for Liquidated Delay Damages in any case of fraud, gross negligence, deliberate default or reckless misconduct by the Contractor).

5. Design

5.1. General Design Obligations

The Contractor shall be deemed to have scrutinised, prior to the Base Date, the Employer's Requirements (including design criteria and calculations, if any).

The Contractor shall carry out, and be responsible for, the design of the Works and for the accuracy of such Employer's Requirements (including design criteria and calculations), except as stated in this Sub-Clause below.

Design shall be prepared by the Contractor's Design unit/Design consultants appointed by the Contractor. The qualifications and experience shall be as prescribed in the Employer's Requirements. The Design unit shall:

(a) be led by the "Team Leader (Design)" who shall be responsible for surveys, investigations, collection of data, and preparation of preliminary and detailed designs;

(b) comprise of engineers or other professionals, qualified, experienced and competent in the disciplines of the design in their respective specialisation or occupations;

(c) comply with the criteria (if any) stated in the Employer's Requirements; and

(d) be qualified and entitled under applicable Laws to design the Works.

The Contractor shall appoint a proof check consultant (the "Proof Consultant"), as per the requirements specified in the Employer's Requirements, after proposing a panel of 3 (three) names of qualified and experienced firms to the Employer, from whom the Authority may choose the Proof Consultant.

The Proof Consultant shall:

(a) evolve a systems approach with the Team Leader (Design) so as to minimise the time required for final designs and construction drawings; and

(b) proof check the detailed calculations, drawings and designs, which have been approved by the Team Leader (Design).

The Employer shall review the proof checked documents mentioned in (b) above and

with their observation submit to the Authority's Engineer for recommendation and subsequently the Employer shall follow the procedure as mentioned in sub-clause 5.2.2 [*Review by Employer*].

The Employer, in case desired so in the Employer's Requirements shall appoint a third-party consultant for reviewing the design. The name of the third-party consultant/ institution shall be maintained in the Employer's Requirements.

The cost of design proof checking and third-party review shall be borne by the Contractor.

The Contractor shall appoint the "Safety Consultant" (if mentioned in the Employer's Requirements) who shall submit a Safety Audit Plan in respect of all design details that have a bearing on safety.

The Employer shall not be responsible for any error, inaccuracy or omission of any kind in the Employer's Requirements as originally included in the Contract and shall not be deemed to have given any representation of accuracy or completeness of any data or information, except as stated in this Sub-Clause below. Any data or information received by the Contractor, from the Employer or otherwise, shall not relieve the Contractor from the Contractor's responsibility for the execution of the Works.

However, the Employer shall be responsible for the correctness of the following portions of the Employer's Requirements and of the following data and information provided by (or on behalf of) the Employer:

(a) portions, data and information which are stated in the Contract as being immutable or the responsibility of the Employer,
(b) definitions of intended purposes of the Works or any parts thereof,
(c) criteria for the testing and performance of the completed Works, and
(d) portions, data and information which cannot be verified by the Contractor, except as otherwise stated in the Contract.

5.2. Contractor's Documents

The Contractor's Documents shall comprise of those documents:

(a) specified in the Employer's Requirements (if any);
(b) required to satisfy all permits, permissions, licences and other regulatory approvals which are the Contractor's responsibility under Sub-Clause 1.12 [*Compliance with Laws*]; and
(c) described in Sub-Clause 5.6 [*As-Built Records*] and/or Sub-Clause 5.7

[*Operation and Maintenance Manuals*], where applicable.

5.2.1. Preparation by Contractor

Unless otherwise stated in the Employer's Requirements, the Contractor's Documents shall be written in the language for communications defined in Sub-Clause 1.4 [*Law and Language*].

The Contractor shall prepare all Contractor's Documents, and any other documents necessary to complete and implement the design during execution of the Works and to instruct the Contractor's Personnel.

5.2.2. Review by Employer

In this Sub-Clause 5.2.2: -

- "Review Period" means the period not exceeding 21 days, or as otherwise stated in the Employer's Requirements, calculated from the date on which the Employer receives a Contractor's Document and a Contractor's Notice;
- "Contractor's Document" excludes any of the Contractor's Documents which is not specified in the Employer's Requirements or these Conditions as being required to be submitted for Review, but includes all documents on which a specified Contractor's Document relies for completeness; and
- "Contractor's Notice" means the Notice which shall state that the relevant Contractor's Document is considered by the Contractor to be ready for Review under this Sub-Clause 5.2.2 and for use, and that it complies with the Employer's Requirements and these Conditions, or the extent to which it does not do so.

If the Employer's Requirements or these Conditions specify that a Contractor's Document is to be submitted to the Employer for Review, it shall be submitted accordingly, together with a Contractor's Notice. By submitting the Documents for review to the Employer's Representative, the Contractor shall be deemed to have represented that it has determined and verified that the design and engineering, including field construction criteria related thereto, are in conformity with the Employer's Requirements, applicable Laws and Good Industry Practice.

The Employer shall, within the Review Period, give a Notice to the Contractor:

(a) of No-objection (which may include comments concerning minor matters which will not substantially affect the Works); or

(b) that the Contractor's Document fails (to the extent stated) to comply with the Employer's Requirements and/or the Contract, with reasons.

If the Employer gives no Notice within the Review Period, the Employer shall be deemed to have given a Notice of No-objection to the Contractor's Document (provided that all other Contractor's Documents on which that Contractor's Document relies (if any) have been given, or are deemed to have been given, a Notice of No-objection).

If the Employer instructs that further Contractor's Documents are reasonably required to demonstrate that the Contractor's design complies with the Contract, the Contractor shall prepare and submit them promptly to the Employer at the Contractor's cost.

If the Employer gives a Notice under sub-paragraph (b) above, the Contractor shall:

(i) revise the Contractor's Document;

(ii) resubmit it to the Employer for Review in accordance with this Sub-Clause 5.2.2, and the Review Period shall be calculated from the date that the Employer receives it; and

(iii) not be entitled to EOT for any delay caused by any such revision and resubmission and/or by subsequent Review by the Employer.

5.2.3. Construction

Except for Contractor's Documents under Sub-Clause 5.6 [*As-Built Records*] and Sub-Clause 5.7 [*Operation and Maintenance Manuals*], for each part of the Works requiring Contractor's Documents to be submitted for Review:

(a) construction of such part shall not commence until a Notice of No-objection is given (or is deemed to have been given) by the Employer for all the Contractor's Documents which are relevant to its design and execution;

(b) construction of such part shall be in accordance with these Contractor's Documents; and

(c) the Contractor may modify any design or Contractor's Documents which have previously been submitted for Review, by giving a Notice to the Employer with reasons. If the Contractor has commenced construction of the part of the Works to which change of such design or Contractor's Documents are relevant:

(i) work on this part shall be suspended;

(ii) the provisions of Sub-Clause 5.2.2 [*Review by Employer*] shall apply as if the Employer had given a Notice in respect of the Contractor's Documents under sub-paragraph (b) of Sub-Clause 5.2.2; and

(iii) work on this part shall not resume until a Notice of No-objection is given (or is deemed to have been given) by the Employer for the revised documents.

5.3. Contractor's Undertaking

The Contractor undertakes that the design, the Contractor's Documents, the execution of the Works and the completed Works will be in accordance with:

(a) the Laws of the Country; and

(b) the documents forming the Contract, as altered or modified by Variations.

5.4. Technical Standards and Regulations

The Contractor's Documents, the execution of the Works and the completed Works (including defects remedied by the Contractor) shall comply with the Country's technical standards, construction and environmental Laws, Laws applicable to the product being produced from the Works, and other standards specified in the Employer's Requirements, applicable to the Works, or defined by applicable Laws.

All these technical or other standards and Laws shall, in respect of the Works, and each Section, be those in force when the Works or Section are taken over under Clause 10 [*Employer's Taking Over*].

References in the Contract to published standards shall be understood to be references to the edition applicable on the Base Date, unless stated otherwise. If changed or new applicable standards come into force in the Country after the Base Date, the Contractor shall promptly give a Notice to the Employer and (if appropriate or requested by the Employer) submit proposals for compliance. To the extent that:

(a) the Employer considers that compliance is required and such compliance requires change(s) to the execution of the Works; and

(b) the Contractor's proposals for compliance constitute a Variation;

then the Employer shall initiate a Variation in accordance with Clause 13 [*Variations and Adjustments*].

5.5. Training

If no training of employees of the Authority/Employer (and/or other identified personnel) by the Contractor is specified in the Employer's Requirements, this Sub-Clause shall not apply.

The Contractor shall carry out training of employees of the Authority/ Employer (and/or other personnel identified in the Employer's Requirements) in the operation and maintenance of the Works, and any other aspect of the Works, to the extent specified in the Employer's Requirements.

If the Employer's Requirements specify training which is to be carried out before taking-over, the Works shall not be considered to be completed for the purposes of taking-over under Sub-Clause 10.1 [*Taking Over the Works and Sections*] until this training has been completed in accordance with the Employer's Requirements.

The timing of the training shall be as stated in the Employer's Requirements (if not stated, as acceptable to the Employer). The Contractor shall provide qualified and experienced training staff, training facilities and all training materials as necessary and/or as stated in the Employer's Requirements.

5.6. As-Built Records

If no as-built records to be prepared by the Contractor are specified in the Employer's Requirements, this Sub-Clause shall not apply.

The Contractor shall prepare, and keep up-to-date, a complete set of "as-built" records of the execution of the Works, showing the exact as-built locations, sizes and details of the work as executed by the Contractor. The format, referencing system, system of electronic storage and other relevant details of the as-built records shall be as stated in the Employer's Requirements (if not stated, as acceptable to the Employer). These records shall be kept on the Site and shall be used exclusively for the purposes of this Sub-Clause.

The Contractor shall submit to the Employer under Sub-Clause 5.2.2 [*Review by Employer*]:

(a) the as-built records for the Works or Section (as the case may be) before the commencement of the Tests on Completion; and

(b) updated as-built records to the extent that any work is executed by the Contractor:

  (i) during and/or after the Tests on Completion, before the issue of any Completion Certificate under Sub-Clause 10.1 [*Taking Over the Works and Sections*]; and

  (ii) after taking over under Sub-Clause 10.1 [*Taking Over the Works and Sections*], before the issue of the Performance Certificate.

The number of copies of as-built records to be submitted by the Contractor under this

Sub-Clause shall be as required under Sub-Clause 1.8 [*Care and Supply of Documents*].

5.7. Operation and Maintenance Manuals

If no operation and maintenance manuals to be prepared by the Contractor are specified in the Employer's Requirements, this Sub-Clause shall not apply.

The Contractor shall prepare, and keep up-to-date, a complete set of operation and maintenance manuals for the Works (the "O&M Manuals" in these Conditions). The format and other relevant details of the O&M Manuals shall be as stated in the Employer's Requirements and, in any case, these manuals shall:

(a) be in sufficient detail for the Employer to:
    (i) operate, maintain and adjust the Works to ensure that the performance of the Works, Section and/or Plant (as the case may be) continues to comply with the performance criteria specified in the Employer's Requirements and the Schedule of Performance Guarantees; and
    (ii) operate, maintain, dismantle, reassemble, adjust and repair the Plant; and
(b) include an inventory of spare parts required for the Employer's future operation and maintenance of the Plant.

Before commencement of the Tests on Completion, the Contractor shall submit provisional O&M Manuals for the Works or Section (as the case may be) to the Employer under Sub-Clause 5.2.2 [*Review by Employer*].

If during the Tests on Completion any error or defect is found in the provisional O&M Manuals, the Contractor shall promptly rectify the error or defect at the Contractor's risk and cost.

Before the issue of any Completion Certificate under Sub-Clause 10.1 [*Taking Over the Works and Sections*], the final O&M Manuals shall be submitted to the Employer under Sub-Clause 5.2.2 [*Review by Employer*].

5.8. Design Error

If errors, omissions, ambiguities, inconsistencies, inadequacies or other defects are found in the Contractor's design and/or the Contractor's Documents, they and the Works shall be corrected in accordance with Sub-Clause 7.5 [*Defects and Rejection*].

If such Contractor's Documents were previously the subject of a Notice of No-objection given (or deemed to be given) by the Employer under Sub-Clause 5.2.2 [*Review by Employer*], the provisions of Sub-Clause 5.2.2 shall apply as if the

Employer had given a Notice in respect of the Contractor's Documents under sub-paragraph (b) of Sub-Clause 5.2.2.

All corrections and resubmissions under this Sub-Clause shall be at the Contractor's risk and cost.

6. Staff and Labour

6.1 Engagement of Staff and Labour

Except as otherwise stated in the Employer's Requirements, the Contractor shall make arrangements for the engagement of all Contractor's Personnel, and for their payment, accommodation, transport and welfare.

6.2 Rates of Wages and Conditions of Labour

The Contractor shall pay fair wages, and observe conditions of labour, which comply with all applicable Laws and are not lower than those established for the trade or industry where the work is carried out.

The Contractor shall comply with all the provisions of the Minimum Wages Act, 1948, and Contract Labour (Regulation and Abolition) Act, 1970, amended from time to time and rules framed there under and other labour laws applicable to contract labour that may be brought into force from time to time.

If no established rates or conditions are applicable, the Contractor shall pay rates of wages and observe conditions which are not lower than the general level of wages and conditions observed locally by employers whose trade or industry is similar to that of the Contractor.

6.3 Recruitment of Persons

The Contractor shall not recruit, or attempt to recruit, staff and labour from amongst the Personnel of the Authority, the Authority's Engineer and/or the Employer.

The Employer shall not recruit, or attempt to recruit, staff and labour from amongst the Contractor's Personnel.

6.4 Labour Laws

The Contractor shall comply with all the relevant labour Laws, applicable to the Contractor's Personnel, including Laws relating to their employment (including wages and working hours), health, safety, welfare, immigration and emigration, and shall allow them all their legal rights, as stated in the Contract Data.

The Contractor shall require the Contractor's Personnel to obey all applicable Laws, including those concerning health and safety at work. Any failure to fulfil these requirements shall attract the penal provisions of this contract arising out of the resultant non-execution of the work.

6.5 Working Hours

No work shall be carried out on the Site on locally recognised days of rest, or outside the normal working hours stated in the Contract Data unless:

(a) otherwise stated in the Contract;

(b) the Employer gives consent; or

(c) the work is unavoidable or necessary for the protection of life or property or for the safety of the Works, in which case the Contractor shall immediately give a Notice to the Employer with reasons and describing the work required.

6.6 Facilities for Staff and Labour

Except as otherwise stated in the Employer's Requirements, the Contractor shall provide and maintain all necessary accommodation and welfare facilities for the Contractor's Personnel.

If such accommodation and facilities are to be located on the Site, except where the Employer has given the Contractor prior permission, they shall be located within the areas identified in the Employer's Requirements. If any such accommodation or facilities are found elsewhere within the Site, the Contractor shall immediately remove them at the Contractor's risk and cost. The Contractor shall also provide facilities for the Employer's Personnel as stated in the Employer's Requirements.

6.7 Health and Safety of Personnel

In addition to the requirements of Sub-Clause 4.8 [*Health and Safety Obligations*], the Contractor shall at all times take all necessary precautions to maintain the health and safety of the Contractor's Personnel. In collaboration with local health authorities, the Contractor shall ensure that:

(a) medical staff, first aid facilities, sick bay, ambulance services and any other medical services stated in the Employer's Requirements are available at all times at the Site and at any accommodation for Contractor's and Employer's Personnel; and

(b) suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of epidemics and pandemic.

The Contractor shall appoint a health and safety officer at the Site, responsible for maintaining health, safety and protection against accidents. This officer shall:

(i) be qualified, experienced and competent for this responsibility; and

(ii) have the authority to issue directives for the purpose of maintaining the health and safety of all personnel authorised to enter and/or work on the Site and to take protective measures to prevent accidents.

Throughout the execution of the Works, the Contractor shall provide whatever is required by this person to exercise this responsibility and authority.

6.8 Contractor's Superintendence

From the Commencement Date until the issue of the Performance Certificate, the Contractor shall provide all necessary superintendence to plan, arrange, direct, manage, inspect, test and monitor the execution of the Works.

Superintendence shall be given by a sufficient number of persons:

(a) who are fluent in or have adequate knowledge of the language for communications (defined in Sub-Clause 1.4 [*Law and Language*] and

(b) who have adequate knowledge of the operations to be carried out (including the methods and techniques required, the hazards likely to be encountered and methods of preventing accidents), for the satisfactory and safe execution of the Works.

6.9 Contractor's Personnel

The Contractor's Personnel (including Key Personnel, if any) shall be appropriately qualified, skilled, experienced and competent in their respective trades or occupations.

The Employer may require the Contractor to remove (or cause to be removed) any person employed on the Site or Works, including the Contractor's Representative and Key Personnel (if any), who:

(a) persists in any misconduct or lack of care;

(b) carries out duties incompetently or negligently;

(c) fails to comply with any provision of the Contract;

(d) persists in any conduct which is prejudicial to safety, health, or the protection of the environment;

(e) is found, based on reasonable evidence, to have engaged in corrupt, fraudulent, collusive or coercive practice; or

(f) has been recruited from the Personnel in breach of Sub-Clause 6.3 [*Recruitment of Persons*].

If appropriate, the Contractor shall then promptly appoint (or cause to be appointed) a suitable replacement. In the case of the replacement of the Contractor's Representative, Sub-Clause 4.3 [*Contractor's Representative*] shall apply. In the case of the replacement of Key Personnel (if any), Sub-Clause 6.12 [*Key Personnel*] shall apply.

6.10 Contractor's Records

Unless otherwise proposed by the Contractor and agreed by the Employer, in each progress report under Sub-Clause 4.20 [*Progress Reports*], the Contractor shall include records of:

(a) occupations and actual working hours of each class of Contractor's Personnel;
(b) the type and actual working hours of each of the Contractor's Equipment;
(c) the types of Temporary Works used;
(d) the types of Plant installed in the Permanent Works; and
(e) the quantities and types of Materials used

for each work activity shown in the Programme, at each work location and for each day of work.

6.11 Disorderly Conduct

The Contractor shall at all times take all necessary precautions to prevent any unlawful, riotous or disorderly conduct by or amongst the Contractor's Personnel, and to preserve peace and protection of persons and property on and near the Site.

6.12 Key Personnel

If no Key Personnel are specified in the Employer's Requirements this Sub-Clause shall not apply.

The Contractor shall appoint the natural persons named in the Tender to the positions of Key Personnel. If not so named, or if an appointed person fails to act in the relevant position of Key Personnel, the Contractor shall submit to the Employer for consent the name and particulars of another person the Contractor proposes to appoint to such position. If consent is withheld or subsequently revoked, the Contractor shall similarly submit the name and particulars of a suitable replacement for such position. If the Employer does not respond within 14 days after receiving any such submission, by giving a Notice stating an objection to the appointment of such person (or

replacement) with reasons, the Employer shall be deemed to have given the Employer's consent.

The Contractor shall not, without the Employer's prior consent, revoke the appointment of any of the Key Personnel or appoint a replacement (unless the person is unable to act as a result of death, illness, disability or resignation without notice, in which case the appointment shall be deemed to have been revoked with immediate effect and the appointment of a replacement shall be treated as a temporary appointment until the Employer gives his/her consent to this replacement, or another replacement is appointed, under this Sub-Clause).

All Key Personnel shall be based at the Site (or, where Works are being executed off the Site, at the location of the Works) for the whole time that the Works are being executed. If any of the Key Personnel is to be temporarily absent during execution of the Works, a suitable replacement shall be temporarily appointed, subject to the Employer's prior consent.

All Key Personnel shall be fluent in the language for communications defined in Sub-Clause 1.4 [*Law and Language*].

7. Plants, Materials and Workmanship

7.1 Method of Execution

The Contractor shall carry out the manufacture, supply, installation, testing and commissioning and/or repair of Plant, the production, manufacture, supply and testing of Materials, and all other operations and activities during the execution of the Works:

(a) in the method (if any) specified in the Contract;
(b) as per the manufacturer's guidelines wherever required;
(c) in a proper workmanlike and careful manner in accordance with recognised Good Industry Practice; and
(d) with properly equipped facilities and non-hazardous Materials, except as otherwise specified in the Contract.

7.2 Samples

The Contractor shall submit the following samples of Materials, and relevant information, to the Employer for consent prior to using the Materials in or for the Works:

(a) samples of Materials specified in the Contract as per the Quality Assurance Plan, at the Contractor's cost; and

(b) additional samples instructed by the Employer as a Variation.

Each sample shall be labelled as to origin and intended use in the Works.

7.3 Inspection

The Authority's Engineer/ Employer's Personnel shall, during all the normal working hours stated in the Contract Data and at all other reasonable times:

(a) have full access to all parts of the Site and to all places from which natural Materials are being obtained;

(b) during production, manufacture and construction (at the Site and, to the extent specified in the Employer's Requirements, elsewhere), be entitled to:

  (i) examine, inspect, measure and test (to the extent stated in the Employer's Requirements) the Materials, Plant and workmanship,

  (ii) check the progress of manufacture of Plant and production and manufacture of Materials, and

  (iii) make records (including photographs and/or video recordings); and

(c) carry out other duties and inspections, as specified in these Conditions and the Employer's Requirements.

The Contractor shall give the Authority's Engineer/ Employer's Personnel full opportunity to carry out these activities, including providing safe access, facilities, permissions and safety equipment.

In respect of the work which the Authority's Engineer/ Employer's Personnel are entitled to examine, inspect, measure and/or test, the Contractor shall give a Notice to the Employer whenever any Materials, Plant or work is ready for inspection, and before it is to be covered up, put out of sight, or packaged for storage or transport. The Authority's Engineer/ Employer's Personnel shall then either carry out the examination, inspection, measurement or testing without unreasonable delay, or the Employer shall promptly give a Notice to the Contractor that the Authority's Engineer/ Employer's Personnel do not require to do so. If the Employer gives no such Notice and/or the Employer's Personnel/Authority's Engineer do not attend at the time stated in the Contractor's Notice (or such time as may be agreed with the Contractor), the Contractor may proceed with covering up, putting out of sight or packaging for storage or transport.

If the Contractor fails to give a Notice in accordance with this Sub-Clause, the Contractor shall, if and when required by the Employer, uncover the work and thereafter reinstate and make good, all at the Contractor's risk and cost.

7.4 Testing by the Contractor

This Sub-Clause shall apply to all tests specified in the Contract, except as otherwise stated under Sub-Clause 12 [*Tests after Completion*].

The Contractor shall provide all apparatus, assistance, documents and other information, temporary supplies of electricity and water, equipment, fuel, consumables, instruments, labour, materials, and suitably qualified, experienced and competent staff, as are necessary to carry out the specified tests efficiently and properly. All apparatus, equipment and instruments shall be calibrated in accordance with the standards specified in the Employer's Requirements or defined by applicable Laws and, if requested by the Employer, the Contractor shall submit calibration certificates before carrying out testing.

The Contractor shall give a Notice to the Employer, stating the time and place for the specified testing of any Plant, Materials and other parts of the Works within the period specified in the Contract Data. This Notice shall be given in reasonable time, having regard to the location of the testing, for the Employer's Personnel to attend. The Employer may, under Clause 13 [*Variations and Adjustments*], vary the location or timing or details of specified tests, or instruct the Contractor to carry out additional tests. If these varied or additional tests show that the tested Plant, Materials or workmanship is not in accordance with the Contract, the Cost and any delay incurred in carrying out this Variation shall be borne by the Contractor.

The Employer shall give a Notice to the Contractor of not less than 72 hours of the Employer's intention to attend the tests. If the Employer does not attend at the time and place stated in the Contractor's Notice under this Sub-Clause, the Contractor may proceed with the tests, unless otherwise instructed by the Employer. These tests shall then be deemed to have been made in the Employer's presence. If the Contractor suffers delay and/or incurs Cost from complying with any such instruction or as a result of a delay for which the Employer is responsible, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to EOT and/ or payment of Cost Plus Profit.

If the Contractor causes any delay to specified tests (including varied or additional tests) and such delay causes the Employer to incur costs, the Employer shall be

entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment of these costs by the Contractor.

The Contractor shall promptly forward to the Employer duly certified reports of the tests. When the specified tests have been passed, the Employer shall endorse the Contractor's test certificate, or issue a test certificate to the Contractor, to that effect. If the Employer has not attended the tests, the Employer shall be deemed to have accepted the readings as accurate.

Sub-Clause 7.5 [*Defects and Rejection*] shall apply in the event that any Plant, Materials and other parts of the Works fails to pass a specified test.

7.5 Defects and Rejections

If, as a result of an examination, inspection, measurement or testing, any Plant, Materials, design or workmanship is found to be defective or otherwise not in accordance with the Contract, the Employer shall give a Notice to the Contractor describing the item of Plant, Materials, design or workmanship that has been found to be defective within the period specified in the Contract Data. The Contractor shall then prepare and submit a proposal for necessary remedial work within a timeframe as agreed between the Parties.

The Employer may Review this proposal, and may give a Notice to the Contractor stating the extent to which the proposed work, if carried out, would not result in the Plant, Materials, design or workmanship complying with the Contract. After receiving such a Notice, the Contractor shall promptly submit a revised proposal to the Employer. If the Employer gives no such Notice within 14 days after receiving the Contractor's proposal (or revised proposal), the Employer shall be deemed to have given a Notice of No-objection.

If the Contractor fails to promptly submit a proposal (or revised proposal) for remedial work, or fails to carry out the proposed remedial work to which the Employer has given (or is deemed to have given) a Notice of No-objection, the Employer may:

(a) instruct the Contractor under sub-paragraph (a) and/or (b) of Sub-Clause 7.6 [*Remedial Work*]; or

(b) reject the design, Plant, Materials or workmanship by giving a Notice to the Contractor, with reasons, in which case sub-paragraph (a) of Sub-Clause 11.4 [*Failure to Remedy Defects*] shall apply.

After remedying defects in any Plant, Materials, design or workmanship, if the Employer requires any such items to be retested, the tests shall be repeated in

accordance with Sub-Clause 7.4 [*Testing by the Contractor*] at the Contractor's risk and cost. If the rejection and retesting cause the Employer to incur additional costs, the Employer shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment of these costs by the Contractor.

7.6 Remedial Work

In addition to any previous examination, inspection, measurement or testing, or test certificate or Notice of No-objection by the Employer, at any time before the issue of the Completion Certificate for the Works the Employer may instruct the Contractor to:

(a) repair or remedy (if necessary, off the Site), or remove from the Site and replace any Plant or Materials which are not in accordance with the Contract;

(b) repair or remedy, or remove and re-execute, any other work which is not in accordance with the Contract; and

(c) carry out any remedial work which is urgently required for the safety of the Works, whether because of an accident, Unforeseeable event or otherwise.

The Contractor shall comply with the instruction as soon as practicable and not later than the time (if any) specified in the instruction, or immediately if urgency is specified under sub-paragraph (c) above.

The Contractor shall bear the cost of all remedial work required under this Sub-Clause, except to the extent that any work under sub-paragraph (c) above is attributable to:

(i) any act by the Employer or the Employer's Personnel. If the Contractor suffers delay and/or incurs Cost in carrying out such work, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to EOT and/or payment of such Cost Plus Profit; or

(ii) a Force Majeure, in which case Sub-Clause 18.4 [*Consequences of a Force Majeure*] shall apply.

If the Contractor fails to comply with the Employer's instruction, the Employer may (at the Employer's sole discretion) employ and pay other persons to carry out the work. Except to the extent that the Contractor would have been entitled to payment for work under this Sub-Clause, the Employer shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment by the Contractor of all costs arising from this failure. This entitlement shall be without prejudice to any other rights the Employer may have, under the Contract or otherwise.

7.7 Ownership of Plant and Materials

Each item of Plant and Materials shall, to the extent consistent with the mandatory requirements of the Laws of the Country, become the property of the Authority at whichever is the earlier of the following times, free from liens and other Encumbrances:

(a) when it is delivered to the Site;

(b) when the Contractor is paid the value of the Plant and Materials under Sub-Clause 8.12 [*Payment for Plant and Materials after Employer's Suspension*]; or

(c) when the Contractor is paid the amount determined for the Plant and Materials under Sub-Clause 14.5 *[Plant and Materials intended for the Works*].

7.8 Royalties

Unless otherwise stated in the Employer's Requirements, the Contractor shall pay all royalties, rents and other payments for:

(a) natural Materials obtained from outside the Site; and

(b) the disposal of material from demolitions and excavations and of other surplus material (whether natural or man-made), except to the extent that disposal areas within the Site are specified in the Employer's Requirements.

8. Commencement, Delays and Suspension

8.1 Commencement of Works

Unless the Commencement Date is stated in the Contract Agreement, the Employer shall give a Notice to Proceed (NTP) to the Contractor stating the Commencement Date not less than 14 days before the Commencement Date and shall ensure that the Employer has provided at least the portion of the total land as specified in the Contract Data required for the Project in conformity with the provisions of Sub-Clause 3.7*[Right of Access to the Site].*

Unless otherwise stated in the Particular Conditions of Contract, the Commencement Date shall be within 42 days after the date on which the Contract comes into full force and effect under Sub-Clause 1.6 [*Contract Agreement*].

The Contractor shall commence the execution of the Works on the Commencement Date and shall then proceed with the Works with due expedition and without delay.

8.2 Time for Completion

The Contractor shall complete the whole of the Works, and each Section (if any), within the Time for Completion for the Works or Section (as the case may be), including completion of all work which is stated in the Contract as being required for the Works or Section to be considered to be completed for the purposes of taking over under Sub-Clause 10.1 *[Taking Over the Works and Sections*]

8.3 Programme

The Contractor shall submit an initial programme for the execution of the Works to the Employer within 28 days after receiving the Notice to Proceed (NTP) under Sub-Clause 8.1 [*Commencement of Works*]. This programme shall be prepared using programming software stated in the Employer's Requirements (if not stated, the programming software acceptable to the Employer).

Unless otherwise stated in the Particular Conditions of Contract, the Contractor shall also submit a revised programme which accurately reflects the actual progress of the Works, whenever any programme ceases to reflect actual progress or is otherwise inconsistent with the Contractor's obligations.

The initial programme and each revised programme shall be submitted to the Employer in one paper copy, one electronic copy and additional paper copies (if any) as stated in the Contract Data, and shall include:

(a) the Commencement Date and the Time for Completion, of the Works and of each Section (if any);

(b) the date on the right of access to and possession of (each part of) the Site is to be given to the Contractor in accordance with Sub-Clause 3.7 [*Right of Access to the Site*];

(c) the order in which the Contractor intends to carry out the Works, including the anticipated timing of each stage of design, preparation and submission of Contractor's Documents, procurement, manufacture, inspection, delivery to Site, construction, erection, installation, work to be undertaken by any nominated Subcontractor (as defined in Clause 4.5 [*Nominated Subcontractors*]), testing, commissioning and trial operation. It shall also indicate milestones, if provided for in the Employer's Requirements;

(d) the Review periods under Sub-Clause 5.2.2 [*Review by Employer*], and periods for Review for any other submissions specified in the Employer's Requirements or required under these Conditions;

(e) the sequence and timing of inspections and tests specified in, or required by, the Contract;

(f) for a revised programme: the sequence and timing of the remedial work (if any) to which the Employer has given a Notice of No-objection under Sub-Clause 7.5 [*Defects and Rejection*] and/or the remedial work (if any) instructed under Sub-Clause 7.6 [*Remedial Work*];

(g) all activities (to the level of detail specified in the Employer's Requirements), logically linked and showing the earliest and latest start and finish dates for each activity, the float (if any), and the critical path(s);

(h) the dates of all locally recognised days of rest and holiday periods (if any);

(i) all key delivery dates of Plant and Materials;

(j) for a revised programme and for each activity: the actual progress to date, any delay to such progress and the effects of such delay on other activities (if any); and

(k) a supporting report which includes:

(i) a description of all the major stages of the execution of the Works;

(ii) a general description of the methods which the Contractor intends to adopt in the execution of the Works;

(iii) details showing the Contractor's reasonable estimate of the number of each class of Contractor's Personnel, and of each type of Contractor's Equipment, required on the Site, for each major stage of the execution of the Works;

(iv) if a revised programme, identification of any significant change(s) to the previous programme submitted by the Contractor; and

(v) the Contractor's proposals to overcome the effects of any delay(s) on progress of the Works.

The Employer shall Review the initial programme, and each revised programme, submitted by the Contractor and may give a Notice to the Contractor stating the extent to which it does not comply with the Contract or ceases to reflect actual progress or is otherwise inconsistent with the Contractor's obligations. If the Employer gives no such Notice:

- within 21 days after receiving the initial programme; or
- within 14 days after receiving a revised programme

the Employer shall be deemed to have given a Notice of No-objection and the initial

programme or revised programme (as the case may be) shall be the Programme.

The Contractor shall proceed in accordance with the Programme, subject to the Contractor's other obligations under the Contract. The Employer's Personnel shall be entitled to rely on the Programme when planning their activities.

Nothing in any programme, the Programme or any supporting report shall be taken as, or relieve the Contractor from any obligation to give, a Notice under the Contract.

If, at any time, the Employer gives a Notice to the Contractor that any programme fails (to the extent stated) to comply with the Contract or ceases to reflect actual progress or is otherwise inconsistent with the Contractor's obligations, the Contractor shall within 14 days after receiving this Notice submit a revised programme to the Employer in accordance with this Sub-Clause.

8.4 Advance Warning

Each Party shall advise the other Party in advance of any known or probable future events or circumstances which may:

(a) adversely affect the work of the Contractor's Personnel;
(b) adversely affect the performance of the Works when completed;
(c) increase the Contract Price; and/or
(d) delay the execution of the Works or a Section (if any).

The Employer may request the Contractor to submit a proposal under Sub-Clause 13.3.2 [*Variation by Request for Proposal*] to avoid or minimise the effects of such event(s) or circumstance(s).

8.5 Extension of Time for Completion

The Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to Extension of Time if and to the extent that completion for the purposes of Sub-Clause 10.1 [*Taking Over the Works and Sections*] is or will be delayed by any of the following causes:

(a) a Variation (except that there shall be no requirement to comply with Sub-Clause 20.2 [*Claims For Payment and/or EOT*]);
(b) a cause of delay giving an entitlement to EOT under a Sub-Clause of these Conditions; or
(c) any delay, impediment or prevention caused by or attributable to the Employer, the Employer's Personnel, or the Employer's other contractors on the Site (or any Unforeseeable shortages in the availability of Employer-Supplied Materials,

if any, caused by epidemic or governmental actions).

When agreeing or determining each EOT, the Authority's Engineer shall review previous agreements and determinations of EOT under Sub-Clause 3.5 [*Agreement or Determination*] and may increase, but shall not decrease, the total EOT.

If a delay caused by a matter which is the Employer's responsibility is concurrent with a delay caused by a matter which is the Contractor's responsibility, the Contractor's entitlement to EOT shall be assessed in accordance with the rules and procedures stated in the Special Provisions (if not stated, as appropriate taking due regard of all relevant circumstances).

8.6 Delays Caused by Public Authorities

If:

(i) the Contractor has diligently followed the procedures laid down by the relevant legally constituted public authorities or private utility entities in the Country;

(ii) these public authorities or entities delay or disrupt the Contractor's work; and

(iii) the delay or disruption was Unforeseeable.

then this delay or disruption caused by the public authorities/entities will be considered as a cause of delay under sub-paragraph (b) of Sub-Clause 8.5 [*Extension of Time for Completion*].

8.7 Rate of Progress

If, at any time:

(a) actual progress is slow to complete the Works or a Section (if any) within the relevant Time for Completion; and/or

(b) progress has fallen (or will fall) behind the Programme (or the initial programme if it has not yet become the Programme) under Sub-Clause 8.3 [*Programme*],

other than as a result of a cause listed in Sub-Clause 8.5 [*Extension of Time for Completion*], then the Employer may instruct the Contractor to submit, under Sub-Clause 8.3 [*Programme*], a revised programme describing the revised methods which the Contractor proposes to adopt in order to expedite progress and complete the Works or a Section (if any) within the relevant Time for Completion.

Unless the Employer gives a Notice to the Contractor stating otherwise, the Contractor shall adopt these revised methods, which may require increases in the

working hours and/or in the numbers of Contractor's Personnel and/or the Goods, at the Contractor's risk and cost. If these revised methods cause the Employer to incur additional costs, the Employer shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment of these costs by the Contractor, in addition to Liquidated Delay Damages (if any).

Sub-Clause 13.3.1 [*Variation by Instruction*] shall apply to revised methods, including acceleration measures, instructed by the Employer to reduce delays resulting from causes listed under Sub-Clause 8.5 [*Extension of Time for Completion*].

8.8 Liquidated Delay Damages

If the Contractor fails to comply with Sub-Clause 8.2 [*Time for Completion*], the Employer shall be entitled subject to Sub-Clause 20.2 [*Claims for Payment and/or EOT*] to payment of Liquidated Delay Damages due to Delay by the Contractor for this default. Liquidated Delay Damages shall be the amount stated in the Contract Data, which shall be paid for every day which shall elapse between the relevant Time for Completion and the relevant Date of Completion of the Works or Section. The total amount due under this Sub-Clause shall not exceed the maximum amount of Liquidated Delay Damages (if any) stated in the Contract Data.

These Liquidated Delay Damages shall be the only damages due from the Contractor for the Contractor's failure to comply with Sub-Clause 8.2 [*Time for Completion*], other than in the event of termination under Sub-Clause 15.2 [*Termination for Contractor's Default*] before completion of the Works. These Liquidated Delay Damages shall not relieve the Contractor from the obligation to complete the Works, or from any other duties, obligations or responsibilities which the Contractor may have under or in connection with the Contract.

This Sub-Clause shall not limit the Contractor's liability for Liquidated Delay Damages in any case of fraud, gross negligence, deliberate default or reckless misconduct by the Contractor.

8.9 Incentives (Bonus) for Early Completion

Unless otherwise stated in the Particular Conditions of Contract, this Sub-Clause shall not apply.

The Contractor shall be entitled to a bonus payment if the Works and/or each Section is completed earlier than the Time for Completion for the Works or Section (as the case may be). The amount of bonus for early completion of the Works and/or each

Section is as stated in the Contract Data. For the purposes of calculating any bonus payment, the applicable Time for Completion stated in the Contract Data is fixed and no adjustments of this time by reason of granting an EOT will be allowed.

8.10 Employer's Suspension

The Employer may at any time instruct the Contractor to suspend progress of part or all of the Works, which instruction shall state the date and cause of the suspension. During such suspension, the Contractor shall protect, store and secure such part or all of the Works (as the case may be) against any deterioration, loss or damage.

To the extent that the cause of such suspension is the responsibility of the Contractor, Sub-Clauses 8.11 [*Consequences of Employer's Suspension*], 8.12 [*Payment for Plant and Materials after Employer's Suspension*] and 8.13 [*Prolonged Suspension*] shall not apply.

8.11 Consequences of Employer's Suspension

If the Contractor suffers delay and/or incurs Cost from complying with an Employer's instruction under Sub-Clause 8.10 [*Employer's Suspension*] and/ or from resuming the work under Sub-Clause 8.14 [*Resumption of Work*], the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to EOT and/or payment of such Cost Plus Profit.

The Contractor shall not be entitled to EOT, or to payment of the Cost incurred, in making good:

(a) the consequences of the Contractor's faulty or defective design, workmanship, Plant or Materials; and/or

(b) any deterioration, loss or damage caused by the Contractor's failure to protect, store or secure in accordance with Sub-Clause 8.10 [*Employer's Suspension*].

8.12 Payment for Plant and Materials after Employer's Suspension

The Contractor shall be entitled to payment of the value (as at the date of suspension instructed under Sub-Clause 8.10 [*Employer's Suspension*]) of Plant and/or Materials which have not been delivered to Site, if:

(a) the work on Plant, or delivery of Plant and/or Materials, has been suspended for more than 28 days and

  (i) the Plant and/or Materials were scheduled, in accordance with the Programme, to have been completed and ready for delivery to the Site during the suspension period; and

(ii) the Contractor provides the Employer with reasonable evidence that the Plant and/or Materials comply with the Contract; and

(b) the Contractor has marked the Plant and/or Materials as the Authority's property in accordance with the Employer's instructions.

8.13 Prolonged Suspension

If the suspension under Sub-Clause 8.10 [*Employer's Suspension*] has continued for more than the number of days specified in the Contract Data, the Contractor may give a Notice to the Employer requesting permission to proceed. If the Employer does not give a Notice under Sub-Clause 8.14 [*Resumption of Work*] within 28 days after receiving the Contractor's Notice under this Sub-Clause, the Contractor may either:

(a) agree to a further suspension, in which case the Parties may agree the EOT and/or Cost Plus Profit (if the Contractor incurs Cost), and/or payment for suspended Plant and/or Materials, arising from the total period of suspension;

or (and if the Parties fail to reach agreement under this sub-paragraph (a))

(b) after giving a (second) Notice to the Employer, treat the suspension as an omission of the affected part of the Works (as if it had been instructed under Sub-Clause 13.3.1 [*Variation by Instruction*]) with immediate effect including release from any further obligation to protect, store and secure under Sub-Clause 8.10 [*Employer's Suspension*]. If the suspension affects the whole of the Works, the Contractor may give a Notice of termination under Sub-Clause 16.2 [*Termination by Contractor*].

8.14 Resumption of Work

The Contractor shall resume work as soon as practicable after receiving a Notice from the Employer to proceed with the suspended work.

At the time stated in this Notice (if not stated, immediately after the Contractor receives this Notice), the Contractor and the Employer shall jointly examine the Works and the Plant and Materials affected by the suspension. The Employer shall record any deterioration, loss, damage or defect in the Works or Plant or Materials which has occurred during the suspension and shall provide this record to the Contractor. The Contractor shall promptly make good all such deterioration, loss, damage or defect so that the Works, when completed, shall comply with the Contract.

9. Tests on Completion

9.1 Contractor's Obligations

The Contractor shall carry out the Tests on Completion in accordance with this Clause and Sub-Clause 7.4 [*Testing by the Contractor*], after submitting the documents under Sub-Clause 5.6 [*As-Built Records*] and Sub-Clause 5.7 [*Operation and Maintenance Manuals*].

The Contractor shall submit to the Employer, not less than 42 days before the date the Contractor intends to commence the Tests on Completion, a detailed test programme showing the intended timing and resources required for these tests.

The Employer may Review the proposed test programme and may give a Notice to the Contractor stating the extent to which it does not comply with the Contract. Within 14 days after receiving this Notice, the Contractor shall revise the test programme to rectify such non-compliance. If the Employer gives no such Notice within 14 days after receiving the test programme (or revised test programme), the Employer shall be deemed to have given a Notice of No-objection. The Contractor shall not commence the Tests on Completion until a Notice of No-objection is given (or is deemed to have been given) by the Employer.

In any case, the Test on Completion shall be carried out in the presence of the Authority's Engineer.

In addition to any date(s) shown in the test programme, the Contractor shall give a Notice to the Employer, of not less than 21 days, of the date after which the Contractor will be ready to carry out each of the Tests on Completion. The Contractor shall commence the Tests on Completion within 14 days after this date, or on such day or days as the Employer shall instruct, and shall proceed in accordance with the Contractor's test programme to which the Employer has given (or is deemed to have given) a Notice of No-objection.

Unless otherwise stated in the Employer's Requirements, the Tests on Completion shall be carried out in stages in the following sequence:

(a) pre-commissioning tests (on or off the Site, as appropriate), which shall include the appropriate inspections and ("dry" or "cold") functional tests to demonstrate that each item of the Works or Section can safely undertake the next stage under sub-paragraph (b) below;

(b) commissioning tests, which shall include the operational tests specified in the Employer's Requirements to demonstrate that the Works or Section can be

operated safely and as specified in the Employer's Requirements, under all available operating conditions; and

(c) trial operation (to the extent possible under available operating conditions), which shall demonstrate that the Works or Section perform reliably and in accordance with the Contract.

The tests of each stage described in sub-paragraphs (b) and (c) above shall not be commenced until the Works or Section have passed the previous stage.

During trial operation, when the Works or Section (as the case may be) are operating under stable conditions, the Contractor shall give a Notice to the Employer that they are ready for any other Tests on Completion, including performance tests. Performance tests shall be carried out to demonstrate whether the Works or Section comply with the performance criteria specified in the Employer's Requirements and with the Schedule of Performance Guarantees.

Trial operation, including performance testing, shall not constitute a taking-over under Clause 10 [*Employer's Taking Over*].

Any product produced by, and any revenue or other benefit resulting from, trial operation under this Sub-Clause shall be the property of the Authority.

As soon as the Works or Section have, in the Contractor's opinion, passed each stage of the Tests on Completion described in sub-paragraphs (a) to (c) above, the Contractor shall submit a certified report of the results of these tests to the Employer within the period specified in the Contract Data. The Employer shall Review each such report and may give a Notice to the Contractor stating the extent to which the results of the tests do not comply with the Contract. If the Employer does not give such a Notice within 14 days after receiving the results of the tests, the Employer shall be deemed to have given a Notice of No-objection.

In considering the results of the Tests on Completion, the Employer shall make allowances for the effect of use of (any part of) the Works by the Employer on the performance or other characteristics of the Works.

9.2 Delayed Tests

If the Contractor has given a Notice under Sub-Clause 9.1 *[Contractor's Obligations*] that the Works or Section (as the case may be) are ready for Tests on Completion, and these tests are unduly delayed by the Employer's Personnel or by a cause for which the Employer is responsible, Sub-Clause 10.3 [*Interference with Tests on Completion*] shall apply.

If the Tests on Completion are unduly delayed by the Contractor, the Employer may by giving a Notice to the Contractor require the Contractor to carry out the tests within 21 days after receiving the Notice. The Contractor shall carry out the tests on such day or days within this period of 21 days as the Contractor may fix, for which the Contractor shall give a prior Notice to the Employer of not less than 7 days.

If the Contractor fails to carry out the Tests on Completion within this period of 21 days:

(a) after a second Notice is given by the Employer to the Contractor, the Employer's Personnel may proceed with the tests;

(b) the Contractor may attend and witness these tests;

(c) within 28 days of these tests being completed, the Employer shall send a copy of the test results to the Contractor; and

(d) if the Employer incurs additional costs as a result of such testing, the Employer shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment by the Contractor of the costs reasonably incurred.

Whether or not the Contractor attends, these Tests on Completion shall be deemed to have been carried out in the presence of the Contractor and the results of these tests shall be accepted as accurate.

9.3 Retesting

If the Works, or a Section, fail to pass the Tests on Completion, Sub-Clause 7.5 [*Defects and Rejection*] shall apply. The Employer or the Contractor may require these failed tests, and the Tests on Completion on any related work, to be repeated under the same terms and conditions. Such repeated tests shall be treated as Tests on Completion for the purposes of this Clause.

9.4 Failure to Pass Tests on Completion

If the Works, or a Section, fail to pass the Tests on Completion repeated under Sub-Clause 9.3 [*Retesting*], the Employer shall report the same with their recommendations to the Authority's Engineer who shall instruct the Employer to take any of the following actions:

(a) instruct further repetition of Tests on Completion under Sub-Clause 9.3 [*Retesting*];

(b) reject the Works if the effect of the failure is to deprive the Employer of substantially the whole benefit of the Works in which event the Employer shall

have the same remedies as are provided in sub-paragraph (d) of Sub-Clause 11.4 [*Failure to Remedy Defects*];

(c) reject the Section if the effect of the failure is that the Section cannot be used for its intended purpose(s) under the Contract, in which event the Employer shall have the same remedy as is provided in sub-paragraph (c) of Sub-Clause 11.4 [*Failure to Remedy Defects*]; or

(d) issue a Provisional Completion Certificate.

In the event of sub-paragraph (d) above, the Contractor shall then proceed in accordance with all other obligations under the Contract, and the Employer shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment by the Contractor or a reduction in the Contract Price as described under sub-paragraphs (b)(i) or (b)(ii) of Sub-Clause 11.4 [*Failure to Remedy Defects*], respectively. This entitlement shall be without prejudice to any other rights the Employer may have, under the Contract or otherwise.

10. Employer's Taking Over

10.1 Taking Over the Works and Sections

Except as stated in Sub-Clause 9.4 [*Failure to Pass Tests on Completion*] and Sub-Clause 10.2 [*Taking Over of Parts of the Works*], the Works shall be taken over by the Employer when:

(a) the Works have been completed in accordance with the Contract, including the passing of the Tests on Completion and except as allowed in sub-paragraph (i) below;

(b) if applicable, the Employer has given (or is deemed to have given) a Notice of No-objection to the as-built records submitted under sub-paragraph (a) or sub-paragraph (b)(i) (as the case may be) of Sub-Clause 5.6 [*As-Built Records*];

(c) if applicable, the Employer has given (or is deemed to have given) a Notice of No-objection to the final O&M Manuals for the Works submitted under Sub-Clause 5.7 [*Operation and Maintenance Manuals*];

(d) if applicable, the Contractor has carried out the training as described under Sub-Clause 5.5 [*Training*]; and

(e) a Completion Certificate for the Works has been issued, or is deemed to have been issued in accordance with this Sub-Clause.

The Contractor may apply for a Completion Certificate by giving a Notice to the

Employer not more than 14 days before the Works will, in the Contractor's opinion, be complete and ready for taking over. If the Works are divided into Sections, the Contractor may similarly apply for a Completion Certificate for each Section.

If any part of the Works is taken over under Sub-Clause 10.2 [*Taking Over of Parts of the Works*], the remaining Works or Section shall not be taken over until the conditions described in sub-paragraphs (a) to (e) above have been fulfilled.

The Employer shall, within 28 days after receiving the Contractor's Notice, either:

(i) issue the Completion Certificate to the Contractor, stating the date on which the Works or Section were completed in accordance with the Contract;

(ii) issue the Provisional Completion Certificate to the Contractor, which will include a list of minor outstanding work and defects which will not substantially affect the safe use of the Works or Section for their intended purpose; or

(iii) reject the application by giving a Notice to the Contractor, with reasons. This Notice shall specify the work required to be done, the defects required to be remedied and/or the documents required to be submitted by the Contractor to enable the Completion Certificate to be issued.

The Contractor shall complete the minor outstanding work and defects listed in case of sub paragraph (ii) and remedy such defects and/or submit such documents in case of sub paragraph (iii), before giving a further Notice under this Sub-Clause.

If the Employer does not issue the Completion Certificate/Provisional Completion Certificate, as the case may be, or reject the Contractor's application within this period of 28 days, and if the conditions described in sub-paragraphs (a) to (d) above have been fulfilled, the Works or Section shall be deemed to have been completed in accordance with the Contract on the fourteenth day after the Employer receives the Contractor's Notice of application and the Completion Certificate shall be deemed to have been issued.

10.2 Taking Over of Parts of the Works

Parts of the Works (other than Sections) shall not be taken over or used by the Employer, except as may be stated in the Employer's Requirements or as may be agreed by both Parties.

10.3 Interference with Tests on Completion

If the Contractor is prevented, for more than 14 days (either a continuous period, or multiple periods which total more than 14 days), from carrying out the Tests on

Completion by the Employer's Personnel or by a cause for which the Employer is responsible (including any performance test that is not possible due to available operating conditions during trial operation):

(a) the Contractor shall carry out the Tests on Completion as soon as practicable and, in any case, before the expiry date of the relevant DLP; and

(b) if the Contractor suffers delay and/or incurs Cost as a result of being so prevented, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to EOT and/or payment of such Cost Plus Profit.

11. Defects after Taking Over

11.1 Completion of Outstanding Work and Remedying Defects

In order that the Works and Contractor's Documents, and each Section, shall be in the condition required by the Contract (reasonable wear and tear excepted) by the expiry date of the relevant Defects Liability Period or as soon as practicable thereafter, the Contractor shall:

(a) complete any work which is outstanding on the relevant Date of Completion, within the time(s) stated in the Provisional Completion Certificate or such other reasonable time as is instructed by the Employer; and

(b) execute all work required to remedy defects or damage, of which a Notice is given to the Contractor by the Employer on or before the expiry date of the DLP for the Works or Section (as the case may be).

If a defect appears or damage occurs during the relevant DLP, a Notice shall be given to the Contractor accordingly within the period specified in the Contract Data, by (or on behalf of) the Employer. Promptly thereafter:

(i) the Contractor and the Employer's Personnel shall jointly inspect the defect or damage;

(ii) the Contractor shall then prepare and submit a proposal for necessary remedial work; and

(iii) the second, third and fourth paragraphs of Sub-Clause 7.5 [*Defects and Rejection*] shall apply.

11.2 Cost of Remedying Defects

All work under sub-paragraph (b) of Sub-Clause 11.1 [*Completion of Outstanding Work and Remedying Defects*] shall be executed at the risk and cost of the Contractor, if and to the extent that the work is attributable to:

(a) the design of the Works, other than a part of the design for which the Employer is responsible (if any);

(b) Plant, Materials or workmanship not being in accordance with the Contract;

(c) improper operation or maintenance which was attributable to matters for which the Contractor is responsible (under Sub-Clause 5.5 [*Training*], Sub-Clause 5.6 [*As-Built Records*] and/or Sub-Clause 5.7 [*Operation and Maintenance Manuals*] or otherwise); or

(d) failure by the Contractor to comply with any other obligation under the Contract.

If the Contractor considers that the work is attributable to any other cause, the Contractor shall give a Notice to the Employer within the period specified in the Contract Data, then the Employer's Representative shall proceed under Sub-Clause 3.5 [*Agreement or Determination*], to agree or determine the cause (and, for the purpose of Sub-Clause 3.5.3 [*Time limits*], the date of this Notice shall be the date of commencement of the time limit for agreement under Sub-Clause 3.5.3). If it is agreed or determined that the work is attributable to a cause other than those listed above, Sub-Clause 13.3.1 [*Variation by Instruction*] shall apply as if such work had been instructed by the Employer.

11.3 Extension of Defects Liability Period

The Employer shall be entitled to an extension of the DLP for the Works or a Section (or a part of the Works, if Sub-Clause 10.2 [*Taking Over of Parts of the Works*] applies):

(a) if and to the extent that the Works, Section (or the part of the Works) or a major item of Plant (as the case may be, and after taking over) cannot be used for the intended purpose(s) by reason of a defect or damage which is attributable to any of the matters under sub-paragraphs (a) to (d) of Sub-Clause 11.2 [*Cost of Remedying Defects*]; and

(b) subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*].

However, a DLP shall not be extended by more than a period stated in the Contract Data after the expiry of the DLP stated in the Contract Data.

If delivery and/or erection of Plant and/or Materials was suspended under Sub-Clause 8.10 [*Employer's Suspension*] (other than where the cause of such suspension is the responsibility of the Contractor) or Sub-Clause 16.1 [*Suspension by Contractor*], the Contractor's obligations under this Clause shall not apply to any defects or damage occurring more than the period stated in the Contract Data after the DLP for the Works, of which the Plant and/or Materials form part, would otherwise have expired.

11.4 Failure to Remedy Defects

If the remedying of any defect or damage under Sub-Clause 11.1 [*Completion of Outstanding Works and Remedying Defects*] is unduly delayed by the Contractor, a date may be fixed by (or on behalf of) the Employer, on or by which the defect or damage is to be remedied. A Notice of this fixed date shall be given to the Contractor by (or on behalf of) the Employer within the period specified in the Contract Data, which Notice shall allow the Contractor reasonable time (taking due regard of all relevant circumstances) to remedy the defect or damage.

If the Contractor fails to remedy the defect or damage by the date stated in this Notice and this remedial work was to be executed at the cost of the Contractor under Sub-Clause 11.2 [*Cost of Remedying Defects*], the Employer shall proceed under Sub-Clause 2.3[*The Authority's Engineer*], whereby the Employer may:

(a) carry out the work or have the work carried out by others (including any retesting), in the manner required under the Contract and at the Contractor's cost, but the Contractor shall have no responsibility for this work. The Employer shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment by the Contractor of the costs reasonably incurred by the Employer in remedying the defect or damage;

(b) accept the damaged or defective work, in which case the Employer shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to:

  (i) payment of Performance Damages by the Contractor in full satisfaction of this failure; or

  (ii) if there is no Schedule of Performance Guarantees under the Contract, or no applicable Performance Damages, a reduction in the Contract Price. The reduction shall be in full satisfaction of this failure only and shall be in the amount as shall be appropriate to cover the reduced value to the Employer as a result of this failure;

(c) treat any part of the Works which cannot be used for its intended purpose(s) under the Contract by reason of this failure as an omission, as if such omission had been instructed under Sub-Clause 13.3.1 [*Variation by Instruction*]; or

(d) terminate the Contract as a whole with immediate effect (and Sub-Clause 15.2 [*Termination for Contractor's Default*] shall not apply) if the defect or damage deprives the Employer of substantially the whole benefit of the Works. The Employer shall then be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to recover from the Contractor all sums paid for the Works, plus financing charges and any costs incurred in dismantling the same, clearing the Site and returning Plant and Materials to the Contractor.

The exercise of discretion under sub-paragraph (c) or (d) above shall be without prejudice to any other rights the Employer may have, under the Contract or otherwise.

11.5 Remedying of Defective Work off Site

If, during the DLP, the Contractor considers that any defect or damage in any Plant cannot be remedied expeditiously on the Site the Contractor shall give a Notice, with reasons, to the Employer requesting consent to remove the defective or damaged Plant off the Site for the purposes of repair within the period specified in the Contract Data. This Notice shall clearly identify each item of defective or damaged Plant, and shall give details of:

(a) the defect or damage to be repaired;

(b) the place to which defective or damaged Plant is to be taken for repair;

(c) the transportation to be used (and insurance cover for such transportation);

(d) the proposed inspections and testing off the Site;

(e) the planned duration required before the repaired Plant shall be returned to the Site; and

(f) the planned duration for reinstallation and retesting of the repaired Plant (under Sub-Clause 7.4 [*Testing by the Contractor*] and/or Clause 9 [*Tests on Completion*] if applicable).

The Contractor shall also provide any further details that the Employer may reasonably require. When the Employer gives consent (which consent shall not relieve the Contractor from any obligation or responsibility under this Clause), the Contractor may remove from the Site such items of Plant as are defective or damaged. As a condition of this consent, the Employer may require the Contractor

to increase the amount of the Performance Security by the full replacement cost of the defective or damaged Plant.

In case of such failures of the Plant, the time taken for repair/replacement can lead to production loss which shall be monetised and the amount such calculated shall be realized from the Contractor in an appropriate manner.

11.6 Further Tests after Remedying Defects

Within 7 days of completion of the work of remedying of any defect or damage, the Contractor shall give a Notice to the Employer describing the remedied Works, Section and/or Plant and the proposed repeated tests (under Clause 9 [*Tests on Completion*] or Clause 12 [*Tests after Completion*], as applicable). If the Employer does not respond within 14 days after receiving this Notice, by giving a Notice to the Contractor objecting to such proposed repeated testing and/or instructing the repeated tests that are necessary to demonstrate that the remedied Works, Section and/or Plant comply with the Contract, the Employer shall be deemed to have agreed with the Contractor's proposed repeated testing.

If the Contractor fails to give such a Notice within the 7 days, the Employer may give a Notice to the Contractor, within 14 days after the defect or damage is remedied, instructing the repeated tests that are necessary to demonstrate that the remedied Works, Section and/or Plant comply with the Contract.

All repeated tests under this Sub-Clause shall be carried out in accordance with the terms applicable to the previous tests, except that they shall be carried out at the risk and cost of the Party liable, under Sub-Clause 11.2 [*Cost of Remedying Defects*], for the cost of the remedial work.

11.7 Right of Access after Taking Over

Until the date 28 days after issue of the Performance Certificate, the Contractor shall have the right of access to all parts of the Works and to records of the operation, maintenance and performance of the Works, except as may be inconsistent with the Employer's/Authority's reasonable security restrictions.

Whenever the Contractor intends to access any part of the Works or such records during the relevant DLP:

(a) the Contractor shall request access by giving a Notice to the Employer, describing the parts of the Works and/or records to be accessed, the reasons for such access, and the Contractor's preferred date for access. This Notice shall

be given in reasonable time in advance of the preferred date for access, taking due regard of all relevant circumstances including the Employer's security restrictions; and

(b) within 7 days after receiving the Contractor's Notice, the Employer shall give a Notice to the Contractor either:

(i) stating the Employer's consent to the Contractor's request; or

(ii) proposing reasonable alternative date(s), with reasons. If the Employer fails to give this Notice within the 7 days, the Employer shall be deemed to have given consent to the Contractor's access on the preferred date stated in the Contractor's Notice.

If the Contractor incurs additional Cost as a result of any unreasonable delay by the Employer in permitting access to the Works or such records by the Contractor, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment of any such Cost Plus Profit.

11.8 Contractor to Search

The Contractor shall, if instructed by the Employer, search for the cause of any defect, under the direction of the Employer. The Contractor shall carry out the search on the date(s) stated in the Employer's instruction or other date(s) agreed with the Employer.

Unless the defect is to be remedied at the cost of the Contractor under Sub-Clause 11.2 [*Cost of Remedying Defects*], the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment of the Cost Plus Profit of the search.

If the Contractor fails to carry out the search in accordance with this Sub-Clause, the search may be carried out by the Employer's Personnel. The Contractor shall be given a Notice of the date when such a search will be carried out and the Contractor may attend at the Contractor's own cost. If the defect is to be remedied at the cost of the Contractor under Sub-Clause 11.2 [*Cost of Remedying Defects*], the Employer shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment by the Contractor of the costs of the search reasonably incurred by the Employer.

11.9 Performance Certificate

Performance of the Contractor's obligations under the Contract shall not be

considered to have been completed until the Employer has issued the Performance Certificate to the Contractor, stating the date on which the Contractor fulfilled the Contractor's obligations under the Contract.

The Employer shall issue the Performance Certificate to the Contractor (with a copy to the Authority) within 28 days after the latest of the expiry dates of the Defects Liability Periods, or as soon thereafter as the Contractor has:

(a) supplied all the Contractor's Documents and, if applicable, the Employer has given (or is deemed to have given) a Notice of No-objection to the as-built records under sub-paragraph (b) of Sub-Clause 5.6 [*As-Built Records*]; and

(b) completed and tested all the Works (including remedying any defects) in accordance with the Contract.

If the Employer fails to issue the Performance Certificate within this period of 28 days, the Performance Certificate shall be deemed to have been issued on the date 28 days after the date on which it should have been issued, as required by this Sub-Clause.

Only the Performance Certificate shall be deemed to constitute acceptance of the Works.

11.10 Unfulfilled Obligations

After the issue of the Performance Certificate, each Party shall remain liable for the fulfilment of any obligation which remains non-performed at that time. For the purposes of determining the nature and extent of non-performed obligations, the Contract shall be deemed to remain in force.

However, in relation to Plant, the Contractor shall not be liable for any defects or damage occurring more than two years after expiry of the DLP for the Plant except if prohibited by law or in any case of fraud, gross negligence, deliberate default or reckless misconduct.

11.11 Clearance of Site

Promptly after the issue of the Performance Certificate, the Contractor shall:

(a) remove any remaining Contractor's Equipment, surplus material, wreckage, rubbish and Temporary Works from the Site;

(b) reinstate all parts of the Site which were affected by the Contractor's activities during the execution of the Works and are not occupied by the Permanent Works; and

(c) leave the Site and the Works in the condition stated in the Employer's Requirements (if not stated, in a clean and safe condition).

If the Contractor fails to comply with sub-paragraphs (a), (b) and/or (c) above within 28 days after the issue of the Performance Certificate, the Employer may sell (to the extent permitted by applicable Laws) or otherwise dispose of any remaining items and/or may reinstate and clean the Site (as may be necessary) at the Contractor's cost.

The Employer shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment by the Contractor of the costs reasonably incurred in connection with, or attributable to, such sale or disposal and reinstating and/or cleaning the Site, less an amount equal to the moneys from the sale (if any).

12. Tests after Completion

12.1 Procedure for Tests after Completion

If Tests after Completion are specified in the Employer's Requirements, this Clause shall apply.

The timing of the Tests after Completion shall be as soon as is reasonably practicable after the Works or Section (as the case may be) have been taken over by the Employer.

The Test after Completion shall be carried out in the presence of Authority's Engineer.

The Authority/Employer shall provide all electricity, water, sewage services (if applicable), fuel, consumables, materials, and make the Employer's Personnel and Plant available for the Tests after Completion. The Contractor shall:

(a) provide all other apparatus, assistance, documents and other information, equipment, instruments, labour, and suitably qualified, experienced and competent staff, as are necessary to carry out the Tests after Completion efficiently and properly;

(b) submit to the Employer, not later than 42 days before the date the Contractor intends to commence the Tests after Completion, a detailed test programme showing the intended timing and resources required for these tests. The Employer may Review the proposed test programme and may give a Notice to the Contractor stating the extent to which it does not comply with the Contract. Within 14 days after receiving this Notice, the Contractor shall revise the test programme to rectify such non-compliance. If the Employer gives no such

Notice within 14 days after receiving the test programme (or revised test programme), the Employer shall be deemed to have given a Notice of No-objection;

(c) in addition to any date(s) shown in the test programme, give a Notice to the Employer of not less than 21 days, of the date after which the Contractor will be ready to carry out each of the Tests after Completion;

(d) not commence the Tests after Completion until a Notice of No-objection is given (or is deemed to have been given) by the Employer to the Contractor's test programme;

(e) commence the Tests after Completion within 14 days after the date stated in the Notice under sub-paragraph (c) above, or on such day or days as the Employer shall instruct;

(f) proceed to carry out the Tests after Completion in accordance with:

(i) the Contractor's test programme to which the Employer has given (or is deemed to have given) a Notice of No-objection;

(ii) the Employer's Requirements; and

(iii) if applicable, the O&M Manuals to which the Employer has given (or is deemed to have given) a Notice of No-objection, under Sub-Clause 5.7 [*Operation and Maintenance Manuals*]; and

in the presence of such Employer's Personnel and Authority's Engineer and/or Contractor's Personnel as either Party may reasonably request.

The results of the Tests after Completion shall be compiled and evaluated by both Parties. Appropriate account shall be taken of the effect of the Employer's prior use of the Works.

12.2 Delayed Tests

If the Contractor has given a Notice under sub-paragraph (c) of Sub-Clause 12.1 [*Procedure for Tests after Completion*] that the Works or Section (as the case may be) are ready for Tests after Completion, and the Contractor is prevented from carrying out the Tests after Completion, or these tests are unduly delayed, by the Employer's Personnel or by a cause for which the Employer is responsible:

(a) the Contractor shall carry out the Tests after Completion as soon as practicable and, in any case, before the expiry date of the relevant DLP; and

(b) if the Contractor incurs Cost as a result of any such prevention and/or delay, including the extension of Tests after Completion beyond DLP, the Contractor

shall be entitled subject to Sub-Clause 20.2 [*Claims for Payment and/or EOT*] to payment of such Cost Plus Profit.

If, for reasons not attributable to the Contractor, a Test after Completion on the Works or any Section cannot be completed during the DLP (or any other period agreed by both Parties), then the Works or Section shall be deemed to have passed this Test after Completion.

12.3 Retesting

Subject to Sub-Clause 12.4 [*Failure to Pass Tests after Completion*], if the Works, or a Section, fail to pass the Tests after Completion:

(a) sub-paragraph (b) of Sub-Clause 11.1 [*Completion of Outstanding Work and Remedying Defects*] shall apply; and

(b) after remedying any defect or damage, Sub-Clause 11.6 [*Further Tests after Remedying Defects*] shall apply.

If and to the extent that this failure and retesting are attributable to any of the matters listed in sub-paragraphs (a) to (d) of Sub-Clause 11.2 [*Cost of Remedying Defects*] and cause the Employer to incur additional costs, the Employer shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment of these costs by the Contractor.

12.4 Failure to Pass Tests after Completion

If:

a) the Works, or a Section, fail to pass any or all of the Tests after Completion; and

b) applicable Performance Damages are set out in the Schedule of Performance Guarantees

the Employer shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment of these Performance Damages by the Contractor in full satisfaction of this failure. If the Contractor pays these Performance Damages to the Employer during the DLP, then the Works or Section shall be deemed to have passed these Tests after Completion.

If the Works, or a Section, fail to pass a Test after Completion and, by giving a Notice to the Employer, the Contractor proposes to make adjustments or modifications to the Works or such Section (including an item of Plant):

(i) the Contractor may be instructed by a Notice given by the Employer that right of

access to the Works or Section cannot be given until a time that is convenient to the Employer, which time shall be reasonable;

(ii) the Contractor shall remain liable to carry out the adjustments or modifications and to satisfy this Test, within a reasonable period of receiving the Notice under sub-paragraph (i) above; and

(iii) if the Contractor does not receive a Notice under sub-paragraph (i) above during the relevant DLP, the Contractor shall be relieved of the obligation to make such adjustments or modifications and the Works or Section (as the case may be) shall be deemed to have passed this Test after Completion.

If the Contractor incurs additional Cost as a result of any unreasonable delay by the Employer in permitting access to the Works or Section by the Contractor, either to investigate the causes of a failure to pass a Test after Completion or to carry out any adjustments or modifications, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment of any such Cost Plus Profit.

13. Variations and Adjustments

13.1 Right to Vary

Variations may be initiated by the Employer under Sub-Clause 13.3 [*Variation Procedure*] at any time before the issue of the Completion Certificate for the Works. Other than as stated under Sub-Clause 11.4 [*Failure to Remedy Defects*], a Variation shall not comprise the omission of any work which is to be carried out by the Employer or by others unless otherwise agreed by the Parties.

The Contractor shall be bound by each Variation instructed under Sub-Clause 13.3.1 [*Variation by Instruction*], and shall execute the Variation with due expedition and without delay, unless the Contractor promptly gives a Notice to the Employer stating (with detailed supporting particulars) that:

(a) the varied work was Unforeseeable having regard to the scope and nature of the Works described in the Employer's Requirements;

(b) the Contractor cannot readily obtain the Goods required for the Variation;

(c) it will adversely affect the Contractor's ability to comply with Sub-Clause 4.8 [*Health and Safety Obligations*] and/or Sub-Clause 4.18 [*Protection of the Environment*];

(d) it will have an adverse impact on the achievement of the Schedule of Performance Guarantees; or

(e) it may adversely affect the Contractor's obligation to complete the Works so that they shall be fit for the purpose(s) for which they are intended under Sub-Clause 4.1 [*Contractor's General Obligations*].

Promptly after receiving this Notice, the Employer shall respond by giving a Notice to the Contractor cancelling, confirming or varying the instruction. Any instruction so confirmed or varied shall be taken as an instruction under Sub-Clause 13.3.1 [*Variation by instruction*].

13.2 Value Engineering

The Contractor may, at any time, submit to the Employer a written proposal which (in the Contractor's opinion) will, if adopted:

(a) accelerate completion;

(b) reduce the cost to the Employer of executing, maintaining or operating the Works;

(c) improve the efficiency or value to the Employer of the completed Works; or

(d) otherwise be of benefit to the Employer.

The proposal shall be prepared at the cost of the Contractor and shall include the details as stated in sub-paragraphs (a) to (c) of Sub-Clause 13.3.1 [*Variation by Instruction*].

The Employer shall, as soon as practicable after receiving such proposal, respond by giving a Notice to the Contractor of the Employer's consent or otherwise, after taking approval from the Authority's Engineer as per Sub-Clause 2.3 [*The Authority's Engineer*]. The Contractor shall not delay any work while awaiting a response.

If the Employer gives his/her consent to the proposal, with or without comments, the Employer shall then instruct a Variation. Thereafter:

(i) the Contractor shall submit any further particulars that the Employer may reasonably require; and

(ii) then the third paragraph of Sub-Clause 13.3.1 [*Variation by Instruction*] shall apply which shall include consideration by the Employer of the sharing (if any) of the benefit, costs and/or delay between the Parties stated in the Particular Conditions of Contract.

13.3 Variation Procedure

Subject to Sub-Clause 13.1 [*Right to Vary*], Variations shall be initiated by the

Employer in accordance with either of the following procedures:

13.3.1. Variation by Instruction

The Employer may instruct a Variation by giving a Notice (describing the required change and stating any requirements for the recording of Costs) to the Contractor in accordance with Sub-Clause 3.4 *[Instructions*].

The Contractor shall proceed with execution of the Variation and shall within 28 days (or other period proposed by the Contractor and agreed by the Employer) of receiving the Employer's instruction, submit to the Employer's Representative detailed particulars including:

(a) a description of the varied work performed or to be performed, including details of the resources and methods adopted or to be adopted by the Contractor;

(b) a programme for its execution and the Contractor's proposal for any necessary modifications (if any) to the Programme according to Sub-Clause 8.3 [*Programme*] and to the Time for Completion; and

(c) the Contractor's proposal for adjustment to the Contract Price, with supporting particulars. Whenever the omission of any work forms part (or all) of a Variation, and if:

- the Contractor has incurred or will incur cost which, if the work had not been omitted, would have been deemed to be covered by a sum forming part of the Contract Price stated in the Contract Agreement; and
- the omission of the work has resulted or will result in this sum not forming part of the Contract Price

this cost may be included in the Contractor's proposal (and, if so, shall be clearly identified). If the Parties have agreed to the omission of any work which is to be carried out by others, the Contractor's proposal may also include the amount of any loss of profit and other losses and damages suffered (or to be suffered) by the Contractor as a result of the omission.

Thereafter, the Contractor shall submit any further particulars that the Employer's Representative may reasonably require. The Employer's Representative shall then refer the matter to the Employer and the Employer shall proceed under Sub-Clause 2.4 *[The Authority's Engineer and the*

Employer] to agree or determine:

(i) EOT, if any; and/or

(ii) the adjustments to the Contract Price and the Schedule of Payments, if any

(and, for the purpose of Sub-Clause 3.5.3 [*Time limits*], the date the Employer's Representative receives the Contractor's submission (including any requested further particulars) shall be the date of commencement of the time limit for agreement under Sub-Clause 3.5.3). The Contractor shall be entitled to such EOT and/or adjustments to the Contract Price, without any requirement to comply with Sub-Clause 20.2 [*Claims For Payment and/or EOT*].

If no Schedule of Rates and Prices is included in the Contract, the adjustments under sub-paragraph (ii) above shall be derived from the Cost Plus Profit of executing the work.

If a Schedule of Rates and Prices is included in the Contract, the following provisions of this Sub-Clause 13.3.1 shall apply to the adjustments under sub-paragraph (ii) above.

For each item of work forming part (or all) of a Variation, the appropriate rate or price for the item shall be the rate or price specified for such item in the Schedule of Rates and Prices or, if there is no such item, the rate or price specified for similar work. However, a new rate or price shall be appropriate for an item of work if no rate or price for this item is specified in the Schedule of Rates and Prices as provided in the Contract Data and no specified rate or price is appropriate because the item of work is not of similar character, or is not executed under similar conditions, as any item in the Contract.

Each new rate or price shall be derived from any relevant rates or prices in the Schedule of Rates and Prices, with reasonable adjustments taking account of all relevant circumstances. If no rates or prices are relevant for the derivation of a new rate or price, it shall be derived from the Cost Plus Profit of executing the work. For the purpose of this Sub-Clause, the cost shall be derived based on the market price.

Until such time as the adjustments under sub-paragraph (ii) above are agreed or determined, the Employer shall assess a provisional rate or price for the purposes of interim payment under Sub-Clause 14.6 [*Interim Payment*].

13.3.2. Variation by Request for Proposal

The Employer may request a proposal, before instructing a Variation, by giving a Notice (describing the proposed change) to the Contractor. The Contractor shall respond to this Notice as soon as practicable, by either:

(a) submitting a proposal, which shall include the matters as described in sub-paragraphs (a) to (c) of Sub-Clause 13.3.1 [*Variation by Instruction*]; or
(b) giving reasons why the Contractor cannot comply (if this is the case), by reference to the matters described in sub-paragraphs (a) to (e) of Sub-Clause 13.1 [*Right to Vary*].

If the Contractor submits a proposal, the Employer shall proceed under Sub-Clause 2.4 *[The Authority's Engineer and the Employer]*and accordingly respond by giving a Notice to the Contractor stating their consent or otherwise. The Contractor shall not delay any work whilst awaiting a response.

If the Employer gives consent to the proposal, with or without comments, the Employer shall then instruct the Variation. Thereafter, the Contractor shall submit any further particulars that the Employer may reasonably require and the third paragraph of Sub-Clause 13.3.1 [*Variation by Instruction*] shall apply.

If the Employer does not give consent to the proposal, with or without comments, and if the Contractor has incurred Cost as a result of submitting it, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment of such Cost.

13.4 Provisional Sums

Each Provisional Sum shall only be used, in whole or in part, in accordance with the Employer's instructions, and the Contract Price shall be adjusted accordingly. The

total sum paid to the Contractor shall include only such amounts for the work, supplies or services to which the Provisional Sum relates, as the Employer shall have instructed. For each Provisional Sum, the Employer may instruct:

(a) work to be executed (including Plant, Materials or Services to be supplied) by the Contractor, and for which adjustments to the Contract Price and the Schedule of Payments (if any) shall be agreed or determined under Sub-Clause 13.3.1 [*Variation by Instruction*]; and/or

(b) Plant, Materials, works or services to be purchased by the Contractor from a nominated Subcontractor (as defined in Sub-Clause 4.5 [*Nominated Subcontractors*]) or otherwise, and for which there shall be included in the Contract Price:

  (i) the actual amounts paid (or due to be paid) by the Contractor; and

  (ii) a sum for overhead charges and profit, calculated as a percentage of these actual amounts by applying the relevant percentage rate (if any) stated in the applicable Schedule. If there is no such rate, the percentage rate stated in the Contract Data shall be applied.

If the Employer instructs the Contractor under sub-paragraph (a) and/or (b) above, this instruction may include a requirement for the Contractor to submit quotations from the Contractor's suppliers and/or subcontractors for all (or some) of the items of the work to be executed or Plant, Materials, works or services to be purchased. Thereafter, the Employer may respond by giving a Notice either instructing the Contractor to accept one of these quotations (but such instruction shall not be taken as an instruction under Sub-Clause 4.5 [*Nominated Subcontractors*]), or revoking the instruction. If the Employer does not so respond within 7 days of receiving the quotations, the Contractor shall be entitled to accept any of these quotations at the Contractor's discretion.

Each Statement that includes a Provisional Sum shall also include all applicable invoices, vouchers and accounts or receipts in substantiation of the Provisional Sum.

13.5 Daywork

If a Daywork Schedule is not included in the Contract, this Sub-Clause shall not apply.

For work of a minor or incidental nature, the Employer may instruct that a Variation shall be executed on a daywork basis. The work shall then be valued in accordance with the Daywork Schedule, and the following procedure shall apply.

Before ordering Goods for such work (other than any Goods priced in the Daywork Schedule), the Contractor shall submit one or more quotations from the Contractor's suppliers and/or subcontractors to the Employer. Thereafter, the Employer may instruct the Contractor to accept one of these quotations (but such instruction shall not be taken as an instruction under Sub-Clause 4.5 [*Nominated Subcontractors*]). If the Employer does not so instruct the Contractor within 7 days of receiving the quotations, the Contractor shall be entitled to accept any of these quotations at the Contractor's discretion.

Except for any items for which the Daywork Schedule specifies that payment is not due, the Contractor shall deliver each day to the Employer accurate statements in duplicate (and one electronic copy), which shall include records (as described under Sub-Clause 6.10 [*Contractor's Records*]) of the resources used in executing the previous day's work.

One copy of each statement shall, if correct and agreed, be signed by the Employer and promptly returned to the Contractor. If not correct or agreed, then the Employer's Representative shall proceed under Sub-Clause 3.5 [*Agreement or Determination*] to agree or determine the resources (and, for the purpose of Sub-Clause 3.5.3 [*Time limits*], the date the works which are the subject of the Variation under this Sub-Clause are completed by the Contractor shall be the date of commencement of the time limit for agreement under Sub-Clause 3.5.3).

In the next Statement, the Contractor shall then submit priced statements of the agreed or determined resources to the Employer, together with all applicable invoices, vouchers and accounts or receipts in substantiation of any Goods used in the daywork (other than Goods priced in the Daywork Schedule).

Unless otherwise stated in the Daywork Schedule, the rates and prices in the Daywork Schedule shall be deemed to include taxes, overheads and profit.

13.6 Adjustments for Changes in Laws

Subject to the following provisions of this Sub-Clause, the Contract Price shall be

adjusted to take account of any increase or decrease in Cost resulting from a change in:

(a) the Laws of the Country (including the introduction of new Laws and the repeal or modification of existing Laws);
(b) the judicial or official governmental interpretation or implementation of the Laws referred to in sub-paragraph (a) above;
(c) any permit, permission, license or approval obtained by the Employer or the Contractor under sub-paragraph (a) or (b), respectively, of Sub-Clause 1.12 [*Compliance with Laws*];
(d) the requirements for any permit, permission, licence and/or approval to be obtained by the Contractor under sub-paragraph (b) of Sub-Clause 1.12 [*Compliance with Laws*]; or
(e) the interpretation or application of any Indian law by a judgement of a court of record which has become final, conclusive and binding, as compared to such interpretation or application by a court of record prior to the Base Date,

made and/or officially published after the Base Date, which affect the Contractor in the performance of obligations under the Contract. In this Sub-Clause "change in Laws" means any of the changes under sub-paragraphs (a), (b), (c) and/or (d) above.

If the Contractor suffers delay and/or incurs an increase in Cost as a result of any change in Laws, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to EOT and/or payment of such Cost.

If there is a decrease in Cost as a result of any change in Laws, the Employer shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to a reduction in the Contract Price.

If any adjustment to the execution of the Works becomes necessary as a result of any change in Laws:

(i) the Contractor shall promptly give a Notice to the Employer, or
(ii) the Employer shall promptly give a Notice to the Contractor (with detailed supporting particulars).

Thereafter, the Employer shall either instruct a Variation under Sub-Clause 13.3.1 [*Variation by Instruction*] or request a proposal under Sub-Clause 13.3.2 [*Variation by Request for Proposal*].

13.7 Adjustments for Changes in Cost

If there are no schedule(s) of cost indexation in the Particular Conditions of Contract, this Sub-Clause shall not apply.

The amounts payable to the Contractor shall be adjusted for rises or falls in the cost of labour, Goods and other inputs to the Works, by the addition or deduction of the amounts calculated in accordance with the schedule(s) of cost indexation in the Particular Conditions of Contract.

To the extent that full compensation for any rise or fall in Costs is not covered by this Sub-Clause or other Clauses of these Conditions, the Contract Price stated in the Contract Agreement shall be deemed to have included amounts to cover the contingency of other rises and falls in costs.

The adjustment to be applied to the amount otherwise payable to the Contractor under Clause 14 [*Contract Price and Payment*] shall be calculated in which the Contract Price is payable. No adjustment shall be applied to work valued on the basis of Cost or current prices.

Until such time as each current cost index is available, the Employer shall use a provisional index for the purpose of interim payments under Sub-Clause 14.6 [*Interim Payment*]. When a current cost index is available, the adjustment shall be recalculated accordingly.

If the Contractor fails to complete the Works within the Time for Completion, adjustment of prices thereafter shall be made using either:

(a) each index or price applicable on the date 49 days before the expiry of the Time for Completion of the Works; or
(b) the current index or price

whichever is more favourable to the Employer.

14. Contract Price and Payment

14.1 The Contract Price

Unless otherwise stated in the Particular Conditions of Contract:

(a) payment for the Works shall be made on the basis of the lump sum Contract Price stated in the Contract Agreement, subject to adjustments, additions (including Cost or Cost Plus Profit to which the Contractor is entitled under these Conditions) and/or deductions in accordance with the Contract;

(b) the Contractor shall pay all taxes, duties and fees required to be paid by the Contractor under the Contract, and the Contract Price shall not be adjusted for any of these costs, except as stated in Sub-Clause 13.6 [*Adjustments for Changes in Laws*]; and

(c) if any quantities are set out in a Schedule, they shall not be taken as the actual and correct quantities of the Works which the Contractor is required to execute, and they shall be used only for the purpose(s) stated in the Schedule and for no other purpose(s).

14.2 Mobilisation Advance

If no amount of mobilisation advance is stated in the Contract Data, this Sub-Clause shall not apply.

Subject to the following provisions of this Sub-Clause, the Employer shall make a mobilisation advance for mobilisation and design. The amount of the mobilisation advance and the interest rate, if applicable, shall be as stated in the Contract Data.

14.2.1 Mobilisation Advance Bank Guarantee

The Contractor shall obtain (at the Contractor's cost) a Mobilisation Advance Bank Guarantee in amount equal to 110% of the amount of mobilisation advance and shall submit it to the Employer. This guarantee shall be issued by a Bank and shall be based on the sample form included in the tender documents or on another form agreed by the Employer (but such consent and/or agreement shall not relieve the Contractor from any obligation under this Sub-Clause).

The Contractor shall ensure that the Mobilisation Advance Bank Guarantee is valid and enforceable until the mobilisation advance has been repaid, but its amount may

be progressively reduced by the amount repaid by the Contractor.

If the terms of the Mobilisation Advance Bank Guarantee specify its expiry date, and the mobilisation advance has not been repaid by the date 28 days before the expiry date:

(a) the Contractor shall extend the validity of this guarantee until the mobilisation advance has been repaid;
(b) the Contractor shall immediately submit evidence of this extension to the Employer; and
(c) if the Employer does not receive this evidence 7 days before the expiry date of this guarantee, the Employer shall be entitled to claim under the guarantee the amount of mobilisation advance which has not been repaid.

When submitting the Mobilisation Advance Bank Guarantee, the Contractor shall include an application (in the form of a Statement) for the mobilisation advance.

14.2.2 Mobilisation Advance

The Employer shall ensure that the mobilisation advance is paid within 14 days after:

(a) the Employer has received both the Performance Security and the Mobilisation Advance Bank Guarantee, in the form and issued by a Bank in accordance with Sub-Clause 4.2.1 [*Contractor's Obligations*] and Sub-Clause 14.2.1 [*Mobilisation Advance Bank Guarantee*] respectively; and
(b) the Employer has received the Contractor's application for the mobilisation advance under Sub-Clause 14.2.1 [*Mobilisation Advance Bank Guarantee*].

14.2.3 Repayment of Mobilisation Advance

The mobilisation advance shall be repaid through percentage deductions in interim payments under Sub-Clause 14.6 [*Interim Payment*]. Unless other percentages are stated in the Contract Data:

(a) deductions, including interest on the amount being recovered, shall commence when the interim payment (excluding the mobilisation advance and deductions and release of retention moneys) exceeds ten percent (10%) of the portion of the Contract Price stated in the Contract Agreement less Provisional Sums; and

(b) deductions shall be made pro-rata from each interim payment until the 100 % of the advance amount is recouped by the time 80% of the Contract Price is billed.

If the mobilisation advance has not been repaid before the issue of the Completion Certificate for the Works, or before termination under Clause 15 [*Termination by Employer*], Clause 16 [*Suspension and Termination by Contractor*] or Clause 18 [*Force Majeure*] (as the case may be), the whole of the balance then outstanding shall immediately become due and payable by the Contractor to the Employer.

14.3 Application for Interim Payment

The Contractor shall submit a Statement to the Employer after the end of the period of payment stated in the Contract Data (if not stated, after the end of each month). Each Statement shall:

(a) be in a form acceptable to the Employer;
(b) be submitted in one paper-original, one electronic copy and additional paper copies (if any) as stated in the Contract Data; and
(c) show in detail the amounts to which the Contractor considers that the Contractor is entitled, with supporting documents which shall include sufficient detail for the Employer to investigate these amounts together with the relevant report on progress in accordance with Sub-Clause 4.20 [*Progress Reports*].

The Statement shall include the following items, as applicable, in the sequence listed:

(i) the estimated contract value of the Works executed, and the Contractor's Documents produced, up to the end of the period of payment (including Variations but excluding items described in sub-paragraphs (ii) to (x) below);
(ii) any amounts to be added and/or deducted for changes in Laws under Sub-Clause 13.6 [*Adjustments for Changes in Laws*], and for changes in Cost under Sub-Clause 13.7 [*Adjustments for Changes in Cost*];
(iii) any amount to be deducted for retention, calculated by applying the percentage of retention stated in the Contract Data to the total of the amounts under sub-paragraphs (i), (ii) and (vi) of this Sub-Clause, until the amount so retained by the Employer reaches the limit of Retention Money (if any) stated

in the Contract Data;

(iv) any amounts to be added and/or deducted for the mobilisation advance and repayments under Sub-Clause 14.2 [*Mobilisation Advance*];

(v) any amounts to be added and/or deducted for Plant and Materials under Sub-Clause 14.5 [*Plant and Materials intended for the Works*];

(vi) any other additions and/or deductions which have become due under the Contract or otherwise, including those under Sub-Clause 3.5 [*Agreement or Determination*];

(vii) any amounts to be added for Provisional Sums under Sub-Clause 13.4 [*Provisional Sums*];

(viii) any amount to be added for release of Retention Money under Sub-Clause 14.9 [*Release of Retention Money*];

(ix) any amount to be deducted for the Contractor's use of utilities provided by the Employer under Sub-Clause 4.19 [*Temporary Utilities*]; and

(x) the deduction of amounts previously paid by the Employer under Sub-Clause 14.7 [*Payment*].

14.4 Schedule of Payments

If the Contract includes a Schedule of Payments specifying the instalments in which the Contract Price will be paid then, unless otherwise stated in this Schedule:

(a) the instalments quoted in the Schedule of Payments shall be treated as the estimated contract values for the purposes of sub-paragraph (i) of Sub-Clause 14.3 [*Application for Interim Payment*], subject to Sub-Clause 14.5 [*Plant and Materials intended for the Works*]; and

(b) if:

(i) these instalments are not defined by reference to the actual progress achieved in execution of the Works; and

(ii) actual progress is found by the Employer to differ from that on which the Schedule of Payments was based.

then the Employer's Representative shall proceed under Sub-Clause 3.5 [*Agreement or Determination*] to agree or determine revised instalments (and, for the purpose of Sub-Clause 3.5.3 [*Time limits*], the date when the difference under sub-paragraph (ii) above was found by the Employer shall be the date

of commencement of the time limit for agreement under Sub-Clause 3.5.3). Such revised instalments shall take account of the extent to which progress differs from that on which the Schedule of Payments was based.

If the Contract does not include a Schedule of Payments, the Contractor shall submit non-binding estimates of the payments which the Contractor expects to become due during each period of 3 months. The first estimate shall be submitted within 42 days after the Commencement Date. Revised estimates shall be submitted at intervals of 3 months, until the issue of the Completion Certificate for the Works.

14.5 Plant and Materials intended for the Works

If no Plant and/or Materials are listed in the Contract Data for payment when shipped and/or payment when delivered, this Sub-Clause shall not apply.

The Contractor shall include, under sub-paragraph (v) of Sub-Clause 14.3 [*Application for Interim Payment*]:

- an amount to be added for Plant and Materials which have been shipped or delivered (as the case may be) to the Site for incorporation in the Permanent Works; and

- an amount to be deducted when the contract value of such Plant and Materials is included as part of the Permanent Works under sub-paragraph (i) of Sub-Clause 14.3 [*Application for Interim Payment*].

then the Employer's Representative shall proceed under Sub-Clause 3.5 [*Agreement or Determination*] to agree or determine each amount to be added for Plant and Materials if the following conditions are fulfilled (and, for the purpose of Sub-Clause 3.5.3 [*Time limits*], the date these conditions are fulfilled shall be the date of commencement of the time limit for agreement under Sub-Clause 3.5.3):

a) the Contractor has:
   (i) kept satisfactory records (including the orders, receipts, Costs and use of Plant and Materials) which are available for inspection by the Employer;
   (ii) submitted evidence demonstrating that the Plant and Materials comply

with the Contract (which may include test certificates under Sub-Clause 7.4 [*Testing by the Contractor*] and/or compliance verification documentation under Sub-Clause 4.9.2 [*Compliance Verification System*]) to the Employer; and

(iii) submitted a statement of the Cost of acquiring and shipping or delivering (as the case may be) the Plant and Materials to the Site, supported by satisfactory evidence;

and either:

b) the relevant Plant and Materials:

(i) are those listed in the Contract Data for payment when shipped;

(ii) have been shipped to the Country, enroute to the Site, in accordance with the Contract; and

(iii) are described in a clean shipped bill of lading or other evidence of shipment, which has been submitted to the Employer together with:

- evidence of payment of freight and insurance;
- any other documents reasonably required by the Employer; and
- a written undertaking by the Contractor that the Contractor will deliver to the Employer (prior to submitting the next Statement) a Bank guarantee in a form and issued by a Bank to which the Employer gives consent (but such consent shall not relieve the Contractor from any obligation in the following provisions of this sub-paragraph), equal to the amount due under this Sub-Clause. This guarantee shall be in a similar form to the form described in Sub-Clause 14.2.1 [*Mobilisation Advance Guarantee*] and shall be valid until the Plant and Materials are properly stored on Site and protected against loss, damage or deterioration; or

c) the relevant Plant and Materials:

(i) are those listed in the Contract Data for payment when delivered to the Site, and

(ii) have been delivered to and are properly stored on the Site, are protected against loss, damage or deterioration, and appear to be in accordance with the Contract.

The amount so agreed or determined shall take account of the evidence and

documents required under this Sub-Clause and of the contract value of the Plant and Materials. If sub-paragraph (b) above applies, the Employer shall have no obligation to make any payment under this Sub-Clause until the Employer has received the Bank guarantee in accordance with sub-paragraph (b)(iii) above. The sum to be paid by the Employer in an interim payment shall be the equivalent to the percentage of this agreed or determined amount stated in the Contract Data. The interim payment shall include the applicable amount to be deducted which shall be equivalent to this additional amount for the relevant Plant and Materials.

14.6 Interim Payments

No amount will be paid to the Contractor until:

(a) the Employer has received the Performance Security in the form, and issued by an entity, in accordance with Sub-Clause 4.2.1[*Contractor's obligations*]; and

(b) the Contractor has appointed the Contractor's Representative in accordance with Sub-Clause 4.3 [*Contractor's Representative*].

14.6.1 Notice of interim payment

The Employer shall submit the verified Statement and supporting documents, together with a Notice to the Contractor, to the Authority's Engineer within 21 days of receipt from the Contractor.

The Authority's Engineer shall, within 21 days of receipt, either return the scrutinized Statement and supporting documents to the Employer for necessary modifications, if any, or submit the scrutinized Statement, along with its recommendations, directly to the Funding Agency for payment, with a copy to the Employer.

Upon receipt of the Authority's Engineer's submission, the Employer shall issue a Notice to the Contractor:

(a) stating the amount which the Employer fairly considers to be due for the interim payment; and

(b) including any additions and/or deductions which have become due under Sub-Clause 3.5 [*Agreement or Determination*] or under the Contract or

otherwise,

with detailed supporting particulars (which shall identify any difference between a notified amount and the corresponding amount in the Statement and give the reasons for such difference).

The Funding Agency shall process and make the payment to the Contractor within 42 days from the date of issuance of the Notice by the Employer to the Contractor.

14.6.2 Withholding (amounts in) an interim payment

The Employer may withhold an interim payment which would (after retention and other deductions) be less than the minimum amount of interim payment (if any) stated in the Contract Data. In this event, the Employer shall promptly give a Notice to the Contractor accordingly.

An interim payment shall not be withheld for any other reason, although:

(a) if anything supplied or work done by the Contractor is not in accordance with the Contract, the estimated cost of rectification or replacement may be withheld until rectification or replacement has been completed;
(b) if the Contractor was or is failing to perform any work, service or obligation in accordance with the Contract, the value of this work or obligation may be withheld until the work or obligation has been performed. In this event, the Employer shall promptly give a Notice to the Contractor describing the failure and with detailed supporting particulars of the value withheld; and/or
(c) if the Employer finds any significant error or discrepancy in the Statement or supporting documents, the amount of the interim payment may take account of the extent to which this error or discrepancy has prevented or prejudiced proper investigation of the amounts in the Statement until such error or discrepancy is corrected in a subsequent Statement.

For each amount so withheld, in the supporting particulars for the interim payment the Employer shall detail his/her calculation of the amount and state the reasons for it being withheld.

14.6.3 Correction or modification

The Employer may, in any interim payment, make any correction or modification that should properly be made to any previous interim payment. An interim payment shall not be deemed to indicate the Employer's acceptance, approval, consent or Notice of No-objection to any Contractor's Document or to (any part of) the Works.

If the Contractor considers that an interim payment does not include any amounts to which the Contractor is entitled, these amounts shall be identified in the next Statement (the "identified amounts" in this paragraph). The Employer shall then make any correction or modification that should properly be made in the next interim payment. Thereafter, to the extent that:

(a) the Contractor is not satisfied that this next interim payment includes the identified amounts; and
(b) the identified amounts do not concern a matter for which the Employer's Representative is already carrying out his/her duties under Sub-Clause 3.5 [*Agreement or Determination*]

the Contractor may, by giving a Notice, refer this matter to the Employer's Representative and Sub-Clause 3.5 [*Agreement or Determination*] shall apply (and, for the purpose of Sub-Clause 3.5.3 [*Time limits*], the date the Employer's Representative receives this Notice shall be the date of commencement of the time limit for agreement under Sub-Clause 3.5.3).

14.7 Payment

The word "day" with reference to this Sub-Clauses 14.6[*Interim Payments*] and 14.7 [*Payment*] shall be interpreted as a business day. The detailed Payment Sequence shall be as per the document mentioned in the Contract Data.

The Employer shall ensure to pay to the Contractor:

(a) the mobilisation advance within the period stated in Sub-Clause 14.2.2 [*Mobilisation Advance*];
(b) the interim payment due under:
    (i) Sub-Clause 14.6 [*Interim Payment*], within the period stated in the Contract

Data (if not stated, 84 days) after the Employer receives the Statement and supporting documents; or

(ii) Sub-Clause 14.13 [*Final Payment*], within the period stated in the Contract Data (if not stated, 70 days) after the Employer receives the Partially Agreed Final Statement (or, if sub-paragraph (ii) of Sub-Clause 14.13 applies, within 112 days after the Employer receives the draft final Statement that is deemed to be a Partially Agreed Final Statement); and

(c) the Final Payment under Sub-Clause 14.13 [*Final Payment*] within the period stated in the Contract Data (if not stated, 84 days) after the Employer:

(i) receives the Final Statement (or if the second paragraph of Sub-Clause 14.13 applies, after the expiry of 14 days after the Employer issues the Notice stating the Final Payment); and

(ii) receives (or the Contractor is deemed to have issued) the discharge under Sub-Clause 14.12 [*Discharge*].

Payment of the amount due shall be made into the bank account, nominated by the Contractor.

14.8 Delayed Payment

If the Contractor does not receive payment in accordance with Sub-Clause 14.7 [*Payment*], the Contractor shall be entitled to receive interest compounded monthly on the amount unpaid during the period of delay. Unless otherwise stated in the Contract Data, this interest shall be calculated at the annual rate of three percent (3%) above the Bank Rate.

The Contractor shall by request, be entitled to payment of this interest by the Employer.

14.9 Release of Retention Money

After the issue of the Completion Certificate for:

(a) the Works, the Contractor shall include the first half of the Retention Money in a Statement; or

(b) for a Section, the Contractor shall include the relevant percentage of the first half of the Retention Money in a Statement.

After the latest of the expiry dates of the Defects Liability Periods, the Contractor shall include the second half of the Retention Money in a Statement promptly after such latest date. If a Completion Certificate was (or was deemed to have been) issued for a Section, the Contractor shall include the relevant percentage of the second half of the Retention Money in a Statement promptly after the expiry date of the DLP for the Section.

In the next interim payment or the Final Payment (as the case may be) after the Employer receives any such Statement, the Employer shall ensure release of the corresponding amount of Retention Money. However, when considering the amount to be due for release of Retention Money under Sub-Clause 14.6 [*Interim Payment*], if any work remains to be executed under Clause 11 [*Defects after Taking Over*] or Clause 12 [*Tests after Completion*], the Employer shall be entitled to withhold the estimated cost of this work until it has been executed.

The relevant percentage for each Section shall be the percentage value of the Section as stated in the Contract Data. If the percentage value of a Section is not stated in the Contract Data, no percentage of either half of the Retention Money shall be released under this Sub-Clause in respect of such Section.

14.10 Statement at Completion

Within 84 days after the Date of Completion of the Works, the Contractor shall submit to the Employer a Statement at completion with supporting documents, in accordance with Sub-Clause 14.3 [*Application for Interim Payment*], showing:

(a) the value of all work done in accordance with the Contract up to the Date of Completion of the Works
(b) any further sums which the Contractor considers to be due at the Date of Completion of the Works; and
(c) an estimate of any other amounts which the Contractor considers have or will become due after the Date of Completion of the Works under the Contract or otherwise. These estimated amounts shall be shown separately (to those of sub-paragraphs (a) and (b) above) and shall include estimated amounts for:
    (i) Claims for which the Contractor has submitted a Notice under Sub-Clause 20.2 [*Claims For Payment and/or EOT*];
    (ii) any matter referred to the DAAB under Sub-Clause 21.4 [*Obtaining*

DAAB's Decision]; and

(iii) any matter for which a NOD has been given under Sub-Clause 21.4 [*Obtaining DAAB's Decision*].

The Employer shall then proceed in accordance with Sub-Clause 14.6 [*Interim Payment*].

14.11 Final Statement

Submission by the Contractor of any Statement under the following provisions of this Sub-Clause shall not be delayed by reason of any referral under Sub-Clause 21.4 [*Obtaining DAAB's Decision*] or any arbitration under Sub-Clause 21.6 [*Arbitration*].

14.11.1 Draft Final Statement

Within 56 days after the issue of the Performance Certificate, the Contractor shall submit to the Employer, a draft final Statement. This Statement shall:

(a) be in the same form as Statements previously submitted under Sub-Clause 14.3 [*Application for Interim Payment*];

(b) be submitted in one paper-original, one electronic copy and additional paper copies (if any) as stated in the Contract Data; and

(c) show in detail, with supporting documents:

(i) the value of all work done in accordance with the Contract;

(ii) any further sums which the Contractor considers to be due at the date of the issue of the Performance Certificate, under the Contract or otherwise; and

(iii) an estimate of any other amounts which the Contractor considers have or will become due after the issue of the Performance Certificate, under the Contract or otherwise, including estimated amounts, by reference to the matters described in sub-paragraphs (c) (i) to (iii) of Sub-Clause 14.10 [*Statement at Completion*]. These estimated amounts shall be shown separately (to those of sub-paragraphs (i) and (ii) above).

Except for any amount under sub-paragraph (iii) above, if the Employer disagrees with or cannot verify any part of the draft final Statement, the Employer shall promptly give a Notice to the Contractor. The Contractor shall then submit such further information as the Employer may reasonably require within the time stated in this Notice, and shall make such changes in the draft as may be agreed between them.

14.11.2 Agreed Final Statement

If there are no amounts under sub-paragraph (iii) of Sub-Clause 14.11.1 [*Draft Final Statement*], the Contractor shall then prepare and submit to the Employer the final Statement as agreed (the "Final Statement" in these Conditions).

However if:

(a) there are amounts under sub-paragraph (iii) of Sub-Clause 14.11.1 [*Draft Final Statement*]; and/or
(b) following discussions between the Employer and the Contractor, it becomes evident that they cannot agree any amount(s) in the draft final Statement,

the Contractor shall then prepare and submit to the Employer a Statement, identifying separately: the agreed amounts, the estimated amounts and the disagreed amount(s) (the "Partially Agreed Final Statement" in these Conditions).

14.12 Discharge

When submitting the Final Statement or the Partially Agreed Final Statement (as the case may be), the Contractor shall submit a discharge which confirms that the total of such Statement represents full and final settlement of all moneys due to the Contractor under or in connection with the Contract. This discharge may state that the total of the Statement is subject to any payment that may become due in respect of any Dispute for which a DAAB proceeding or arbitration is in progress under Clause 21 [*Disputes and Arbitration*] and/or that it becomes effective after the Contractor has received:

(a) full payment of the total amount stated in the Final Statement; and

(b) the Performance Security.

If the Contractor fails to submit this discharge, the discharge shall be deemed to have been submitted and to have become effective when the conditions of sub-paragraphs (a) and (b) have been fulfilled. If no Final Statement has been submitted by the Contractor and the second paragraph of Sub-Clause 14.13 [*Final Payment*] applies, the discharge shall be deemed to have been issued by the Contractor after the Contractor has received the Final Payment under the second paragraph of Sub-Clause 14.13 and the Performance Security.

A discharge under this Sub-Clause shall not affect either Party's liability or entitlement in respect of any Dispute for which a DAAB proceeding or arbitration is in progress under Clause 21 [*Disputes and Arbitration*].

14.13 Final Payment

Within 28 days after receiving the Final Statement or the Partially Agreed Final Statement (as the case may be), and the discharge under Sub-Clause 14.12 [*Discharge*], the Employer shall give a Notice to the Contractor stating:

(a) the amount which the Employer fairly considers is finally due, including any additions and/or deductions which have become due under Sub-Clause 3.5 [*Agreement or Determination*] or under the Contract or otherwise; and

after giving credit to the Employer for all amounts previously paid by the Employer and for all sums to which the Employer is entitled, and after giving credit to the Contractor for all amounts (if any) previously paid by the Contractor and/or received by the Employer under the Performance Security, the balance (if any) due from the Employer to the Contractor or from the Contractor to the Employer, as the case may be (the "Final Payment" in these conditions), with detailed supporting particulars.

If the Contractor has not submitted a draft final Statement within the time specified under Sub-Clause 14.11.1 [*Draft Final Statement*], the Employer shall request the Contractor to do so. Thereafter, if the Contractor fails to submit a draft final Statement within a period of 28 days, within a further 28 days after this time limit has expired the Employer shall give a Notice to the Contractor stating the Final Payment, with detailed supporting particulars.

If the Contractor has not submitted a discharge under Sub-Clause 14.12 [*Discharge*] but has either:

(i) submitted a Partially Agreed Final Statement under Sub-Clause 14.11.2 [*Agreed Final Statement*]; or

(ii) not done so but, to the extent that a draft final Statement submitted by the Contractor is deemed by the Employer to be a Partially Agreed Final Statement,

the Employer shall proceed in accordance with Sub-Clause 14.6 [*Interim Payments*] and Sub-Clause 14.7 [*Payment*] to make an interim payment to the Contractor.".

14.14 Cessation of Employer's Liability

The Employer shall not be liable to the Contractor for any matter or thing under or in connection with the Contract or execution of the Works, except to the extent that the Contractor shall have included an amount expressly for it in:

(a) the Final Statement or Partially Agreed Final Statement; and

(b) (except for matters or things arising after the issue of the Completion Certificate for the Works) the Statement under Sub-Clause 14.10 [*Statement at Completion*].

Unless the Contractor makes or has made a Claim under Sub-Clause 20.2 [*Claims For Payment and/or EOT*] in respect of an amount or amounts included in the Final Payment within 56 days of receiving the Final Payment the Contractor shall be deemed to have accepted the Final Payment as correct. The Employer shall then have no further liability to the Contractor, other than to return the Performance Security to the Contractor.

However, this Sub-Clause shall not limit the Employer's liability under the Employer's indemnification obligations, or the Employer's liability in any case of fraud, gross negligence, deliberate default or reckless misconduct by the Employer.

14.15 Currencies of Payment

The Contract Price shall be paid in the currency named in the Contract Data.

15. Termination by Employer

15.1 Notice to Correct

If the Contractor fails to carry out any obligation under the Contract, the Employer under intimation to the Authority's Engineer, may by giving a Notice to the Contractor, require the Contractor to make good the failure and to remedy it within a specified time ("Notice to Correct" in these Conditions). The Notice to Correct shall:

(a) describe the Contractor's failure;

(b) state the Sub-Clause and/or provisions of the Contract under which the Contractor has the obligation; and

(c) specify the time within which the Contractor shall remedy the failure, which shall be reasonable, taking due regard of the nature of the failure and the work and/or other action required to remedy it.

After receiving a Notice to Correct the Contractor shall immediately respond by giving a Notice to the Employer describing the measures the Contractor will take to remedy the failure, and stating the date on which such measures will be commenced in order to comply with the time specified in the Notice to Correct.

The time specified in the Notice to Correct shall not imply any extension of the Time for Completion.

15.2 Termination for Contractor's Default

Termination of the Contract under this Clause shall not prejudice any other rights of the Employer under the Contract or otherwise.

15.2.1 Notice

The Employer shall, with the consent of the Authority's Engineer, be entitled to give a Notice (which shall state that it is given under this Sub-Clause 15.2.1) to the Contractor of the Employer's intention to terminate the Contract if the Contractor or, in the case of sub-paragraph (f), (g) or (h) below a Notice of termination, if the Contractor:

(a) fails to comply with:

(i) a Notice to Correct;

(ii) a binding agreement, or final and binding determination, under Sub-Clause 3.5 [*Agreement or Determination*]; or

(iii) a decision of the DAAB under 21.4 [*Obtaining DAAB's Decision*] (whether binding or final and binding) and such failure constitutes a material breach of the Contractor's obligations under the Contract.

(b) abandons the Works or otherwise plainly demonstrates an intention not to continue performance of the Contractor's obligations under the Contract;

(c) without reasonable excuse fails to proceed with the Works in accordance with Clause 8 [*Commencement, Delays and Suspension*] or, if there is a maximum amount of Liquidated Delay Damages stated in the Contract Data, the Contractor's failure to comply with Sub-Clause 8.2 [*Time for Completion*] is such that the Employer would be entitled to Liquidated Delay Damages that exceed this maximum amount;

(d) without reasonable excuse fails to comply with a Notice of rejection given by the Employer under Sub-Clause 7.5 [*Defects and Rejection*] or an Employer's instruction under Sub-Clause 7.6 [*Remedial Work*], within 28 days after receiving it;

(e) subcontracts the whole, or any part of, the Works in breach of Sub-Clause 4.4 [*Subcontractors*], or assigns the Contract without the required agreement under Sub-Clause 1.7 [*Assignment*];

(f) becomes bankrupt or insolvent; goes into liquidation, administration, reorganisation, winding-up or dissolution, death; becomes subject to the appointment of a liquidator, receiver, administrator, manager or trustee; enters into a composition or arrangement with the Contractor's creditors; or any act is done or any event occurs which is analogous to or has a similar effect to any of these acts or events under applicable Laws;

or if the Contractor is a JV:

(i) any of these matters apply to a member of the JV,

(ii) the other member(s) do not promptly confirm to the Employer that, in accordance with Sub-Clause 1.13(a) [*Joint and Several Liability*], such member's obligations under the Contract shall be fulfilled in accordance with the Contract; or

(g) is found, based on reasonable evidence, to have engaged in corrupt, fraudulent, collusive or coercive practice at any time in relation to the Works or to the Contract.

15.2.2 Termination

Unless the Contractor remedies the matter described in a Notice given under Sub-Clause 15.2.1 [*Notice*] within 14 days of receiving the Notice, the Employer may, with the consent of the Authority's Engineer, by giving a second Notice to the Contractor, immediately terminate the Contract. The date of termination shall be the date the Contractor receives this second Notice.

However, in the case of sub-paragraph (f), (g) or (h) of Sub-Clause 15.2.1 [Notice], the Employer may by giving a Notice under Sub-Clause 15.2.1 immediately terminate the Contract and the date of termination shall be the date the Contractor receives this Notice.

15.2.3 After termination

After termination of the Contract under Sub-Clause 15.2.2 [*Termination*], the Contractor shall:

(a) comply immediately with any reasonable instructions included in a Notice given by the Employer under this Sub-Clause 15.2.2[*Termination*]
  (i) for the assignment of any subcontract; and
  (ii) for the protection of life or property or for the safety of the Works;
(b) deliver to the Employer:
  (i) any Goods required by the Employer,
  (ii) all Contractor's Documents, and
  (iii) all other design documents made by or for the Contractor; and
(c) leave the Site and, if the Contractor does not do so, the Employer

shall have the right to expel the Contractor from the Site.

15.2.4 Completion of the Works

After termination under this Sub-Clause, the Employer may complete the Works and/or arrange for any other entities to do so. The Employer and/or these entities may then use any Goods, Contractor's Documents and other design documents made by or on behalf of the Contractor to complete the Works.

After such completion of the Works, the Employer shall give another Notice to the Contractor that the Contractor's Equipment and Temporary Works will be released to the Contractor at or near the Site. The Contractor shall then promptly arrange their removal, at the risk and cost of the Contractor. However, if by this time the Contractor has failed to make a payment due to the Employer, these items may be sold (to the extent permitted by applicable Laws) by the Employer in order to recover this payment. Any balance of the proceeds shall then be paid to the Contractor.

15.3 Valuation after Termination for Contractor's Default

After termination of the Contract under Sub-Clause 15.2 [*Termination for Contractor's Default*], the Employer's Representative shall assess the value of the Permanent Works, Goods and Contractor's Documents, and any other sums due to the Contractor for work executed in accordance with the Contract and then the valuation shall be referred to the Employer. The Employer shall proceed under Sub-Clause 2.4 *[The Authority's Engineer and the Employer]* to agree or determine the valuation done by the Employer's Representative (and, for the purpose of Sub-Clause 3.5.3 [*Time limits*], the date of termination shall be the date of commencement of the time limit for agreement under Sub-Clause 3.5.3). This valuation shall include any additions and/or deductions, and the balance due (if any), by reference to the matters described in sub-paragraphs (a) and (b) of Sub-Clause 14.13 [*Final Payment*].

This valuation shall not include the value of any Contractor's Documents, Materials, Plant and Permanent Works to the extent that they do not comply with the Contract.

15.4 Payment after Termination for Contractor's Default

The Employer may withhold payment to the Contractor of the amounts agreed or determined under Sub-Clause 15.3 [*Valuation after Termination for Contractor's Default*] until all the costs, losses and damages (if any) described in the following provisions of this Sub-Clause have been established. After termination of the Contract under Sub-Clause 15.2 [*Termination for Contractor's Default*], the Employer shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to payment by the Contractor of:

(a) the additional costs of execution of the Works, and all other costs reasonably incurred by the Employer (including costs incurred in clearing, cleaning and reinstating the Site as described under Sub-Clause 11.11 [*Clearance of Site*]), after allowing for any sum due to the Contractor under Sub-Clause 15.3 [*Valuation after Termination for Contractor's Default*];

(b) any losses and damages suffered by the Employer in completing the Works; and

(c) Liquidated Delay Damages, if the Works or a Section have not been taken over under Sub-Clause 10.1 [*Taking Over the Works and Sections*] and if the date of termination under Sub-Clause 15.2 [*Termination for Contractor's Default*] occurs after the date corresponding to the Time for Completion of the Works or Section (as the case may be). Such Liquidated Delay Damages shall be paid for every day that has elapsed between these two dates.

15.5 Termination for Employer's Convenience

The Employer shall be entitled to terminate the Contract at any time for the Employer's convenience, by giving a Notice of such termination to the Contract or (which Notice shall state that it is given under this Sub-Clause 15.5). After giving a Notice to terminate under this Sub-Clause, the Employer shall immediately:

(a) have no right to further use any of the Contractor's Documents, which shall be returned to the Contractor, except those for which the Contractor has received payment or for which payment is due;

(b) if Sub-Clause 4.6 [*Co-operation*] applies, have no right to allow the continued use (if any) of any Contractor's Equipment, Temporary Works, access arrangements and/or other of the Contractor's facilities or services; and

(c) make arrangements to return the Performance Security to the Contractor.

Termination under this Sub-Clause shall take effect 28 days after the later of the dates on which the Contractor receives this Notice or the Employer returns the Performance Security. Unless and until the Contractor has received payment of the amount due under Sub-Clause 15.6 [*Valuation after Termination for Employer's Convenience*], the Employer shall not execute (any part of) the Works or arrange for (any part of) the Works to be executed by any other entities.

After this termination, the Contractor shall proceed in accordance with Sub-Clause 16.3 [*Contractor's Obligations After Termination*].

15.6 Valuation after Termination for Employer's Convenience

After termination under Sub-Clause 15.5 [*Termination for Employer's Convenience*] the Contractor shall, as soon as practicable, submit detailed supporting particulars (as reasonably required by the Employer) of:

(a) the value of work done, which shall include:
  (i) the matters described in sub-paragraphs (a) to (e) of Sub-Clause 18.5 [*Optional Termination*], and
  (ii) any additions and/or deductions, and the balance due (if any), by reference to the matters described in sub-paragraphs (a) and (b) of Sub-Clause 14.13 [*Final Payment*]; and

(b) the amount of any loss of profit or other losses and damages suffered by the Contractor as a result of this termination.

The Employer's Representative shall refer the matter to the Employer and the Employer shall proceed under Sub-Clause 2.4 *[The Authority's Engineer and the Employer]* to agree or determine the matters described in sub-paragraphs (a) and (b) above (and, for the purpose of Sub-Clause 3.5.3 [*Time limits*], the date

the Employer's Representative receives the Contractor's particulars under this Sub-Clause shall be the date of commencement of the time limit for agreement under Sub-Clause 3.5.3). The Employer shall pay the amount so agreed or determined to the Contractor.

15.7 Payment after Termination for Employer's Convenience

The Employer shall pay the Contractor the amount agreed or determined under Sub-Clause 15.6 [*Valuation after Termination for Employer's Convenience*] within 112 days after the Employer receives the Contractor's submission under that Sub-Clause.

16. Suspension and Termination by Contractor

16.1 Suspension by Contractor

If:

(a) the Employer fails to provide reasonable evidence in accordance with Sub-Clause 3.10 [*Change in Financial Arrangements*];
(b) the Employer fails to comply with Sub-Clause 14.7 [*Payment*]; or
(c) the Employer fails to comply with:
    (i) a binding agreement, or final and binding determination under Sub-Clause 3.5 [*Agreement or Determination*]; or
    (ii) a decision of the DAAB under 21.4 [*Obtaining DAAB's Decision*] (whether binding or final and binding)

and such failure constitutes a material breach of the Employer's obligations under the Contract,

the Contractor may, not less than 21 days after giving a Notice to the Employer (which Notice shall state that it is given under this Sub-Clause 16.1), suspend work (or reduce the rate of work) unless and until the Employer has remedied such default.

This action shall not prejudice the Contractor's entitlements to financing charges under Sub-Clause 14.8 [*Delayed Payment*] and to termination under Sub-Clause 16.2 [*Termination by Contractor*]. If the Employer subsequently remedies

the default as described in the above Notice before the Contractor gives a Notice of termination under Sub-Clause 16.2 [*Termination by Contractor*], the Contractor shall resume normal working as soon as is reasonably practicable.

If the Contractor suffers delay and/or incurs Cost as a result of suspending work (or reducing the rate of work) in accordance with this Sub-Clause, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to EOT and/or payment of such Cost Plus Profit.

16.2 Termination by Contractor

Termination of the Contract under this Clause shall not prejudice any other rights of the Contractor, under the Contract or otherwise.

16.2.1 Notice

The Contractor shall be entitled to give a Notice (which shall state that it is given under this Sub-Clause 16.2.1) to the Employer of the Contractor's intention to terminate the Contract if:

(a) the Contractor does not receive the reasonable evidence within 42 days after giving a Notice under Sub-Clause 16.1 [*Suspension by Contractor*] in respect of a failure to comply with Sub-Clause 3.10 [*Change in Financial Arrangements*];

(b) the Contractor does not receive a payment under Sub-Clause 14.7 [*Payment*] within 42 days after the expiry of the relevant period for payment stated in Sub-Clause 14.7;

(c) the Employer fails to comply with:

(i) a binding agreement, or final and binding determination under Sub-Clause 3.5 [*Agreement or Determination*]; or

(ii) a decision of the DAAB under 21.4 [*Obtaining DAAB's Decision*] (whether binding or final and binding)

and such failure constitutes a material breach of the Employer's obligations under the Contract;

(d) the Employer substantially fails to perform, and such failure constitutes a material breach of, the Employer's obligations under the

Contract;

(e) the Contractor does not receive a Notice to Proceed (NTP) under Sub-Clause 8.1 [*Commencement of Works*] within 84 days after both Parties have signed the Contract Agreement;

(f) the Employer:

(i) fails to comply with Sub-Clause 1.6 [*Contract Agreement*], or

(ii) assigns the Contract without the required agreement under Sub-Clause 1.7 [*Assignment*];

(g) a prolonged suspension affects the whole of the Works as described in sub-paragraph (b) of Sub-Clause 8.13 [*Prolonged Suspension*];

(h) the Employer becomes bankrupt or insolvent; goes into liquidation, administration, reorganisation, winding-up or dissolution; becomes subject to the appointment of a liquidator, receiver, administrator, manager or trustee; enters into a composition or arrangement with the Employer's creditors; or any act is done or any event occurs which is analogous to or has a similar effect to any of these acts or events under applicable Laws; or

(i) the Employer is found, based on reasonable evidence, to have engaged in corrupt, fraudulent, collusive or coercive practice at any time in relation to the Works or to the Contract.

16.2.2 Termination

Unless the Employer remedies the matter described in a Notice given under Sub-Clause 16.2.1 [*Notice*] within 14 days of receiving the Notice, the Contractor may by giving a second Notice to the Employer immediately terminate the Contract. The date of termination shall then be the date the Employer receives this second Notice.

If the Contractor suffers delay and/or incurs Cost during the above period of 14 days, the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to EOT and/or payment of such Cost Plus Profit.

16.3 Contractor's Obligations After Termination

After termination of the Contract under Sub-Clause 15.5 [*Termination for*

Employer's Convenience], Sub-Clause 16.2 [*Termination by Contractor*] or Sub-Clause 18.5 [*Optional Termination*], the Contractor shall promptly:

(a) cease all further work, except for such work as may have been instructed by the Employer for the protection of life or property or for the safety of the Works. If the Contractor incurs Cost as a result of carrying out such instructed work the Contractor shall be entitled subject to Sub-Clause 20.2 [*Claims For Payment and/or EOT*] to be paid such Cost Plus Profit;
(b) deliver to the Employer all Contractor's Documents, Plant, Materials and other work for which the Contractor has received payment; and
(c) remove all other Goods from the Site, except as necessary for safety, and leave the Site.

16.4 Payment after Termination by Contractor

After termination under Sub-Clause 16.2 [*Termination by Contractor*], the Employer shall promptly:

(a) pay the Contractor in accordance with Sub-Clause 18.5 [*Optional Termination*]; and
(b) subject to the Contractor's compliance with Sub-Clause 20.2 [*Claims For Payment and/or EOT*], pay the Contractor the amount of any loss of profit or other losses and damages suffered by the Contractor as a result of this termination.

17. Care of the Works and Indemnities

17.1 Responsibility for Care of the Works

Unless the Contract is terminated in accordance with these Conditions or otherwise, subject to Sub-Clause 17.2 [*Liability for Care of the Works*] the Contractor shall take full responsibility for the care of the Works, Goods and Contractor's Documents from the Commencement Date until the issue (or deemed issue) of the Completion Certificate for the Works, when responsibility for the care of the Works shall pass to the Employer. If a Completion Certificate is issued (or is deemed to be issued) for any Section, responsibility for the care of the Section shall then pass to the Employer.

If the Contract is terminated in accordance with these Conditions or otherwise, the Contractor shall cease to be responsible for the care of the Works from the date of termination.

After responsibility has accordingly passed to the Employer, the Contractor shall take responsibility for the care of any work which is outstanding on the Date of Completion, until this outstanding work has been completed.

If any loss or damage occurs to the Works, Goods or Contractor's Documents, during the period when the Contractor is responsible for their care, from any cause whatsoever except as stated in Sub-Clause 17.2 [*Liability for Care of the Works*], the Contractor shall rectify the loss or damage at the Contractor's risk and cost, so that the Works, Goods or Contractor's Documents (as the case may be) comply with the Contract.

17.2 Liability for Care of the Works

The Contractor shall be liable for any loss or damage caused by the Contractor to the Works, Goods or Contractor's Documents even after the issue of a Completion Certificate. The Contractor shall also be liable for any loss or damage, which occurs after the issue of a Completion Certificate and which arose from an event which occurred before the issue of this Completion Certificate, for which the Contractor was liable.

The Contractor shall have no liability whatsoever, whether by way of indemnity or otherwise, for loss or damage to the Works, Goods or Contractor's Documents caused by any of the following events (except to the extent that such Works, Goods or Contractor's Documents have been rejected by the Employer under Sub-Clause 7.5 [*Defects and Rejection*] before the occurrence of any of the following events):

(a) interference, whether temporary or permanent, with any Right of Way, light, air, water or other easement (other than that resulting from the Contractor's method of construction) which is the unavoidable result of the execution of the Works in accordance with the Contract;
(b) use or occupation by the Authority/Employer of any part of the Permanent Works, except as may be specified in the Contract;

(c) fault, error, defect or omission in any element of the design of the Works by the Employer, other than design carried out by the Contractor in accordance with the Contractor's obligations under the Contract;

(d) any operation of the forces of nature (other than those allocated to the Contractor in the Contract Data) which is Unforeseeable or against which an experienced contractor could not reasonably have been expected to have taken adequate preventative precautions;

(e) any Force Majeure and/or;

(f) any act or default of the Authority, Employer, Personnel of Authority or Employer or Employer's other contractors.

If any of the events described in sub-paragraphs (a) to (f) above occurs and results in damage to the Works, Goods or Contractor's Documents the Contractor shall promptly give a Notice to the Employer. Thereafter, the Contractor shall rectify any such loss and/or damage that may arise to the extent instructed by the Employer. Such instruction shall be deemed to have been given under Sub-Clause 13.3.1 [*Variation by Instruction*] and, in the case of sub-paragraph (e) above, shall be without prejudice to any other rights the Contractor may have under Sub-Clause 18.4 [*Consequences of a Force Majeure*].

If the loss and/or damage to the Works or Goods or Contractor's Documents results from a combination of:

(i) any of the events described in sub-paragraphs (a) to (f) above, and

(ii) a cause for which the Contractor is liable,

and the Contractor suffers a delay and/or incurs Cost from rectifying the loss and/or damage, the Contractor shall subject to Sub-Clause 20.2 [*Claims for Payment and/or EOT*] be entitled to a proportion of EOT and/or Cost Plus Profit to the extent that any of the above events have contributed to such delay and/or Cost.

17.3 Intellectual and Industrial Property Rights

In this Sub-Clause, "infringement" means an infringement (or alleged infringement) of any patent, registered design, copyright, trademark, trade name, trade secret or other intellectual or industrial property right relating to the Works; and "claim" means a third party claim (or proceedings pursuing a third party claim)

alleging an infringement.

Whenever a Party receives a claim but fails to give a Notice to the other Party of the claim within 28 days of receiving it, the first Party shall be deemed to have waived any right to indemnity under this Sub-Clause.

The Employer shall indemnify and hold the Contractor harmless against and from any claim (including legal fees and expenses) alleging an infringement which is or was:

(a) an unavoidable result of the Contractor's compliance with the Employer's Requirements and/or any Variation; or
(b) a result of any Works being used by the Employer:
    (i) for a purpose other than that indicated by, or reasonably to be inferred from, the Contract, or
    (ii) in conjunction with anything not supplied by the Contractor, unless such use was disclosed to the Contractor before the Base Date or is stated in the Contract.

The Contractor shall indemnify and hold the Authority, the Authority's Engineer and the Employer, harmless against and from any other claim (including legal fees and expenses) alleging an infringement which arises out of or in relation to:

(i) the Contractor's execution of the Works; or
(ii) the use of Contractor's Equipment.

If a Party is entitled to be indemnified under this Sub-Clause, the indemnifying Party may (at the indemnifying Party's cost) assume overall responsibility for negotiating the settlement of the claim, and/or any litigation or arbitration which may arise from it. The other Party shall, at the request and cost of the indemnifying Party, assist in contesting the claim. This other Party (and the Contractor's Personnel or the Employer's /Authority's Personnel, as the case may be) shall not make any admission which might be prejudicial to the indemnifying Party, unless the indemnifying Party failed to promptly assume overall responsibility for the conduct of any negotiations, litigation or arbitration after being requested to do so by the other Party.

17.4 Indemnities by Contractor

The Contractor shall indemnify and hold harmless the Authority, the Authority's Engineer the Employer, the Employer's Personnel, and their respective agents, against and from all third-party claims, damages, losses and expenses (including legal fees and expenses) in respect of:

(a) bodily injury, sickness, disease or death of any person whatsoever arising out of or in the course of or by reason of the Contractor's execution of the Works, unless attributable to any negligence, wilful act or breach of the Contract by the Authority, the Authority's Engineer, the Employer, the Employer's Personnel, or any of their respective agents; and

(b) damage to or loss of any property, real or personal (other than the Works), to the extent that such damage or loss:

  (i) arises out of or in the course of or by reason of the Contractor's execution of the Works, and

  (ii) is attributable to any negligence, wilful act or breach of the Contract by the Contractor, the Contractor's Personnel, their respective agents, or anyone directly or indirectly employed by any of them.

The Contractor shall also indemnify and hold harmless the Authority, the Authority's Engineer and the Employer against all acts, errors or omissions by the Contractor in carrying out the Contractor's design obligations that result in the Works (or Section or major item of Plant, if any), when completed, not being fit for the purpose(s) for which they are intended under Sub-Clause 4.1 [*Contractor's General Obligations*].

17.5 Indemnities by Employer

The Employer shall indemnify and hold harmless the Contractor, the Contractor's Personnel, and their respective agents, against and from all third party claims, damages, losses and expenses (including legal fees and expenses) in respect of:

(a) bodily injury, sickness, disease or death, or loss of or damage to any property other than the Works, which is attributable to any negligence, wilful act or breach of the Contract by the Employer, the Employer's Personnel,

or any of their respective agents; and

(b) damage to or loss of any property, real or personal (other than the Works), to the extent that such damage or loss arises out of any event described under sub-paragraphs (a) to (f) of Sub-Clause 17.2 [*Liability for Care of the Works*].

17.6 Shared Indemnities

The Contractor's liability for indemnification, under Sub-Clause 17.4 [*Indemnities by Contractor*] and/or under Sub-Clause 17.3 [*Intellectual and Industrial Property Rights*], shall be reduced proportionately to the extent that any event described under sub-paragraphs (a) to (f) of Sub-Clause 17.2 [*Liability for Care of the Works*] may have contributed to the said damage, loss or injury.

Similarly, the Employer's liability to indemnify the Contractor, under Sub-Clause 17.5 [*Indemnities by Employer*] and/or under Sub-Clause 17.3 [*Intellectual and Industrial Property Rights*], shall be reduced proportionately to the extent that any event for which the Contractor is responsible under Sub-Clause 17.1 [*Responsibility for Care of the Works*] may have contributed to the said damage, loss or injury.

18. Force Majeure

18.1 Force Majeure

"**Force Majeure**" means an exceptional event or circumstance which:

(i) is beyond a Party's control;
(ii) the Party could not reasonably have provided against before entering into the Contract;
(iii) having arisen, such that the Party could not reasonably have avoided or overcome; and
(iv) is not substantially attributable to the other Party.

A Force Majeure may comprise but is not limited to any of the following events or circumstances provided that conditions (i) to (iv) above are satisfied:

(a) war, hostilities (whether war be declared or not), invasion, act of foreign enemies;

(b) rebellion, terrorism, revolution, insurrection, military or usurped power, or civil war;

(c) blockade, embargo, politically motivated sabotage, riot, commotion or disorder by persons other than the Contractor's Personnel and other employees of the Contractor and Subcontractors;

(d) strike or lockout (interrupting supplies and services to the Project or industry-wide or State-wide strikes or industrial action for a continuous period of 24 (twenty-four) hours and an aggregate period exceeding 10 (ten) days in an Accounting Year) not solely involving the Contractor's Personnel and other employees of the Contractor and Subcontractors;

(e) encountering munitions of war, fire or explosive materials, ionising radiation or contamination by radioactivity, except as may be attributable to the Contractor's use of such munitions, explosives, radiation or radioactivity; or

(f) act of God, epidemic, pandemic, natural catastrophes such as earthquake, tsunami, flood, landslide, cyclone and other extremely adverse weather conditions.

18.2 Notice of a Force Majeure

If a Party is or will be prevented from performing any obligations under the Contract due to a Force Majeure (the "Affected Party" in this Clause), then the Affected Party shall give a Notice to the other Party of such a Force Majeure, and shall specify the obligations, the performance of which is or will be prevented (the "prevented obligations" in this Clause). The Notice shall include full particulars of:

(a) the nature and extent of each Force Majeure Event which is the subject of any claim for relief under this Clause 18 with evidence in support thereof;

(b) the estimated duration and the effect or probable effect which such Force Majeure Event is having or will have on the Affected Party's performance of its obligations under this Contract;

(c) the measures which the Affected Party is taking or proposes to take for alleviating the impact of such Force Majeure Event; and

(d) any other information relevant to the Affected Party's claim.

This Notice shall be given within 14 days after the Affected Party became aware, or should have become aware, of the Force Majeure, and the Affected Party shall then be excused performance of the prevented obligations from the date such performance is prevented by the Force Majeure. If this Notice is received by the other Party after this period of 14 days, the Affected Party shall be excused performance of the prevented obligations only from the date on which this Notice is received by the other Party.

Thereafter, the Affected Party shall be excused performance of the prevented obligations for so long as such Force Majeure prevents the Affected Party from performing them. Other than performance of the prevented obligations, the Affected Party shall not be excused performance of all other obligations under the Contract.

However, the obligations of either Party to make payments due to the other Party under the Contract shall not be excused by a Force Majeure.

18.3 Duty to Minimise Delay

Each Party shall at all times use all reasonable endeavours to minimise any delay in the performance of the Contract as a result of a Force Majeure.

If the Force Majeure has a continuing effect, the Affected Party shall give further Notices describing the effect every 28 days after giving the first Notice under Sub-Clause 18.2 [*Notice of a Force Majeure*].

The Affected Party shall immediately give a Notice to the other Party when the Affected Party ceases to be affected by the Force Majeure. If the Affected Party fails to do so, the other Party may give a Notice to the Affected Party stating that the other Party considers that the Affected Party's performance is no longer prevented by the Force Majeure, with reasons.

18.4 Consequences of a Force Majeure

If the Contractor is the Affected Party and suffers delay and/or incurs Cost by reason of the Force Majeure of which he/she gave a Notice under Sub-Clause 18.2 [*Notice of a Force Majeure*], the Contractor shall be entitled subject to Sub-

Clause 20.2 [*Claims For Payment and/or EOT*] to:

(a) EOT; and/or

(b) if the Force Majeure is of the kind described in Sub-Clauses (a) to (e) of Sub-Clause 18.1 [*Force Majeure*] and, in the case of sub-paragraphs (b) to (e) of that Sub-Clause, occurs in the Country, payment of such Cost.

18.5 Optional Termination

If the execution of substantially all the Works in progress is prevented for a continuous period of 84 days by reason of a Force Majeure of which Notice has been given under Sub-Clause 18.2 [*Notice of a Force Majeure*], or for multiple periods which total more than 140 days due to the same Force Majeure, then either Party may give to the other Party a Notice of termination of the Contract. In this event, the date of termination shall be the date 7 days after the Notice is received by the other Party, and the Contractor shall proceed in accordance with Sub-Clause 16.3 [*Contractor's Obligations After Termination*].

After the date of termination, the Contractor shall, as soon as practicable, submit detailed supporting particulars (as reasonably required by the Employer's Representative) of the value of the work done, which shall include:

(a) the amounts payable for any work carried out for which a price is stated in the Contract;

(b) the Cost of Plant and Materials ordered for the Works which have been delivered to the Contractor, or of which the Contractor is liable to accept delivery. This Plant and Materials shall become the property of (and be at the risk of) the Authority when paid for by the Employer, and the Contractor shall place the same at the Employer's disposal;

(c) any other Cost or liability which in the circumstances was reasonably incurred by the Contractor in the expectation of completing the Works;

(d) the Cost of removal of Temporary Works and Contractor's Equipment from the Site and the return of these items to the Contractor's place of business (or to any other destination(s) at no extra cost); and

(e) the Cost of repatriation of the Contractor's staff and labour employed wholly in connection with the Works at the date of termination.

The Employer's Representative shall refer the matter to the Employer and the

Employer shall proceed under Sub-Clause 2.4 *[The Authority's Engineer and the Employer]* to agree or determine the value of work done (and, for the purpose of Sub-Clause 3.5.3 [*Time limits*], the date the Employer's Representative receives the Contractor's particulars under this Sub-Clause shall be the date of commencement of the time limit for agreement under Sub-Clause 3.5.3).

The Employer shall issue a Notice, under Sub-Clause 14.6.1 [*Notice of interim payment*], for the amount so agreed or determined.

18.6 Release from Performance under the Law

In addition to any other provision of this Clause, if any event arises outside the control of the Parties (including, but not limited to, a Force Majeure) which:

(a) makes it impossible or unlawful for either Party or both Parties to fulfil their contractual obligations; or
(b) under the law governing the Contract, entitles the Parties to be released from further performance of the Contract,

and if the Parties are unable to agree on an amendment to the Contract that would permit the continued performance of the Contract, then after either Party gives a Notice to the other Party of such event:

(i) the Parties shall be discharged from further performance, and without prejudice to the rights of either Party in respect of any previous breach of the Contract; and
(ii) the amount payable by the Employer to the Contractor shall be the same as would have been payable under Sub-Clause 18.5 [*Optional Termination*], and such amount shall be paid by the Employer, as if the Contract had been terminated under that Sub-Clause.

19. Insurance

19.1 General Requirements

Without limiting either Party's obligations or responsibilities under the Contract, the Contractor shall effect and maintain all insurances for which the Contractor is responsible with insurers and in terms, both of which shall be subject to

consent by the Authority/ Employer. These terms shall be consistent with terms (if any) and agreed by both Parties before the date that both Parties signed the Contract Agreement.

The insurances required to be provided under this Clause are the minimum required by the Employer, and the Contractor may, at the Contractor's own cost, add such other insurances that the Contractor may deem prudent.

Whenever required by the Employer, the Contractor shall produce the insurance policies which the Contractor is required to effect under the Contract. As each premium is paid, the Contractor shall promptly submit either a copy of each receipt of payment to the Employer, or confirmation from the insurers that the premium has been paid.

If the Contractor fails to effect and keep in force any of the insurances required under Sub-Clause 19.2 [*Insurances to be provided by the Contractor*] then, and in any such case, the Employer may ensure that the Authority effect and keep in force such insurances and pay any premium as may be necessary and recover the same from the Contractor from time to time by deducting the amount(s) so paid from any moneys due to the Contractor or otherwise recover the same as a debt from the Contractor. The provisions of Clause 20 [*Employer's and Contractor's Claims*] shall not apply to this Sub-Clause.

If either the Contractor or the Authority/Employer fails to comply with any condition of the insurances effected under the Contract, the Party so failing to comply shall indemnify the other Party against all direct losses and claims (including legal fees and expenses) arising from such failure.

The Contractor shall also be responsible for the following:

(a) notifying the insurers of any changes in the nature, extent or programme for the execution of the Works; and

(b) the adequacy and validity of the insurances in accordance with the Contract at all times during the performance of the Contract.

The permitted deductible limits allowed in any policy shall not exceed the amounts stated in the Contract Data (if not stated, the amounts agreed with the Employer).

Where there is a shared liability the loss shall be borne by each Party (the

Contractor, the Authority/Employer) in proportion to each Party's liability, provided the non-recovery from insurers has not been caused by a breach of this Clause by the Contractor or the Employer. In the event that non-recovery from insurers has been caused by such a breach, the defaulting Party shall bear the loss suffered.

19.2 Insurance to be provided by the Contractor

The Contractor shall provide the following insurances:

19.2.1 The Works

The Contractor shall insure and keep insured in the joint names of the Contractor and the Authority from the Commencement Date until the date of the issue of the Completion Certificate for the Works:

(a) the Works and Contractor's Documents, together with Materials and Plant for incorporation in the Works, for their full replacement value. The insurance cover shall extend to include loss and damage of any part of the Works as a consequence of failure of elements defectively designed or constructed with defective material or workmanship; and

(b) an additional amount of fifteen percent (15%) of such replacement value (or such other amount as may be specified in the Contract Data) to cover any additional costs incidental to the rectification of loss or damage, including professional fees and the cost of demolition and removal of debris.

The insurance cover shall cover the Authority/Employer and the Contractor against all loss or damage from whatever cause arising until the issue of the Completion Certificate for the Works. Thereafter, the insurance shall continue until the date of the issue of the Performance Certificate in respect of any incomplete work for loss or damage arising from any cause occurring before the date of the issue of the Completion Certificate for the Works, and for any loss or damage occasioned by the Contractor in the course of any operation carried out by the Contractor for the purpose of complying with the Contractor's obligations under Clause 11[*Defects after Taking Over*] and Clause 12[*Tests after*

Completion].

However, the insurance cover provided by the Contractor for the Works may exclude any of the following:

(i) the cost of making good any part of the Works which is defective (including defective material and workmanship) or otherwise does not comply with the Contract, provided that it does not exclude the cost of making good any loss or damage to any other part of the Works attributable to such defect or non-compliance;

(ii) indirect or consequential loss or damage including any reductions in the Contract Price for delay;

(iii) wear and tear, shortages; and

(iv) unless otherwise stated in the Contract Data, the risks arising from Force Majeure.

19.2.2 Goods

The Contractor shall insure, in the joint names of the Contractor and the Authority, the Goods and other things brought to Site by the Contractor to the extent specified and/or amount stated in the Contract Data (if not specified or stated, for their full replacement value including delivery to Site).

The Contractor shall maintain this insurance from the time the Goods are delivered to the Site until they are no longer required for the Works.

19.2.3 Liability for breach of professional duty

To the extent, if any, that the Contractor is responsible for the design of part of the Permanent Works under Sub-Clause 4.1 [*Contractor's General Obligations*], and/or any other design under the Contract, and consistent with the indemnities specified in Clause 17 [*Care of the Works and Indemnities*]:

(a) the Contractor shall effect and maintain professional indemnity insurance, against liability arising out of any act, error or omission by the Contractor in carrying out the Contractor's design obligations,

in an amount not less than that stated in the Contract Data (if not stated, the amount agreed with the Employer); and

(b) if stated in the Contract Data, such professional indemnity insurance shall also indemnify the Contractor against liability arising out of any act, error or omission by the Contractor in carrying out the Contractor's design obligations under the Contract that results in the Works (or Section or Part or major item of Plant, if any), when completed, not being fit for the purpose(s) for which they are intended under Sub-Clause 4.1 [*Contractor's General Obligations*].

The Contractor shall maintain this insurance for the period specified in the Contract Data.

19.2.4 Injury to persons and damage to property

The Contractor shall insure, in the joint names of the Contractor and the Authority, against liabilities for death or injury to any person, or loss of or damage to any property (other than the Works) arising out of the performance of the Contract and occurring before the issue of the Performance Certificate, other than loss or damage caused by a Force Majeure.

The insurance policy shall include a cross liability clause such that the insurance shall apply to the Contractor and the Authority as separate insureds.

Such insurance shall be effected before the Contractor begins any work on the Site and shall remain in force until the issue of the Performance Certificate and shall be for not less than the amount stated in the Contract Data (if not stated, the amount agreed with the Employer).

19.2.5 Injury to employees

The Contractor shall effect and maintain insurance against liability for claims, damages, losses and expenses (including legal fees and expenses) arising out of the execution of the Works in respect of injury, sickness, disease or death of any person employed by the Contractor or any of the Contractor's other personnel.

The Authority and the Employer shall also be indemnified under the policy of insurance, except that this insurance may exclude losses and claims to the extent that they arise from any act or neglect of the Employer or of the Employer's Personnel.

The insurance shall be maintained in full force and effect during the whole time that the Contractor's Personnel are assisting in the execution of the Works. For any person employed by a Subcontractor, the insurance may be effected by the Subcontractor, but the Contractor shall be responsible for the Subcontractor's compliance with this Sub-Clause.

19.2.6 Other insurances required by Laws and by local practice

The Contractor shall provide all other insurances required by the Laws of the Country where (any part of) the Works are being carried out, at the Contractor's own cost.

Other insurances required by local practice (if any) shall be detailed in the Contract Data and the Contractor shall provide such insurances in compliance with the details given, at the Contractor's own cost.

19.3 Waiver of Subrogation

All insurance policies in respect of the insurance obtained by the Contractor pursuant to this Clause 19 shall include a waiver of any and all rights of subrogation or recovery of the insurers thereunder against, inter alia, the Authority, the Employer and its assigns, successors, undertakings and their subsidiaries, affiliates, employees, insurers and underwriters, and of any right of the insurers to any set-off or counterclaim or any other deduction, whether by attachment or otherwise, in respect of any liability of any such person insured under any such policy or in any way connected with any loss, liability or obligation covered by such policies of insurance.

19.4 Contractor's Waiver

The Contractor hereby further releases, assigns and waives any and all rights of subrogation or recovery against, inter alia, the Authority, the Employer and its assigns, undertakings and their subsidiaries, affiliates, employees, successors, insurers and underwriters, which the Contractor may otherwise have or acquire

in or from or in any way connected with any loss, liability or obligation covered by policies of insurance maintained or required to be maintained by the Contractor pursuant to this Contract (other than third party liability insurance policies) or because of deductible sub-clauses in or inadequacy of limits of any such policies of insurance.

20. Employer's and Contractor's Claims

20.1 Claims

A Claim may arise:

(a) if the Employer considers that the Employer is entitled to any additional payment from the Contractor (or reduction in the Contract Price) and/ or to an extension of the DLP;
(b) if the Contractor considers that the Contractor is entitled to any additional payment from the Employer and/or to EOT; or
(c) if either Party considers that he/she is entitled to another entitlement or relief against the other Party. Such other entitlement or relief may be of any kind whatsoever (including in connection with any certificate, instruction, Notice, opinion or valuation of the Employer) except to the extent that it involves any entitlement referred to in sub-paragraphs (a) and/or (b) above.

In the case of a Claim under sub-paragraph (a) or (b) above, Sub-Clause 20.2 [*Claims For Payment and/or EOT*] shall apply.

In the case of a Claim under sub-paragraph (c) above, where the other Party has disagreed with the requested entitlement or relief (or is deemed to have disagreed if he/she does not respond within a reasonable time), a Dispute shall not be deemed to have arisen except if any of sub-paragraphs (a) to (c) of Sub-Clause 21.4 [*Obtaining DAAB's Decision*] applies. The claiming Party may, by giving a Notice refer the Claim to the Employer's Representative. Subsequently, the Employer's Representative shall refer the matter to the Employer and the Employer shall proceed under Sub-Clause 2.4 *[The Authority's Engineer and the Employer]* and Sub-Clause 3.5 [*Agreement or Determination*] shall apply. This Notice shall be given as soon as practicable after the claiming Party becomes aware of the disagreement (or deemed disagreement) and shall include details

of the claiming Party's case and the other Party's disagreement (or deemed disagreement).

20.2 Claims For Payment and/or EOT

If either Party considers that he/she is entitled to any additional payment by the other Party (or, in the case of the Employer, a reduction in the Contract Price) and/or to EOT (in the case of the Contractor) or an extension of the DLP (in the case of the Employer) under any Clause of these Conditions or otherwise in connection with the Contract, the following Claim procedure shall apply:

20.2.1 Notice of Claim

The claiming Party shall give a Notice to the other Party, describing the event or circumstance giving rise to the cost, loss, delay or extension of DLP for which the Claim is made as soon as practicable, and no later than 28 days after the claiming Party became aware, or should have become aware, of the event or circumstance (the "Notice of Claim" in these Conditions).

If the claiming Party fails to give a Notice of Claim within this period of 28 days, the claiming Party shall not be entitled to any Claim as per sub-paragraph (a) or (b) of Sub-Clause 20.1 [*Claims*] and the other Party shall be discharged from any liability in connection with the event or circumstance giving rise to the Claim.

20.2.2 Initial response

If the other Party considers that the claiming Party has failed to give the Notice of Claim within the period of 28 days under Sub-Clause 20.2.1 [*Notice of Claim*] the other Party shall, within 14 days after receiving the Notice of Claim, give a Notice to the claiming Party accordingly (with reasons).

If the other Party does not give such a Notice within this period of 14 days, the Notice of Claim shall be deemed to be a valid Notice.

If the claiming Party receives a Notice from the other Party under this Sub-Clause and disagrees with the other Party or considers there are circumstances which justify late submission of the Notice of Claim, the claiming Party shall include in its fully detailed Claim under Sub-Clause

20.2.4 [*Fully detailed claim*] details of such disagreement or why such late submission is justified (as the case may be).

20.2.3 Contemporary records

In this Sub-Clause 20.2, "contemporary records" means records that are prepared or generated at the same time, or immediately after, the event or circumstance giving rise to the Claim.

The claiming Party shall keep such contemporary records as may be necessary to substantiate the Claim.

Without admitting the Employer's liability, the Employer may monitor the Contractor's contemporary records and/or instruct the Contractor to keep additional contemporary records. The Contractor shall permit the Employer to inspect all these records during normal working hours (or at other times agreed by the Contractor), and shall if instructed submit copies to the Employer. Such monitoring, inspection or instruction (if any) by the Employer shall not imply acceptance of the accuracy or completeness of the Contractor's contemporary records.

20.2.4 Fully detailed Claim

In this Sub-Clause 20.2, "fully detailed Claim" means a submission which includes:

(a) a detailed description of the event or circumstance giving rise to the Claim;
(b) a statement of the contractual and/or other legal basis of the Claim;
(c) all contemporary records on which the claiming Party relies; and
(d) detailed supporting particulars of the entitlement claimed as per sub-paragraph (a) or (b) of Sub-Clause 20.1 [*Claims*]

Within either:

(i) 84 days after the claiming Party became aware, or should have become aware, of the event or circumstance giving rise to the Claim, or
(ii) such other period (if any) as may be proposed by the claiming Party

and agreed by the other Party

the claiming Party shall submit to the Employer's Representative a fully detailed Claim.

If within this time limit the claiming Party fails to submit the statement under sub-paragraph (b) above, the Notice of Claim shall be deemed to have lapsed, it shall no longer be considered as a valid Notice, and the Employer's Representative shall, within 14 days after this time limit has expired, give a Notice to the claiming Party accordingly.

If the Employer's Representative does not give such a Notice within this period of 14 days, the Notice of Claim shall be deemed to be a valid Notice. If the other Party disagrees with such deemed valid Notice of Claim the other Party shall give a Notice to the Employer's Representative which shall include details of the disagreement. Thereafter, the agreement or determination of the Claim under Sub-Clause 20.2.5 [*Agreement or determination of the Claim*] shall include a review by the Employer's Representative of such disagreement.

If the claiming Party receives a Notice from the other Party under this Sub-Clause 20.2.4 and if the claiming Party disagrees with such Notice or considers there are circumstances which justify late submission of the statement under sub-paragraph (b) above, fully detailed Claim shall be supplemented with details of the claiming Party's disagreement or why such late submission is justified (as the case may be).

If the event or circumstance giving rise to the Claim has a continuing effect, Sub-Clause 20.2.6 [*Claims of continuing effect*] shall apply.

20.2.5 Agreement or determination of the Claim

After receiving a fully detailed Claim under Sub-Clause 20.2.4 [*Fully detailed Claim*], or an interim or final fully detailed Claim (as the case may be) under Sub-Clause 20.2.6 [*Claims of continuing effect*], the Employer's Representative shall refer the matter to the Employer and the Employer shall proceed under Sub-Clause 2.4 *[The Authority's Engineer and the Employer*] to agree or determine:

(a) the additional payment (if any) to which the claiming Party is entitled (or the reduction of the Contract Price (in the case of the Employer as the claiming Party); and/or

(b) the extension (if any) of the Time for Completion (before or after its expiry) under Sub-Clause 8.5 [*Extension of Time for Completion*] (in the case of the Contractor as the claiming Party), or the extension (if any) of the DLP (before its expiry) under Sub-Clause 11.3 [*Extension of Defects Liability Period*] (in the case of the Employer as the claiming Party),

to which the claiming Party is entitled under the Contract.

If a Notice is given under Sub-Clause 20.2.2 [*Initial response*] and/or under Sub-Clause 20.2.4 [*Fully detailed Claim*], the Claim shall nevertheless be agreed or determined in accordance with this Sub-Clause 20.2.5. The agreement or determination of the Claim shall include whether or not the Notice of Claim shall be treated as a valid Notice taking account of the details (if any) included in the fully detailed claim of the claiming Party's disagreement with such Notice(s) or why late submission is justified (as the case may be). The circumstances which may be taken into account (but shall not be binding) may include:

- whether or to what extent the other Party would be prejudiced by acceptance of the late submission;
- in the case of the time limit under Sub-Clause 20.2.1 [*Notice of Claim*], any evidence of the other Party's prior knowledge of the event or circumstance giving rise to the Claim, which the claiming Party may include in its supporting particulars; and/or
- in the case of the time limit under Sub-Clause 20.2.4 [*Fully detailed Claim*], any evidence of the other Party's prior knowledge of the contractual and/or other legal basis of the Claim, which the claiming Party may include in its supporting particulars.

If, having received the fully detailed Claim under Sub-Clause 20.2.4 [*Fully detailed Claim*], or in the case of a Claim under Sub-Clause 20.2.6 [*Claims of continuing effect*] an interim or final fully detailed Claim (as the

case may be), the Employer's Representative requires necessary additional particulars:

(i) he/she shall promptly give a Notice to the Contractor, describing the additional particulars and the reasons for requiring them;

(ii) he/she shall nevertheless give his/her response on the contractual or other basis of the Claim, by giving a Notice to the Contractor, within the time limit for agreement under Sub-Clause 3.5.3 [*Time limits*];

(iii) as soon as practicable after receiving the Notice under sub-paragraph (i) above, the Contractor shall submit the additional particulars; and

(iv) the Employer's Representative shall refer the matter to the Employer and the Employer shall proceed under Sub-Clause 2.4 [*The Authority's Engineer and the Employer*] to agree or determine the matters under sub-paragraphs (a) and/or (b) above (and, for the purpose of Sub-Clause 3.5.3 [*Time limits*], the date the Employer's Representative receives the additional particulars from the Contractor shall be the date of commencement of the time limit for agreement under Sub-Clause 3.5.3).

20.2.6 Claims of continuing effect

If the event or circumstance giving rise to a Claim under this Sub-Clause 20.2 has a continuing effect:

(a) the fully detailed Claim submitted under Sub-Clause 20.2.4 [*Fully detailed Claim*] shall be considered as interim;

(b) in respect of this first interim fully detailed Claim, the Employer's Representative shall give his/her response on the contractual or other legal basis of the Claim, by giving a Notice to the claiming Party, within the time limit for agreement under Sub-Clause 3.5.3 [*Time limits*];

(c) after submitting the first interim fully detailed Claim the claiming Party shall submit further interim fully detailed Claims at monthly intervals, giving the accumulated amount/time of the entitlements under sub-paragraph (a) or (b) of Sub-Clause 20.1 [*Claims*]; and

(d) the claiming Party shall submit a final fully detailed Claim within 28 days after the end of the effects resulting from the event or circumstance, or within such other period as may be proposed by the claiming Party and agreed by the other Party. This final fully detailed Claim shall give the total amount/time of the entitlements under sub-paragraph (a) or (b) of Sub-Clause 20.1 [*Claims*].

20.2.7 General requirements

After receiving the Notice of Claim, and until the Claim is agreed or determined under Sub-Clause 20.2.5 [*Agreement or determination of the Claim*], in each payment under Sub-Clause 14.7 [*Payment*] the Employer shall include such amounts for any Claim as have been reasonably substantiated as due to the claiming Party under the relevant provision of the Contract.

The Employer shall only be entitled to claim any payment from the Contractor and/or to extend the DLP, or set off against or make any deduction from any amount due to the Contractor, by complying with this Sub-Clause 20.2.

The requirements of this Sub-Clause 20.2 are in addition to those of any other Sub-Clause which may apply to the Claim. If the claiming Party fails to comply with this or any other Sub-Clause in relation to the Claim of any entitlement as per sub paragraph (a) or (b) of Sub-Clause 20.1 [*Claims*], shall take account of the extent (if any) to which the failure has prevented or prejudiced proper investigation of the Claim by the Employer's Representative.

21. Disputes and Arbitration

21.1 Constitution of the DAAB

Disputes shall be decided by a DAAB in accordance with Sub-Clause 21.4 [*Obtaining DAAB's Decision*]. The Parties shall jointly appoint the member(s) of the DAAB and constitute it whenever a Dispute arises between them in connection with, or arising out of, the Contract or the execution of the Works.

The DAAB shall comprise, as stated in the Contract Data, either one suitably qualified member (the “sole member”) or three suitably qualified members (the “members”). If the number is not so stated, and the Parties do not agree otherwise, the DAAB shall comprise three members.

The sole member or three members (as the case may be) shall be selected from those named in the list in the Contract Data, other than anyone who is unable or unwilling to accept appointment to the DAAB.

If the DAAB is to comprise three members, each Party shall select one member for the agreement of the other Party. These members shall consult with each other and shall agree the third member, who shall be appointed to act as chairperson.

The DAAB shall be deemed to be constituted on the date that the Parties and the sole member or the three members (as the case may be) of the DAAB have all signed a DAAB Agreement.

The terms of the remuneration of either the sole member or each of the three members, including the remuneration of any expert whom the DAAB consults, shall be mutually agreed by the Parties when agreeing the terms of the DAAB Agreement. Each Party shall be responsible for paying one-half of this remuneration.

If at any time the Parties so agree, they may appoint a suitably qualified person or persons to replace any one or more members of the DAAB. Unless the Parties agree otherwise, a replacement DAAB member shall be appointed if a member declines to act or is unable to act as a result of death, illness, disability, resignation or termination of appointment. The replacement member shall be appointed in the same manner as the replaced member was required to have been selected or agreed, as described in this Sub-Clause.

The appointment of any member may be terminated by mutual agreement of both Parties, but not by the Employer or the Contractor acting alone.

Unless otherwise agreed by both Parties, the term of the DAAB (including the appointment of each member) shall expire either:

(a) on the date the discharge shall have become, or deemed to have become, effective under Sub-Clause 14.12 [*Discharge*]; or

(b) 28 days after the DAAB has given its decision on all Disputes, referred to it under Sub-Clause 21.4 [*Obtaining DAAB's Decision*] before such discharge has become effective,

whichever is later.

However, if the Contract is terminated under any Sub-Clause of these Conditions or otherwise, the term of the DAAB (including the appointment of each member) shall expire 28 days after:

(i) the DAAB has given its decision on all Disputes, which were referred to it (under Sub-Clause 21.4 [*Obtaining DAAB's Decision*]) within 224 days after the date of termination; or

(ii) the date that the Parties reach a final agreement on all matters (including payment) in connection with the termination

whichever is earlier.

21.2 Failure to Appoint DAAB Member(s)

If any of the following conditions apply, namely:

(a) if the DAAB is to comprise a sole member, the Parties fail to agree the appointment of this member by the date stated in the first paragraph of Sub-Clause 21.1 [*Constitution of the DAAB*]; or

(b) if the DAAB is to comprise three persons, and if by the date stated in the first paragraph of Sub-Clause 21.1 [*Constitution of the DAAB*]:

(i) either Party fails to select a member (for agreement by the other Party);

(ii) either Party fails to agree a member selected by the other Party; and/or

(iii) the other two members fail to agree the appointment of the third member (to act as chairperson) of the DAAB;

(c) the Parties fail to agree the appointment of a replacement within 42 days after the date on which the sole member or one of the three members declines to act or is unable to act as a result of death, illness, disability, resignation, or termination of appointment; or

(d) if, after the Parties have agreed the appointment of the member(s) or

replacement, such appointment cannot be effected because one Party refuses or fails to sign a DAAB Agreement with any such member or replacement (as the case may be) within 14 days of the other Party's request to do so, or because the terms of the DAAB Agreement (including the amount of the monthly fee or the daily fee) cannot be agreed with the member or replacement within 14 days after he/she has been advised by the Parties that they have agreed to his/her appointment,

then, unless otherwise agreed by the Parties, either or both Parties may apply to the Authority, who shall be the appointing official under the Contract as specified in the Contract Data. The appointing official shall, after due consultation with both Parties and after consulting the prospective member(s) or replacement: -

- appoint the member(s) of the DAAB or the replacement; and
- set the terms of the appointment, including the amounts of the monthly fee and the daily fee for each member or replacement.

Selection of the member(s) or replacement to be so appointed shall not be limited to those persons named in the list in the Contract Data or, in the case of sub-paragraph (d) above, to the member(s) or replacement agreed by the Parties.

This appointment and its terms shall be final and conclusive.

Thereafter, the Parties and the member(s) so appointed shall be deemed to have signed and be bound by a DAAB Agreement under which:

(i) the monthly services fee and daily fee shall be as stated in the terms of the appointment; and

(ii) the law governing the DAAB Agreement shall be the governing law of the Contract defined in Sub-Clause 1.4 [*Law and Language*].

21.3 Avoidance of Disputes

If the Parties so agree, they may jointly request (in writing) the DAAB to provide assistance and/or informally discuss and attempt to resolve any issue or disagreement that may have arisen between them during the performance of the Contract. If the DAAB becomes aware of an issue or disagreement, it may invite the Parties to make such a joint request.

Such joint request may be made at any time, except during the period that the actions are being carried out under Sub-Clause 3.5 [*Agreement or Determination*] on the matter at issue or in disagreement, unless the Parties agree otherwise.

Such informal assistance may take place during any meeting, Site visit or otherwise. However, unless the Parties agree otherwise, both Parties shall be present at such discussions. The Parties are not bound to act on any advice given during such informal meetings, and the DAAB shall not be bound in any future Dispute resolution process or decision by any views or advice given during the informal assistance process, whether provided orally or in writing.

21.4 Obtaining DAAB's Decision

If a Dispute arises between the Parties, then either Party may refer the Dispute to the DAAB for its decision (whether or not any informal discussions have been held under Sub-Clause 21.3 [*Avoidance of Disputes*]).

In addition to the situation described in the definition of Dispute under Sub-Clause 1.1.35 above, a Dispute shall be deemed to have arisen if:

(a) there is a non-payment as referred to under sub-paragraph (b) of Sub-Clause 16.2.1 [*Notice*];
(b) the Contractor is entitled to receive interest under Sub-Clause 14.8 [*Delayed Payment*] but does not receive payment thereof from the Employer within 28 days after his request for such payment; or
(c) a Party has given:
    (i) a Notice of intention to terminate the Contract under Sub-Clause 15.2.1 [*Notice*] or Sub-Clause 16.2.1 [*Notice*] (as the case may be); or
    (ii) a Notice of termination under Sub-Clause 15.2.2 [*Termination*], Sub-Clause 16.2.2 [*Termination*], Sub-Clause 18.5 [*Optional Termination*] or Sub-Clause 18.6 [*Release from Performance under the Law*] (as the case may be);

    and the other Party has disagreed with the first Party's entitlement to give such Notice; which Dispute may be referred by either Party under this Sub-Clause 21.4 without the need for a NOD (and Sub-Clause 3.5

[*Agreement or Determination*] and sub-paragraph (a) of Sub-Clause 21.4.1 [*Reference of a Dispute to the DAAB*] shall not apply).

Where a Dispute is to be referred to the DAAB for its decision, the following provisions shall apply.

21.4.1 Reference of a Dispute to the DAAB

The reference of a Dispute to the DAAB (the "reference" in this Sub-Clause 21.4) shall:

(a) subject to sub-paragraph (ii) of Sub-Clause 3.5.3 [*Time limits*] and the provisions of the second paragraph of Sub-Clause 21.4 [*Obtaining DAAB's Decision*], be made within 42 days of the date of the relevant NOD under Sub-Clause 3.5.5 [*Dissatisfaction with Authority's Engineer determination*]. If the Dispute is not referred to the DAAB within this period of 42 days, such NOD shall be deemed to have lapsed and no longer be valid;
(b) state that it is given under this Sub-Clause;
(c) set out the referring Party's case relating to the Dispute;
(d) be in writing, with a copy to the other Party; and
(e) for a DAAB of three persons, be deemed to have been received by the DAAB on the date it is received by the chairperson of the DAAB.

The reference of a Dispute to the DAAB under this Sub-Clause shall, unless prohibited by law, be deemed to interrupt the running of any applicable statute of limitation or prescription period.

21.4.2 The Parties' obligations after the reference

Both Parties shall promptly make available to the DAAB all information, access to the Site, and appropriate facilities, as the DAAB may require for the purposes of making a decision on the Dispute.

Unless the Contract has already been abandoned or terminated, the Parties shall continue to perform their obligations in accordance with the Contract.

21.4.3 The DAAB's decision

The DAAB shall complete and give its decision within:

(a) 84 days after receiving the reference; or
(b) such period as may be proposed by the DAAB and agreed by both Parties.

However, if at the end of this period, the due date(s) for payment of any DAAB member's invoice(s) has passed but such invoice(s) remains/remain unpaid, the DAAB shall not be obliged to give its decision until such outstanding invoice(s) has/have been paid in full, in which case the DAAB shall give its decision as soon as practicable after payment has been received.

The decision shall be given in writing to both Parties, shall be reasoned, and shall state that it is given under this Sub-Clause.

The decision shall be binding on both Parties, who shall promptly comply with it whether or not a Party gives a NOD with respect to such decision under this Sub-Clause.

If the decision of the DAAB requires a payment of an amount by one Party to the other Party

(i) subject to sub-paragraph (ii) below, this amount shall be immediately due and payable without any Statement or Notice; and
(ii) the DAAB may (as part of the decision), at the request of a Party but only if there are reasonable grounds for the DAAB to believe that the payee will be unable to repay such amount in the event that the decision is reversed under Sub-Clause 21.6 [*Arbitration*], require the payee to provide an appropriate security (at the DAAB's sole discretion) in respect of such amount.

The DAAB proceeding shall not be deemed to be an arbitration and the DAAB shall not act as arbitrator(s).

21.4.4 Dissatisfaction with DAAB's decision

If either Party is dissatisfied with the DAAB's decision:

(a) such Party may give a NOD to the other Party, with a copy to the DAAB;
(b) this NOD shall state that it is a "Notice of Dissatisfaction with the DAAB's

Decision" and shall set out the matter in Dispute and the reason(s) for dissatisfaction; and

(c) this NOD shall be given within 28 days after receiving the DAAB's decision.

If the DAAB fails to give its decision within the period stated in Sub-Clause 21.4.3 [*The DAAB's decision*], then either Party may, within 28 days after this period has expired, give a NOD to the other Party in accordance with sub-paragraphs (a) and (b) above.

Except as stated in the last paragraph of Sub-Clause 3.5.5 [*Dissatisfaction with Authority's Engineer determination*], in Sub-Clause 21.7 [*Failure to Comply with DAAB's Decision*] and in Sub-Clause 21.8 [*No DAAB In Place*], neither Party shall be entitled to commence arbitration of a Dispute unless a NOD in respect of that Dispute has been given in accordance with this Sub-Clause 21.4.4.

If the DAAB has given its decision as to a matter in Dispute to both Parties, and no NOD under this Sub-Clause 21.4.4 has been given by either Party within 28 days after receiving the DAAB's decision, then the decision shall become final and binding on both Parties.

(i) If the dissatisfied Party is dissatisfied with only part(s) of the DAAB's decision: this part(s) shall be clearly identified in the NOD;
(ii) this part(s), and any other parts of the decision that are affected by such part(s) or rely on such part(s) for completeness, shall be deemed to be severable from the remainder of the decision; and
(iii) the remainder of the decision shall become final and binding on both Parties as if the NOD had not been given.

21.5 Amicable Settlement

Where a NOD has been given under Sub-Clause 21.4 [*Obtaining DAAB's Decision*], both Parties shall attempt to settle the Dispute amicably before the commencement of arbitration. However, unless both Parties agree otherwise, arbitration may be commenced on or after the twenty-eighth (28th) day after the day on which this NOD was given, even if no attempt at amicable settlement

has been made.

21.6 Arbitration

Unless settled amicably, and subject to Sub-Clause 3.5.5 [*Dissatisfaction with Authority's Engineer determination*], Sub-Clause 21.4.4 [*Dissatisfaction with DAAB's decision*], Sub-Clause 21.7 [*Failure to Comply with DAAB's Decision*] and Sub-Clause 21.8 [*No DAAB In Place*], any Dispute in respect of which the DAAB's decision (if any) has not become final and binding shall be finally settled by arbitration. Unless otherwise agreed by both Parties:

(a) the Dispute shall be finally settled under the Arbitration and Conciliation Act 1996;
(b) the Dispute shall be settled by one or three arbitrators appointed in accordance with this Act; and
(c) the arbitration shall be conducted in the ruling language defined in Sub-Clause 1.4 [*Law and Language*].

The arbitrator(s) shall have full power to open up, review and revise any certificate, determination (other than a final and binding determination), instruction, opinion or valuation of the Employer, the Employer's Representative and/or of the Authority's Engineer and any decision of the DAAB (other than a final and binding decision) relevant to the Dispute. Nothing shall disqualify the natural person(s) who has/have acted on behalf of the Employer under the Contract from being called as witness(es) and giving evidence before the arbitrator(s) on any matter whatsoever relevant to the Dispute.

In any award dealing with costs of the arbitration, the arbitrator(s) may take account of the extent (if any) to which a Party failed to cooperate with the other Party in constituting a DAAB under Sub-Clause 21.1 [*Constitution of the DAAB*] and/or Sub-Clause 21.2 [*Failure to Appoint DAAB Member(s)*].

Neither Party shall be limited in the proceedings before the arbitrator(s) to the evidence or arguments previously put before the DAAB to obtain its decision, or to the reasons for dissatisfaction given in the Party's NOD under Sub-Clause 21.4 [*Obtaining DAAB's Decision*]. Any decision of the DAAB shall be admissible in evidence in the arbitration.

Arbitration may be commenced before or after completion of the Works. The obligations of the Parties and the DAAB shall not be altered by reason of any arbitration being conducted during the progress of the Works.

If an award requires a payment of an amount by one Party to the other Party, this amount shall be immediately due and payable.

21.7 Failure to Comply with DAAB's Decision

In the event that a Party fails to comply with any decision of the DAAB, whether binding or final and binding, then the other Party may, without prejudice to any other rights it may have, refer the failure itself directly to arbitration under Sub-Clause 21.6 [*Arbitration*] in which case Sub-Clause 21.4 [*Obtaining DAAB's Decision*] and Sub-Clause 21.5 [*Amicable Settlement*] shall not apply to this reference. The arbitral tribunal (constituted under Sub-Clause 21.6 [*Arbitration*]) shall have the power, by way of summary or other expedited procedure, to order, whether by an interim or provisional measure or an award (as may be appropriate under applicable law or otherwise), the enforcement of that decision.

In the case of a binding but not final decision of the DAAB, such interim or provisional measure or award shall be subject to the express reservation that the rights of the Parties as to the merits of the Dispute are reserved until they are resolved by an award.

Any interim or provisional measure or award enforcing a decision of the DAAB which has not been complied with, whether such decision is binding or final and binding, may also include an order or award of damages or other relief.

21.8 Dispute Resolution in Absence of DAAB

If the DAAB has expired for any reason and no new DAAB is being constituted:

(a) Sub-Clause 21.4 [*Obtaining DAAB's Decision*] and Sub-Clause 21.5 [*Amicable Settlement*] shall not apply; and
(b) the Dispute may be referred by either Party directly to arbitration under Sub-Clause 21.6 [*Arbitration*] without prejudice to any other rights the Party may have.

Ministry of Jal Shakti

(A Government of India undertaking)

1st Floor, JP Krishna Building, Pallimukh Junction,
Pettah, Thiruvananthapuram, Kerala-695024

EPC TENDER DOCUMENT FOR

DEVELOPMENT OF GENERAL HOSPITAL TRIVANDRUM

WAP/INFRA/KERALA/2025/GHT/512

Date: 18.06.2025

VOLUME-III

PARTICULAR CONDITIONS OF CONTRACT

The following Particular Conditions shall supplement Volume II General Conditions of Contract (GCC. Whenever there is a conflict, the provisions herein shall prevail over those in the General Conditions.

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PART A – CONTRACT DATA

Sub-Clause	Data to be given	Data
1.1.26 Cost Plus Profit	where the Contract allows for Cost Plus Profit, percentage profit to be added to the Cost:	15%
1.1.34 Defects Liability Period	Defects Liability Period (DLP)	As per G.O.(P) No. 161/2019/Fin dated 25.11.2019
1.1.36 Employer	The Employer	**WAPCOS Limited represented by its Project Director** 1st Floor, JP Krishna Building, Pallimukku, Pettah, Trivandrum – 695024 Land Line : 0471- 2998886 Email: wapcosspvtrivandrum@gmail.com, wapcoscochin@gmail.com
1.1.40 Employer's Representative:	The Employer's Representative	Represented by The Project Director, General Hospital Trivandrum as appointed by the Employer
1.1.67 Milestone	Milestone table	Milestone shall mean the Deliverables as per Volume IV: Employer's Requirement Section III Clause 3.1
1.1.94 Site	Site	General Hospital Thiruvananthapuram
1.1.106 Time for Completion	Time for Completion:	27 calendar months (3 months for Design and 24 months for Demolition & Construction) (excluding Defect Liability Period) from the date of commencement
1.3 (d) Notices and Other Communications	address of Employer for communications:	WAPCOS Limited, 1st Floor, JP Krishna Building, Pallimukku, Pettah, Trivandrum – 695024 Land Line : 0471- 2998886 Email: wapcosspvtrivandrum@gmail.com, wapcoscochin@gmail.com

Sub-Clause	Data to be given	Data
1.3 (d) Notices and Other Communications	address of Employer's Representative for communications:	WAPCOS Limited, 1st Floor, JP Krishna Building, Pallimukku, Pettah, Trivandrum – 695024 Land Line : 0471- 2998886 Email: wapcosspvtrivandrum@gmail.com, wapcoscochin@gmail.com
1.3 (d) Notices and Other Communications	address of Contractor for communications:	***[To be filled by the Contractor]***
1.4 Law and Language	ruling language:	English
1.4 Law and Language	language for communications:	English
1.5 Priority of Documents	If there is a Notice issued regarding the priority of documents, the Employer shall issue notification or clarification within	7 days
1.6 Contract Agreement	the Contractor shall submit the signed duplicate copy of the LOA and the Performance Security within --- days from the date of issue of LOA	21 days
1.6 Contract Agreement	the Parties shall sign the Contract Agreement within --- days from the date of issue of LOA	28 days
1.8 Care and Supply of Documents	number of additional paper copies of Contractor's Documents	The Contractor shall provide five set of hard copies to the Employer for all documents for this projects. Also, Electronic copy to be kept at Project Site
1.8 Care and Supply of Documents	After receiving a notice of error or defect in a document prepared by the Contractor for execution of Work, the Contractor shall rectify the error or defect within	15 days
2.2.3 Financial Arrangement	after receiving information as per Sub-Clause 2.2.3, the Authority shall provide reasonable evidence for financial arrangement within	45 days

Sub-Clause	Data to be given	Data
2.4 Authority's Engineer and The Employer	the Authority's Engineer shall give response/decision to the matters referred to them by the Employer within	15 days
3.7 Right of Access to the Site	After the Contract comes into full force and effect, the Contractor shall be given right of access to all or part of the Site within	15 days of signing from the Contract Agreement
3.10 Change in Financial Arrangements	The Employer shall provide with reasonable evidence for financial arrangement, if Authority intends to execute a Variation price greater than	10%
3.10 Change in Financial Arrangements	The Employer shall provide with reasonable evidence for financial arrangement, if the total of Variations accumulates beyond	25%
4.2 Performance Security	Performance Security (as percentages of the Contract Price)	5%
4.3 Contractor's Representative	The Contractor's Representative:	*To be provided by Contractor*
4.4 (a) Subcontractors	maximum allowable accumulated value of work subcontracted (as a percentage of the Contract Price):	Not applicable
4.4 (b) Subcontractors	parts of the Works for which subcontracting is not permitted	Not applicable
4.4 Subcontractors	Subcontractors for which the Contractor shall give Notice before:	Not applicable

Sub-Clause	Data to be given	Data
	(i) intended appointment (ii) intended commencement of work and (iii) intended commencement of work on Site	
4.15.2 Utilities	the period after which the Contractor becomes eligible for an EOT or additional payment due to delay in utility shifting by the entity owning the utilities	180 days
4.15.3 Felling of Trees	the period within which the Employer shall procure the Applicable Permits for felling trees in a forest area	60 days
4.20 Progress Reports	number of additional paper copies of Progress Reports	2 copies
6.4 Labour Laws	applicable Labour laws	The Contractor shall comply with all relevant labour laws applicable in India, including but not limited to: 1. **The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996** and Kerala Rules, 1998. 2. **The Contract Labour (Regulation and Abolition) Act, 1970** and Kerala Contract Labour Rules, 1974. 3. **The Minimum Wages Act, 1948**, along with applicable notifications by the Government of Kerala. 4. **The Employees' Provident Funds and Miscellaneous Provisions Act, 1952**, and Kerala EPF Rules. 5. **The Employees' State Insurance Act, 1948**, and relevant Kerala ESI Rules. 6. **The Payment of Wages Act, 1936**, and Kerala-specific amendments.

Sub-Clause	Data to be given	Data
		7. **The Factories Act, 1948**, where applicable, along with the Kerala Factories Rules, 1957. 8. **The Workmen's Compensation Act, 1923**, for workers' compensation in case of injury. 9. **The Maternity Benefit Act, 1961**, ensuring benefits for female workers. 10. **The Kerala Shops and Commercial Establishments Act, 1960**, if relevant. 11. **The Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979**, if migrant labour is engaged. 12. **The Equal Remuneration Act, 1976**, for gender-equal wages. 13. Any other statutory provisions or amendments enforced by the Government of India and the Government of Kerala. The Contractor shall ensure strict compliance with the above laws, maintain proper records, and provide necessary documentation to the Employer as required.
6.5Working Hours	normal working hours on the Site	As per applicable Labour Laws
7.4 Testing by the Contractor	the notice period that the Contractor must provide to the Employer for the Employer's personnel to attend the testing of any Plant, Materials, and other parts of the Works	7 days
7.5 Defects and Rejections	the period within which the Employer must notify the Contractor of any defects or non-conformities of any Plant, Materials, design or workmanship after	7 days

Sub-Clause	Data to be given	Data
	examination, inspection, measurement, or testing	
8.1 Commencement of Works	The portion of total land that has to be provided by the Employer to the Contractor for commencing the work	90%
8.3 Programme	number of additional paper copies of programmes	5 copies
8.8 Liquidated Delay Damages	Liquidated Delay Damages payable for each day of delay and maximum amount of Liquidated Delay Damages	0.1% of Contract Price per day, subject to a maximum amount of 10% of the Contract Price. The Delay Damages shall be recovered from payments due to the Contractor.
8.13 Prolonged Suspension	maximum period for suspension under Sub-Clause 8.10 (*Employer's Suspension*)	84 days
9.1 Contractor's Obligations	period by which the Contractor shall submit the Certified Test Report of the results of Tests on Completion to the Employer according to Sub-Clause 9.1	7 days
11.1 Completion of Outstanding Work and Remedying Defects	the period within which the Employer shall notify the Contractor of any defect or damage occurring during the relevant DLP	7 days
11.2 Cost of Remedying Defects	the period within which the Contractor must notify the Employer if the Contractor considers that the work is attributable to the causes other than mentioned in the Sub-Clause 11.2	7 days
11.3 Extension of Defects Liability Period	a DLP shall not be extended by more than	As per G.O.(P) No. 161/2019/Fin dated 25.11.2019

Sub-Clause	Data to be given	Data
11.4 Failure to Remedy Defects	the period within which the Employer shall give the Contractor notice of the fixed date for remedying defects or damage if the Contractor has delayed in doing so	7 days
11.5 Remedying of Defective Work off Site	the period within which the Contractor must notify the Employer to obtain consent for the removal of defective or damaged Plant for repair during the DLP	7 days
13.3.1 Variation by Instruction	Determination of rates	Determination of rates shall be based on DSR 2021 or latest amended at the time of variation with applicable Cost Index for Thiruvananthapuram.
13.4 (b) (ii) Provisional Sums	percentage rate to be applied to Provisional Sums for overhead charges and profit	Not applicable
14.2 Mobilisation Advance	total amount of Mobilisation Advance (as a percentage of the final accepted Contract Price)	10 % “First tranche of Mobilisation Advance at 3 (three) percent of the Contract Price, prior to initial design and after the mobilization and start of work, and against submission of progress of work duly certified by the Employer’s Representative for the first tranche of Mobilisation Advance, the Contractor shall be entitled for another tranche of Mobilisation Advance - of 7 (seven) percent of the Contract Price”

Sub-Clause	Data to be given	Data
14.2 Mobilisation Advance	interest rate of Mobilisation Advance	10% per annum simple interest
14.3 Application of Interim Payment	period of payment	45 days
14.3 (iii) Application of Interim Payment	percentage of retention	2.5%
14.3 (iii) Application of Interim Payment	limit of Retention Money (as a percentage of Contract Price)	2.5 %
14.6.2 Withholding (amounts in) an interim payment	minimum amount of interim payment	70% of RA bill amount
14.11.1(b) Draft Final Statement	number of additional paper copies of draft Final Statement	5 Copies
14.15 Currencies of Payment	Currency for payment of Contract Price	INR (Indian National Rupees)
19.1 Periods for submission of insurance:		a. 14 days from signing the Contract Agreement b. 28 days from signing the Contract Agreement
19.2 Insurance to be provided by the Contractor	The Contractor shall provide the following insurances:	(i) Contractor's All Risk (CAR) Insurance (ii) Workmen Compensation Insurance (iii) Third Party Liability – Minimum Rs.10,00,000 per occurrence (iv) Insurance for Goods, Plant, and Equipment. Contractor's All Risk (CAR) Insurance which shall include, but not limited to, insurance cover for the following: (i) The Works (ii) Goods, Plant & Equipment

Sub-Clause	Data to be given	Data
		(iii) Liability for the breach of Professional Duty (iv) Injury to persons and damage to properties (v) Injury to Employees (vi) Other insurances, if any, as required by Laws and by local practice
19.2.1 (b) The Works	Percentage to Contract Price to cover any additional costs incidental to the rectification of loss or damage, including professional fees and the cost of demolition and removal of debris.	15%
19.2.3 (a) Liability for breach of professional duty	amount of insurance required for liability for breach of professional duty	5% of the Contract Price
19.2.3 (b) Liability for breach of professional duty	insurance required against liability for fitness for purpose	Yes
19.2.3 Liability for breach of professional duty	period of insurance required for liability for breach of professional duty	27 Months or issue of Completion Certificate, whichever is later
19.2.4 Injury to persons and damage to property	amount of insurance required for injury to persons and damage to property	5% of the Contract Price
21.1 Constitution of the DAAB	time for appointment of DAAB	DAAB shall be appointed on need basis
21.1 Constitution of the DAAB	the DAAB shall comprise of	Three members
21.1 Constitution of the DAAB	list of proposed members of DAAB - proposed by Employer	Shall be provided on constitution of DAAB
21.1 Constitution of the DAAB	list of proposed members of DAAB - proposed by Contractor	Shall be provided on constitution of DAAB on request by the Employer

Sub-Clause	Data to be given	Data
21.2 Failure to Appoint DAAB Member(s)	Appointing entity (official) for DAAB members	Secretary, Health and Family Welfare Department, Govt. of Kerala
21.6 Arbitration	Place of Arbitration shall be	Thiruvananthapuram

PART B – SPECIAL PROVISIONS

Sub-Clause 1.2 Interpretation	1.2 (a) is replaced with: "(a) Words indicating one gender include all genders; and "he/she" is replaced with:" it"; "him/her" is replaced with "it"; "his" and "his/her" are replaced with: "its"; "himself/herself" are replaced with: "itself". Further, "and" is deleted from the end of sub-paragraph (i) and added at the end of sub-paragraph (j). sub-paragraph (o) is added: (o) "The word "tender" is synonymous with "bid" or "proposal", the word tenderer with "bidder" or "proposer" and the words "tender documents" with "request for bids documents" or "request for proposal documents" or "bidding/bid document(s)", as applicable."
Sub-Clause 1.5 Priority of Documents	The following documents are added in the list of Priority Documents: "(d) the Particular Conditions Part C- Fraud and Corruption; (e) the Particular Conditions Part D- Environmental and Social (ES) Metrics for Progress Reports;" and the list renumbered accordingly:
Sub-clause 1.6 Contract Agreement	The following is added as the third sentence of the first paragraph of the Sub-Clause: "The Contract Agreement shall be based on the form annexed to the Particular Conditions."
Sub-Clause 1.11 Confidentiality	The following is added at the end of the second paragraph: "The Contractor shall be permitted to disclose information required to establish its qualifications to compete for other projects." "or" at the end of (b) is deleted. "or" at the end of (c) is added. The following is then added as (d): "is being provided to the Funding Agency".
Sub-Clause 4.3 Contractor's Representative	The following sentence is added at the end of the Sub- Clause: "If the Contractor's Representative's delegates are not fluent in the said language, the Contractor shall make competent interpreters available during all working hours in a number deemed sufficient by the Employer."
Sub-Clause 4.5.1 Objection to nomination	In sub-paragraph (c): "and" is deleted from the end of (i);

	"." at the end of (ii) is replaced with: ", and". The following is then added as (iii): "(iii) be paid only if and when the Contractor has received from the Employer / Funding Agency payments for sums due under the Subcontract referred to under Sub-Clause 4.5.2 [*Payment to nominated Subcontractors*]."
Sub Clause 4.6 **Co-operation**	The first para is replaced as: The Contractor shall, as instructed by the Employer, co-operate with and allow appropriate opportunities for carrying out work by:
Sub Clause 4.9.1 **Quality Management System**	Sr. No. (b) is replaced as: (b) quality control mechanism including sampling and testing of Materials, test frequencies, standards, acceptance criteria, testing facilities, reporting, recording and interpretation of test results, approvals, check list for site activities, and proforma for testing and calibration in accordance with the requirement of Employer's Representative and Good Industry Practice; and
4.15. **Access Route**	The following is added at the end of Sub-Clause 4.15: "The Contractor shall take all necessary safety measures to avoid the occurrence of incidents and injuries to any third party associated with the use of, if any, Contractor's Equipment on public roads or other public infrastructure. The Contractor shall monitor and use road safety incidents and accidents reports to identify negative safety issues and establish and implement necessary measures to resolve them."
Sub Clause 4.16 **Transport of Goods**	Sr. No. (a) is replaced as (a) give a Notice to the Employer not less than 21 days before the date on which any Plant, or a major item of other Goods (as specified by the Employer's Representative), will be delivered to the Site;
Sub-Clause 4.18 **Protection of the Environment**	The following is added at the end of this Sub-Clause: "In the event of damage to the environment, property and/or nuisance to people, on or off Site as a result of the Contractor's operations, the Contractor shall agree with the Employer the appropriate actions and time scale to remedy, as practicable, the damaged environment to its former condition. The Contractor shall implement such remedies at its cost to the satisfaction of the Employer."

Sub-Clause 4.25 Code of Conduct	The following is added as Sub-Clause 4.25: "The Contractor shall take all necessary measures to ensure that each Contractor's Personnel is made aware of the Code of Conduct including specific behaviors that are prohibited, and understands the consequences of engaging in such prohibited behaviors. These measures include providing instructions and documentation that can be understood by the Contractor's Personnel and seeking to obtain that person's signature acknowledging receipt of such instructions and/or documentation, as appropriate. The Contractor shall also ensure that the Code of Conduct is visibly displayed in multiple locations on the Site and any other place where the Works will be carried out, as well as in areas outside the Site accessible to the local community and project affected people. The posted Code of Conduct shall be provided in languages comprehensible to Contractor's Personnel, Employer's Personnel and the local community. The Contractor's Management Strategy and Implementation Plans shall include appropriate processes for the Contractor to verify compliance with these obligations"
Sub-Clause 5.4 Technical Standards and Regulations	The following is added as a second paragraph: "If so stated in the Employer's Requirements, the Contractor shall: (a) take into account climate change considerations in the design of structural elements of the Works and new buildings if any; and apply the concept of universal access to the design and construction of structures and new buildings if any (the concept of universal access means unimpeded access for people of all ages and abilities in different situations and under various circumstances.)
Sub-Clause 6.5 Working Hours	The following is inserted at the end of the Sub-Clause: The Contractor shall provide the Contractor's Personnel annual holiday and sick, maternity and family leave, as required by applicable Laws or as stated in the Employer's Requirements."
Sub-Clause 6.6 **Facilities for Staff and Labour**	The following is added as the last paragraph: "If stated in the Employer's Requirements, the Contractor shall give access to or provide services that accommodate the physical, social and cultural needs of the Contractor's Personnel. The Contractor shall also provide similar facilities for the Employer's Personnel as stated in the Employer's Requirements."

Sub-Clause 7.3 **Inspection**	The following is added in the first paragraph after "Employer's Personnel" /staff or consultants acting on behalf of Funding Agency, stakeholders, independent experts, Inspection Authority as per the Act)" The following is added as (b) (iv): "(iv) carryout environmental and social audit, and"
Sub Clause 10.2 **Taking Over of Parts of the Works**	Partially completed works may be handed over to the Employer, with the decision to take over resting at the Employer's discretion
Sub-Clause 13.6 Adjustments for Changes in Laws	The following is added at the end of the Sub-Clause: "Notwithstanding the foregoing, the Contractor shall not be entitled to an extension of time if the relevant delay has already been taken into account in the determination of a previous extension of time and such Cost shall not be separately paid if the same shall already have been taken into account in the indexing of any inputs to the table of adjustment data in accordance with the provisions of Sub- Clause 13.7. [Adjustments for Changes in Cost]."
Sub-Clause 13.7 Adjustments for Changes in Cost	***"Price escalation will be applicable as per G.O. (P) No. 84/2023/Fin dated 16.08.2023, as amended from time to time."***
	The following is inserted at the end of (vi) after: [Agreement or Determination]: "any reimbursement due to the Contractor under the Dispute Avoidance/ Adjudication Agreement. (Appendix General Conditions of Dispute Avoidance/ Adjudication Agreement)."
Sub-Clause 15.1 **Notice to Correct**	Add the following: After receiving a "Notice to Correct", the Contractor shall respond within 7 days
Sub-Clause 15.2 Termination for Contractor's Default	In Sub-Clause 15.2.1, sub-paragraph (g) is replaced with the following: "(g) is found, based on reasonable evidence, to have engaged in Fraud and Corruption as defined in paragraph 2.2 of Particular Conditions - Part C- Fraud and Corruption, in competing for or in executing the Contract."
Sub-Clause 18.4 Consequences of a Force Majeure	The following added at the end of Sub-Clause 18.4(b) after deleting the ".": ", including the costs of rectifying or replacing the Works and/or Goods damaged or destroyed by Force Majeure, to the extent they are not indemnified through the insurance policy referred to

	in Sub-Clause 19.2 [Insurance to be Provided by the Contractor]."
Sub-Clause 18.5 Optional Termination	In sub-paragraph (c), "and necessarily" is inserted after "reasonably".
19.2.1 (b) Additional amount to be insured for the Works	Contract Price + 25%
19.2.1 (iv) List of risks arising from Force Majeure that shall not be excluded from the insurance cover for the Works	• Earthquake • Flood • Storm • Fire • Explosion • Civil Commotion • Riot • Terrorism • Landslide • Subsidence • Inundation • any other emergency declared by the Government of India or State Government.
19.2.2 Extent and amount of insurance required for Goods	Full value of Goods including freight, transit, handling, and unloading until incorporation in the Works
Sub-Clause 19.2 Insurance to be provided by the Contractor	In the first paragraph of Sub-clause 19.2.3 [Liability for breach of professional duty]: -"if any" is deleted on the first line. -"part of the Permanent Works under Sub-Clause 4.1 [Contractor's General Obligations], and/or any other design under the Contract" is replaced with "the Permanent Works". The second paragraph of Sub-Clause 19.2.5 [Injury to employees] is replaced with: "The Employer shall also be indemnified under the policy of insurance, against liability for claims, damages, losses and expenses (including legal fees and expenses) arising from injury, sickness, disease or death of any person employed by the Contractor or any other of the Contractor's Personnel, except that this insurance may exclude losses and claims to the extent that they arise from any act or neglect of the Employer or of the Employer's Personnel."

Sub-Clause 20.1 Claims	In a): “any additional payment” is replaced with “payment”.
Sub-Clause 20.2 Claims for Payment and/or EOT	The first paragraph is replaced with: “If either Party considers that it is entitled to claim under 20.1 (a) or (b), the following claim procedure shall apply:”
21.1 Constitution of the DAAB	Save where expressly stated to the contrary in the Contract, any Dispute shall be finally settled by binding arbitration under the Arbitration and Conciliation Act 1996 or (amended as on date) by sole arbitrators appointed by the Authority. The procedural law of the arbitration shall be Indian law. The award of the arbitrator shall be final and conclusive and binding upon the Parties. English Language The request for arbitration, the answer to the request, the terms of reference, any written submissions, any orders and awards shall be in English and, if oral hearings take place, English shall be the language to be used in the hearings. Enforcement of Award The Parties agree that the decision or award resulting from arbitration shall be final and binding upon the Parties and shall be enforceable in accordance with the provisions of the Arbitration and Conciliation Act. It is also acknowledged and accepted that the Employer is only working as intermediary between the Authority and the Funding Agency. Thus, in the event of any dispute arises under the present Contract Agreement, the payment related to Arbitration Cost and Arbitral Award shall be borne by the Authority/ Funding agency. The said clause if found inapplicable, even then the other terms of the Arbitration Clause shall survive and shall be acted upon.

PART C - FRAUD AND CORRUPT PRACTICES

1.1 The Bidders and their respective officers, employees, agents and advisers shall observe the highest standard of ethics during the Bidding Process and subsequent to the issue of the LOA and during the subsistence of the Agreement. Notwithstanding anything to the contrary contained herein, or in the LOA or the Agreement, the 'Authority'/ Employer may reject a Bid, withdraw the LOA, or terminate the Agreement, as the case may be, without being liable in any manner whatsoever to the Bidder or Successful Bidder, as the case may be, if it determines that the Bidder or Successful Bidder, as the case may be, has, directly or indirectly or through an agent, engaged in corrupt practice, fraudulent practice, coercive practice, undesirable practice or restrictive practice in the Bidding Process. In such an event, the Employer's Representative shall be entitled to forfeit and appropriate the Bid Security or Performance Security, as the case may be, as Damages, without prejudice to any other right or remedy that may be available to the Authority / Employer under the Bidding Documents and/ or the Agreement, or otherwise.

1.2 Without prejudice to the rights of the Authority / Employer under Clause 4.1 hereinabove and the rights and remedies which the 'Authority' / Employer may have under the LOA or the Agreement, or otherwise if a Bidder or Successful Bidder, as the case may be, is found by the Authority / Employer to have directly or indirectly or through an agent, engaged or indulged in any corrupt practice, fraudulent practice, coercive practice, undesirable practice or restrictive practice during the Bidding Process, or after the issue of the LOA or the execution of the Agreement, such Bidder or Contractor shall not be eligible to participate in any tender or TENDER issued by the 'Authority' / Employer during a period of 1(one) year from the date such Bidder or Successful Bidder, as the case may be, is found by the 'Authority' / Employer to have directly or indirectly or through an agent, engaged or indulged in any corrupt practice, fraudulent practice, coercive practice, undesirable practice or restrictive practices, as the case may be.

1.3 For the purposes of this Clause 4.3, the following terms shall have the meaning hereinafter respectively assigned to them:

1.3.1 "Corrupt practice" means

i. the offering, giving, receiving, or soliciting, directly or indirectly, of anything of value to influence the actions of any person connected with the Bidding Process (for avoidance of doubt, offering of employment to or employing or engaging in any manner whatsoever, directly or indirectly, any official of the 'Authority' / Employer who is or has been associated in any manner, directly or indirectly, with the Bidding Process or the Bid Acceptance or has dealt with

matters concerning the Agreement or arising there from, before or after the execution thereof, at any time prior to the expiry of one year from the date such official resigns or retires from or otherwise ceases to be in the service of the Authority/ Employer, shall be deemed to constitute influencing the actions of a person connected with the Bidding Process); or

ii. save and except as permitted under the Clause 4.1 of this Tender Document, engaging in any manner whatsoever, whether during the Bidding Process or after the issue of the LOA or after the execution of the Agreement, as the case may be, any person in respect of any matter relating to the Project or the LOA or the Agreement, who at any time has been or is a legal, financial or technical adviser of 'the Authority/ Employer in relation to any matter concerning the Project;

1.3.2 Fraudulent practice" means a misrepresentation or omission of facts or suppression of facts or disclosure of incomplete facts, in order to influence the Bidding Process;

1.3.3 "Coercive practice" means impairing or harming, or threatening to impair or harm, directly or indirectly, any person or property to influence any person's participation or action in the Bidding Process;

1.3.4 "Undesirable practice" means (i) establishing contact with any person connected with or employed or engaged by 'The Authority' / Employer with the objective of canvassing, lobbying or in any manner influencing or attempting to influence the Bidding Process; or having a Conflict of Interest; and

1.3.5 "Restrictive practice" means forming a cartel or arriving at any understanding or arrangement among Bidders with the objective of restricting or manipulating a full and fair competition in the Bidding Process.

PART D - ENVIRONMENTAL AND SOCIAL (ES)

The Contractor shall submit the following requirement in the format acceptable to the Employer as per the requirement below:

Metrics for Progress Reports

a. *environmental incidents or non-compliances with contract requirements, including contamination, pollution or damage to ground or water supplies;*
b. *health and safety incidents, accidents, injuries that require treatment and all fatalities;*
c. *interactions with regulators: identify agency, dates, subjects, outcomes (report the negative if none);*
d. *status of all permits and agreements:*
    (i) work permits: number required, number received, actions taken for those not received;
    (ii) status of permits and consents:
        - list areas/facilities with permits required (quarries, asphalt & batch plants), dates of application, dates issued (actions to follow up if not issued), dates submitted to resident engineer (or equivalent), status of area (waiting for permits, working, abandoned without reclamation, decommissioning plan being implemented, etc.);
        - list areas with landowner agreements required (borrow and spoil areas, camp sites), dates of agreements, dates submitted to resident engineer (or equivalent);
        - identify major activities undertaken in each area in the reporting period and highlights of environmental and social protection (land clearing, boundary marking, topsoil salvage, traffic management, decommissioning planning, decommissioning implementation);
        - for quarries: status of relocation and compensation (completed, or details of activities and current status in the reporting period).
e. *health and safety supervision:*
    (i) safety officer: number days worked, number of full inspections & partial inspections, reports to construction/project management;
    (ii) number of workers, work hours, metric of PPE use (percentage of workers with full personal protection equipment (PPE), partial, etc.), worker violations observed (by type of violation, PPE or otherwise), warnings given, repeat warnings given, follow-up actions taken (if any);
f. *worker accommodations:*
    (i) number of expats housed in accommodations, number of locals;

(ii) date of last inspection, and highlights of inspection including status of accommodations' compliance with national and local law and good practice, including sanitation, space, etc.;

(iii) actions taken to recommend/require improved conditions, or to improve conditions.

g. Health services: provider of health services, information and/or training, location of clinic, number of non-safety disease or illness treatments and diagnoses (no names to be provided);

h. gender (for expats and locals separately): number of female workers, percentage of workforce, gender issues raised and dealt with (cross-reference grievances or other sections as needed);

i. training:

(i) number of new workers, number receiving induction training, dates of induction training;

(ii) number and dates of toolbox talks, number of workers receiving Occupational Health and Safety (OHS), environmental and social training;

(iii) number and dates of communicable diseases (including STDs) sensitization and/or training, no. workers receiving training (in the reporting period and in the past); same questions for gender sensitization, flag person training.

(iv) number and date of SEA and SH prevention sensitization and/or training events, including number of workers receiving training on Code of Conduct for Contractor's Personnel (in the reporting period and in the past), etc.

j. environmental and social supervision:

(i) environmentalist: days worked, areas inspected and numbers of inspections of each (road section, work camp, accommodations, quarries, borrow areas, spoil areas, swamps, forest crossings, etc.), highlights of activities/findings (including violations of environmental and/or social best practices, actions taken), reports to environmental and/or social specialist/construction/site management;

(ii) sociologist: days worked, number of partial and full site inspections (by area: road section, work camp, accommodations, quarries, borrow areas, spoil areas, clinic, HIV/AIDS center, community centers, etc.), highlights of activities (including violations of environmental and/or social requirements observed, actions taken), reports to environmental and/or social specialist/construction/site management; and

(iii) community liaison person(s): days worked (hours community center open), number of people met, highlights of activities (issues raised, etc.), reports to environmental and/or social specialist /construction/site management.

k. *Grievances: list new grievances (e.g. number of allegations of SEA and SH) received in the reporting period and number of unresolved past grievances by date received, complainant's age and sex, how received, to whom referred to for action, resolution and date (if completed), data resolution reported to complainant, any required follow-up (Cross-reference other sections as needed):*
   (i) Worker grievances;
   (ii) Community grievances

l. Traffic, road safety and vehicles/equipment:
   (i) traffic and road safety incidents and accidents involving project vehicles & equipment: provide date, location, damage, cause, follow-up;
   (ii) traffic and road safety incidents and accidents involving non-project vehicles or property (also reported under immediate metrics): provide date, location, damage, cause, follow-up;
   (iii) overall condition of vehicles/equipment (subjective judgment by environmentalist); non-routine repairs and maintenance needed to improve safety and/or environmental performance (to control smoke, etc.).

m. Environmental mitigations and issues (what has been done):
   (i) dust: number of working bowsers, number of waterings/day, number of complaints, warnings given by environmentalist, actions taken to resolve; highlights of quarry dust control (covers, sprays, operational status); % of rock/ spoil lorries with covers, actions taken for uncovered vehicles;
   (ii) erosion control: controls implemented by location, status of water crossings, environmentalist inspections and results, actions taken to resolve issues, emergency repairs needed to control erosion/sedimentation;
   (iii) quarries, borrow areas, spoil areas, asphalt plants, batch plants: identify major activities undertaken in the reporting period at each, and highlights of environmental and social protection: land clearing, boundary marking, topsoil salvage, traffic management, decommissioning planning, decommissioning implementation;
   (iv) blasting: number of blasts (and locations), status of implementation of blasting plan (including notices, evacuations, etc.), incidents of off-site damage or complaints (cross-reference other sections as needed);
   (v) spill clean-ups, if any: material spilled, location, amount, actions taken, material disposal (report all spills that result in water or soil contamination;
   (vi) waste management: types and quantities generated and managed, including amount taken offsite (and by whom) or reused/recycled/disposed on-site;

(vii) details of tree plantings and other mitigations required undertaken in the reporting period;

(viii) details of water and swamp protection mitigations required undertaken in the reporting period.

n. compliance:

(i) compliance status for conditions of all relevant consents/permits, for the Work, including quarries, etc.): statement of compliance or listing of issues and actions taken (or to be taken) to reach compliance;

(ii) compliance status of C-ESMP/ESIP requirements: statement of compliance or listing of issues and actions taken (or to be taken) to reach compliance

(iii) compliance status of SEA and SH prevention and response action plan: statement of compliance or listing of issues and actions taken (or to be taken) to reach compliance

(iv) compliance status of Health and Safety Management Plan re: statement of compliance or listing of issues and actions taken (or to be taken) to reach compliance

(v) other unresolved issues from previous reporting periods related to environmental and social: continued violations, continued failure of equipment, continued lack of vehicle covers, spills not dealt with, continued compensation or blasting issues, etc. Cross-reference other sections as needed.

Ministry of Jal Shakti
(A Government of India undertaking)

1st Floor, JP Krishna Building, Pallimukh Junction,
Pettah, Thiruvananthapuram, Kerala-695024

EPC TENDER DOCUMENT FOR

DEVELOPMENT OF GENERAL HOSPITAL TRIVANDRUM

WAP/INFRA/KERALA/2025/GHT/512

Date: 18.06.2025

VOLUME- IV

EMPLOYER'S REQUIREMENTS

TABLE OF CONTENTS

SECTION I: SCOPE OF WORK

1.1 INTRODUCTION

1.1.1 General

This Project is the Development of Master Plan at General Hospital, Thiruvananthapuram. The Hospital is situated in an area having an extent of 16.01 Acres. The hospital which primarily caters to the people of Thiruvananthapuram has an average daily footfall of 2500-5000 patients. Since the facilities are limited, there is an urgent need for the expansion of hospital, not only to provide state-of-the-art health care facilities to the patients but also to cater to an enhanced population both in the BPL & APL categories, in line with the current policy of the Government. The Project comprises of the construction of **MAIN BLOCK (Trauma, OPD & IPD), LAUNDRY BLOCK and SERVICE BLOCK.**

The recent pandemic of COVID-19 has brought to the forefront the necessity to have sufficient health care systems in place, to meet any emergency situations. The threat to mankind from such a disaster has now been accepted by all and the different countries across the globe have realized the importance for continued research as well as containment facilities. Kerala has been looked up on as a role model in effectively monitoring and combating the situation. However, the healthcare system must also be capable to modify or convert facilities at short notice to such isolation facilities which can be effective in quarantine. The Government General Hospitals are one of the front runners in each district that need to be ready to combat any such future situations. Hence, the MAIN BLOCK in the General Hospital Thiruvananthapuram shall be provided with all modern healthcare facilities that should be emulated across similar hospitals in the state

The Buildings and services are to be designed based on the leading principles of energy efficiency and sustainability. The basic emphasis given while developing the Master plan has been to design a hassle-free environment for healing in which nature & environment has an important role to play without compromising on safety and convenience of the patients. Great care has to be taken to retain the landscape wherever possible as well as to follow the contour to minimize cutting and filling.

As with any other project, maintenance is of utmost importance – especially so with a Hospital Project frequented by general public. Hence, a Standard Operating Procedure (SOP) is also insisted upon, in the interest of safety of the people, ensuring cleanliness and long life of various Equipment. With the implementation of master plan at Thiruvananthapuram General Hospital, a paradigm shift can definitely be brought out in the way Government Hospitals are assessed and utilized by the general public

1.1.2 Objective

The existing condition of the hospital is with insufficient infrastructure with regard to both in-patient and out-patient facilities, to cater 2500-3000 patients visiting the hospital on a daily basis with an intake of 130-135 IP per day. The hospital is also lacking in proportionate state-of-the-art diagnostic facilities, operational support services and proper occupational facilities for the doctors, nursing and paramedical staff. The total site area is 16.01 Acres.

The main objective of the Project is the development of the General Hospital with new purpose-built infrastructure with most modern medical equipment and facilities in order to address the short falls in the old existing Trivandrum General hospital and to ensure the delivery of improved healthcare services improving both the patient experience and operational efficiency. The project comprises of the construction of MAIN BLOCK (Trauma, OPD & IPD) (G+3 floors), Laundry block (B+G+2 floors) and service block (G+4 floors). The proposed no. of beds is as detailed below:

BED ALLOCATION	
IP beds	**240**
ICU beds	**26**
Casualty beds	**63**
OPD beds	**119**
Dialysis	**23**
OT	**2**
TOTAL	**473**
Bystander Male	**20**
Bystander Female	**20**

1.1.3 Project Location

General hospital is 1.6 kilometer away from Pettah railway station, on Palayam-Airport road, Trivandrum district, State of Kerala, India. The Hospital is located Near, General Hospital Junction, Vanchiyoor, Thiruvananthapuram, Kerala 695035.

Trivandrum is on west coast near southern tip of mainland India. Thiruvananthapuram city is governed by Municipal Corporation which comes under Thiruvananthapuram

Metropolitan Region. General Hospital is located at 8°30'0"N 76°56'34"E having an average elevation of 85 ft (26 m) above sea level.

1.1.4 Project Details

The Project comprises of Construction of three (3) Blocks, namely MAIN BLOCK (Trauma, OPD & IPD) (G +3) Building having a total area of 20,121.83 SqM), LAUNDRY BLOCK (B+G+2) Building having a total area of 1464.09 SqM) and SERVICE BLOCK (G+4) Building having a total area of 1906 SqM.

1.1.5 Departments and Facilities

i. Main Block

Floor	Major Activity	Floor height (m)	Area (sq. m.)
Ground	OP Entrance, Main Lobby, Enquiry/Reception, Insurance counter, Registration/ billing counters, waiting area, USG room (3 nos), Lift lobby, Ortho Consultation room, Pre assessment room, Room for Minor Procedure, Dressing room, plaster room, electrical room, ELV room, Toilet facilities (Male, Female, PH), General OPD, PMR OPD, Doctors rest room, ICTC, Nebulisation room, Anti rabies OPD, Observation room (Male & Female), Pharmacy, Pharmacy Store, Pharmacy Manager room, Main Trauma Entrance, Green Stable – Main Lobby, Casualty waiting area, Police aid facility, CR/ Console room, OPD X-ray, CD burner room, Room for Radiologist, (2 nos), Staff Change room (Male/ Female), CT AHU, CT Equipment room, CT Scan room, Console, MRI, MRI equipment room, Technician room, AHU Room, OP x-ray room, CR/Console room, Mamogram, Triage lobby, Decontamination room, Counselling room, ELV room, Bhoomika clinic, Doctors rest room, Duty Doctor Consultation room, Plaster room, Observation room, Injection room, ECG room, Dog bite / snake bite room, Isolation room, Minor procedure room, Nurse Duty room, Room for sexual assault victims, AHU	4.2	5591.35

	room, Yellow area ward, Trauma Store, Stable yellow ward, Resuscitate / red ward, Nurse rest room, Change rooms, Toilet facilities, Emergency OT, Septic OT, kitchen, public cafeteria, etc.		
First	Lift lobbies, Doctors Lounge, Waiting area, Feeding room, Electrical room, Physiotherapy area, toilet facilities, OPD facilities for departments such as Respiratory Medicine, General Medicine, Cardiology, NCD, Paediatric, Neurology, Nephrology, Urology, Gastroenterology, Oncology, Dermatology, Surgery OPD, Ophthalmology, Dental & ENT, ICU – 24 bedded, AHU for ICU, Nursing station, CU, DU, Intensivist, Isolation room, Duty Doctors room, Duty nurses room, waiting area, Nurse in charge room, store, etc.	4.2	5303.84
Second	Lift lobbies, Waiting area, toilet facilities, feeding room, Electrical room, pantry, toilet facilities for waiting areas, nursing in charge & store, 30 bedded ward (4 sets), Cu, DU, Toilet facilities, NS, Procedure rooms for wards, Duty Doctor and Duty nurse rooms for wards, staff dining area, Chemotherapy room – 1 with duty doctor and duty nurse room, NS, Medicine preparation room, toilet facilities and Bio safety cabinets, Chemotherapy room – 2 with high dose chemo store, medicine preparation, toilet facilities, NS, CU and Utility room. Staff room, assessment room, store, technician room, Fistula, dialysis preparation room, NS, patient toilets, store for tube, Pathology lab – Micro biology, Haematology, Biochemistry, clinical pathology, sterilisation, media preparation, culture / urine section, grossing room, sample collection, chemical store, lab store, receiving, pathologist, records room, in charge room, quality. Blood bank area – waiting area, issue counter, counselling room, wash area, tested blood storage, bleeding room, store and record room,	4.2	5303.84

	change room, transferable disease lab, component store, serology lab, sterilization, apheresis, refreshment area, toilet facilities, etc.		
Third	Lift lobby, waiting area, toilet facilities, feeding room, Electrical room, pantry, toilet facilities for waiting areas, nursing in charge & store, 30 bedded ward (4 sets), Cu, DU, Toilet facilities, NS, Procedure rooms for wards, Duty Doctor and Duty nurse rooms for wards, bystanders room (male / female) with toilet facilities, staff dining area, etc. A portion of the 3rd floor is kept as open terrace, Lift head room – 2 no.s	4.2	3540.88
Terrace	Stair head room for three stairs, services room – 2 nos, electrical room, etc., Lift head room – 7 no.s	3	381.92
Terrace roof	Fire water tank – 20,384 L capacity, Domestic water tank – 43,680 L capacity, Flush water tank – 24,024 L capacity.	2.2	
	Total	**22 m**	**20121.83 sq.m.**

Note : *The maximum height of building for the clearance from Airport Authority India at the proposed area is 50.2 m above MSL. As the elevation of the land in the proposed location of the main building is 26m, the maximum possible height of building is limited to 24.2 m.*

ii. **Laundry Block**

Total area of 1464.09 SqM - Basement+Ground+2 Floors - having a well-built Laundry system with Washer extractor, Drying Tumbler, Ironing and Drying Press with the services listed in the following table

Floor	Major Activity	Floor Height (m)	Area (sq. m.)
Basement	Lobby, Boiler Room, Electrical Panel Room, area for future expansion, etc.	3.8	312.253
Ground	Fire Control Room, Lobby, Issue area, Store, Laundry supervisor, Infected receiving, Infected sorting & wash, Sorting, Receiving, Washing, PH Toilet, etc.	3.8	372.45
First	Lobby, packing area, Tailoring area, Manual press area, Steam pressing area, Toilet	3.8	348.90

	facilities, Floor Supervisor room, Dryer, Washer & Extractor, etc.		
Second	Lobby, Staff dining & pantry, Toilet facilities and change rooms (Male / Female), Staff rest room, laundry supervisor officer rest room, Manual drying area, Folding and stacking area, etc.	3.8	348.90
Terrace	Lobby, Staircase head room,Open terrace, OH tanks, etc.	3	81.59
	Total	**18.2 m**	**1464.09 sq. m.**

iii. **Service Block**

Total area of 1906 SqM - Ground+4 Floors - service building to house the DG panels, HT/LT panels, Transformer, AC plant, Medical Gas etc. with the services listed in the following table:

Floor	**Major Activity**	**Floor Height (m)**	**Area (sq. m.)**
Ground	Lobby, Substation, HT Panel, Electrical panel room, Fire control room, UPS room, DG Sync panel area, Diesel tank area, etc.	4.25	366.35
First	Lobby, MGPS plant room, MGPS manifold room, Medical gas store, Technician room, etc.	3.65	366.35
Second	AC Plant room	4.625	366.35
Third	Biomedical Workshop, Biomedical Services manager room (2 nos), Biomedical Services Technician room, Spare parts store, Toilet facilities (Male/Female), etc.	3.675	366.35
Fourth	Hospital Support services Maintenance Manager cabins (2 units), Housekeeping Manager cabin (2 units), Housekeeping dept store, Utility, Maintenance Dept, Maintenance Dept workshop, Toilet facilities (Male/Female), etc.	3.6	366.35
Terrace	Staircase head room, Cooling tower, Solar water heater, etc.	3	74.28
	Total	**22.8 m**	**1906.03 sq. m.**

1.1.6 General Specifications and Standards

The execution of the Work shall strictly adhere to the CPWD/KPWD specifications that have been updated to the latest version at the time of tender submission, unless specifically stated otherwise. The project's guiding specifications include the following codes and standards:

1. NMC Guidelines
2. Indian Public Health Standards (IPHS)
3. NABH Standards
4. CPWD specification
5. Kerala PWD Specification
6. BIS specification
7. National Building Code 2016
8. National Electrical Code, 2011
9. Indian Electricity Act 2003
10. Bio-Medical Waste (Management & Handling) Rules 1998.
11. Requirements of the local Water Supply Company, Electricity Supply Company/Department.
12. Requirements of the Pollution Control Board, Fire Department, Aviation authorities, and other statutory authorities, as applicable.
13. Requirements of any other standards and bye-laws as applicable.
14. Applicable particular specifications
15. IGBC Green Healthcare Facilities Rating System
16. Relevant KMBR.

The Technical specifications to be followed are detailed in "**Section II: TECHNICAL SPECIFICATIONS",** where there is discrepancy between CPWD specifications and BIS codes the former will prevail. In addition to this, if there are any other specifications or standards applicable to works not explicitly mentioned here, it is essential to adhere to the relevant standards from BIS or CPWD as appropriate.

1.2 SCOPE OF WORK

Scope of work consists of but not limited to the following on a single point responsibility basis. Demolition of existing buildings and removal of debris as per GoK rules, Topographical survey, soil investigation, data collection, preparation of Detailed project report including structural, architectural, MEP design conforming to applicable standards and specifications vetted by IIT/NIT/ reputed engineering institute as per directions of the Employer /Authority Engineer, procurement of materials and labour force, obtaining all statutory approvals, permits and NOCs etc from local bodies and competent authorities including environmental, ECBC/EIA/IGBC clearances etc as applicable and construction of various components as enlisted in forgoing paras at highest standard and quality, performance testing, trail run, commissioning and handing over within a period of 25 months from the start date followed by 30 days post construction operation by the Contractor. The DLP is for 5 years for civil works and 3 years for Electrical, Plumbing and mechanical works.

The components of work carried out by the Contractor includes, but not limited to the area as follows:

a. Site Analysis, Topographic survey, Soil Investigation, detailed architectural drawing, structural design, MEP and other service drawings, vetting of structural drawings, Design Basis Report, all necessary Local Authorities/ Stakeholders/ permissions/ approvals, fulfillment of all the required Contractual Documents.
b. Demolition of existing building as per the plan, the dismantled material shall be the property of the Contractor on payment of valuation as per Annexure A. The valuation amount shall be deducted from Contractor's bill on completion of demolition process. The dismantled material shall be removed properly from site by the Contractor. Relocation of existing facilities will be done by Hospital Authority.
c. Detailed design, GFC preparation and obtaining approvals from the Employer and complete execution of the following elements, but not limited to, in accordance with the tender documents.
    i. MAIN BLOCK (TRAUMA, OPD & IPD)
    ii. LAUNDRY BLOCK
    iii. SERVICE BLOCK
    iv. Associated utilities and corresponding structures
    v. Underground utility, diversion if any (Bidders to visit site and confirm any such elements before bidding)
    vi. Electrical (Internal & External)
    vii. HVAC, Fire fighting works
    viii. MOT and MGPS
    ix. ELV systems
    x. Elevators
    xi. Water Treatment Plant (WTP), Effluent Treatment Plant (ETP) Sewage Treatment Plant (STP) and Sewerage system, Solid Waste Management, Incinerator and Biogas
    xii. Storm water collection and reuse
    xiii. Signage

xiv. Site levelling and landscaping
xv. Associated Roads
xvi. Retaining Walls etc.
xvii. RO plant
xviii. Alternate source of water supply

d. The overall planning/ designing shall be carried out by the Contractor taking in to account the master plan, required parking facilities as per standard norms, connecting corridor shall be provided as required by the Employer, peripheral roads and allied works like retaining walls, drain, landscape, ETP etc. as per the requirements.
e. The water demand based on the beds and details provided in the ER to be calculated by the Contractor and the UGT & ETP required to be designed accordingly and got it approved by Employer's Representative before execution.
f. Waste water generated based on the water demand to be calculated and the Sewerage connection excluding the STP required to be designed and got it approved by Employer's Representative-before execution.
g. All internal roads and approach roads are under the scope of the Contractor.
h. The construction work shall be carried out with the standard norms for quality and safety as well as environmental protection like EHS for workers/ labours accommodation along with necessary facilities, Labour Insurance, Safety provisions, security as well as Client & Consultants office arrangements etc. to be taken care.
i. All Required services designs, Load calculations to be prepared by the Contractor and it is to be submitted to the Employer as well as Concerned department for their review, comments/ approval.
j. The structural designs of the buildings and all other associated structures shall be done by the Contractor and shall be proof checked/vetted by the IIT/NIT/ reputed engineering institute as per directions of the Employer /Authority Engineer.
k. Obtaining mandatory approvals from local bodies/ statutory authorities, as required for commencement of construction of work and on completion of the work.
l. Statutory Approvals:
    i. The Contractor shall obtain all necessary approvals including pre-construction approvals from Municipal and other local bodies including Municipal bodies, Water supply agencies concerned, Electric Supply and Inspectorate. agencies concerned, Police and Security Agencies, Chief Controller of Explosives, Fire Department, Civil Aviation, Air Force, Ground Water Department, in accordance to prevailing rules, Building Bye-Laws, tree replantation if required., as the case may be but not limited to, related to/ required for Construction/ Completion. All expenditure on this account shall be borne by the Contractor and fees for the clearances (excluding liaising fees) shall be reimbursed by KIIFB as per actuals on recommendation of the EMPLOYER. These approvals shall include obtaining approval from all the competent authorities and other statutory bodies like Ministry of Environment and forests,

State Pollution Control Board, civil aviation, railways and local development bodies, ECBC approval, IGBC, EIA, EI, etc. as applicable and necessary according to the local Acts, Laws, Regulations, etc. and make any changes desired by such authorities at no extra cost.

ii. Obtaining approval of the Architectural drawings from relevant local statutory body & obtain Commencement Certificate from local bodies leading to commencement of construction of the project if required.
iii. Obtaining NOCs (No Objection Certificates) from Fire Department, Lift Inspector, Storm water drainage & sewerage department, Municipal Corporation/ Local Bodies, Civil Aviation, Railways, completion and/ or occupancy certificates etc. as required.
iv. Obtaining approval of electrical drawings from Electrical Inspectorate, as applicable.
v. Any other approval required from the appropriate Statutory Authorities/ Local Bodies.
vi. Engagement of IGBC consultant
vii. Compliance as per Indian Green Building Council (IGBC) with minimum silver rating and obtaining necessary approval
viii. BIM models to be developed for all the buildings up to (level of development) initially of LOD200 and developed to LOD500.
ix. Obtaining all required statutory approvals during different stages/ phases, before starting, during and after completion of the project.
x. Engagement of ECBC consultant and obtain ECBC approval required for obtaining building permit.
xi. Supervision of works with required quality assurance.
xii. Any other services and utilities as per requirements and direction of / Employer for completion of the project. EMPLOYER may, at the written request of the Contractor, assist them in obtaining the approvals from relevant authorities. However any such request by the Contractor shall not bind the Employer in any manner. The original documents of approval shall be submitted to the Employer.
xiii. Contractor will carry out any part of the work essential for proper completion of the project or and as mandated by any statutory requirements not specifically mentioned in the Guiding Bid Document at Contractors on cost and no payment will be made by the Employer in this regard.

m. It shall be duty of the Contractor to make all the arrangements for obtaining power, water, communication facilities etc for construction/testing/commissioning at their own cost. However the Employer may assist/authorize the Contractor for obtaining such connections from concerned utilities. All cost of power, water etc shall be borne by the Contractor during the construction period and one month post construction period, if required.
n. Testing labortatory shall be installed at site by Contractor for all materials specified by Employer’s Representative

o. Contractor shall submit Quality Assurance Plan in line with relevant codes of practices, both for material and works for approval of the Employer which will form basis for the tests be done including 3rd party tests. Cost of all the tests shall be borne by the Contractor or manufacture as the case may be. The rates quoted by the Contractor for the work shall be deemed to include all such costs including incidental charges thereof.

p. The items and quantities mentioned in Volume IV: Employer's Requirements are indicative. The Contractor will have to derive the exact requirement of the Project after detailed engineering and design and submit for the approval of competent authority before execution of the work. The works have to be carried out to ensure the complete functionality of the hospital as per the latest standards and state of the art technologies. The quantities and items may vary for the successful completion and commissioning of the project to the entire satisfaction of the Authority / Employer. No additional cost shall be paid on the account of variation in items or/ and quantities stipulated in Volume IV.

q. The building shall be designed as differently abled friendly as per the NBC for both physical as well as visually challenged people

r. The construction area, pathways, and working zones should be distinctly separated using barricades with adequate signages, and security guards must be deployed, all at the Contractor's cost.

s. Since construction is being carried out within an existing functioning hospital compound, the facilities must continue to function without disruption. Hence, the Entry and Exit control plan without disrupting the Hospital function must be submitted to the Employer's Representative for approval before mobilization.

t. The Contractor must provide a detailed program outlining the plan for managing the existing services such as sewerage, storm water pipes, of the hospital during construction and minimizing disruptions. The Contractor shall rectify any damage caused to the existing facility during construction period at his own cost.

1.3 IGBC GREEN HEALTHCARE FACILITIES RATING & CERTIFICATION

1.3.1 Project Vision

All Buildings are envisioned to be designed and constructed based on sustainability and green building principles. The vision is to conserve energy & water, reduce waste, renewable energy generation, reduce urban heat island effect and use sustainable materials.

1.3.2 Project Approach &Strategies

Minimum silver rating for buildings shall be obtained by the Contractor with due compliance to various criteria stipulated under IGBC Green Healthcare Facilities Rating System.

1.4 ARCHITECTURE

1.4.1 Concept Designs

The design reflects the strategic planning of the Buildings for the present and the emerging needs in view of advances in health care and the needs of the population.

Total plinth area – Main Block (Trauma, OPD & IPD) – 20,122 sqm, Laundry Block -1464 sqm and Service Block 1906 sqm with facilities mentioned in the table under 1.4.1.

In the Main Block the ground floor is planned at 0.45 M level, First floor at 4.65M level, Second floor at 8.85M level, Third floor at 13.05 M level and Terrace at 17.25 M

- There are two main entrances through large porches at +0.45 M level: Main OP entrance and Main Trauma entrance which has a separate Emergency Entry.
- The ground floor accommodates mainly Casualty sections, Radiology, Registration, Pharmacy, Canteen and some OP departments.
- First Floor accommodates mainly ICU and OP departments.
- Second Floor accommodates IP wards, Dialysis ward, diagnostic facilities with various labs; blood storage facilities apart from some OP departments.
- Third Floor accommodates IP wards and bystander rooms.
- Terrace Floor accommodates Solar panels (Solar photovoltaic system shall be of minimum capacity 50 KWp; however, PV system shall be in conformity with KSECBC, IGBC and KMBR latest amendments and standards).

The lifts proposed in the buildings are as follows:

- 3 nos 20P patient-cum bed lifts in Trauma block
- 3 nos 20P visitors' lifts in Trauma block
- 1 no 20P Fire lift in Trauma block
- 2 nos 15P Service lift in Trauma block
- 1 no 15P Service lift in Laundry block
- 1 no 15P Service lift in Service block

The number and capacities of the lifts may vary as per the norms of KMBR 2019 and NBC 2016.

All statutory regulation of NMCG for all surgical departments have to be considered in addition to IPH and NABH Standards.

All national standards applicable for hospital planning, layout and engineering have to be adopted in the design and specifications of the building.

Green building measures like the use of Aerated Autoclaved Concrete blocks and solar power systems etc. shall be provided, apart from design and orientation to maximize natural lighting and ventilation.

Traffic flow of hospital has to be studied meticulously and planned in such a way that patient will have a separate vertical circulation core with bed lifts and a main staircase while

doctors and medical staff can use the vertical circulation core with lifts and dedicated staircases, which is placed away from the public circulation routes. It helps doctors and staff to reach the concerned departments and faculty offices without mingling with the flow of the general public.

1.4.2 Aesthetics

Aesthetics is of utmost importance to enable a healing environment; this aesthetics is met by providing pleasing architectural elevation features coupled with the use of state-of-the-art technology, creating an enabling environment.

a. Architectural features

The basic Architectural features of the building are as follows:

- The simple geometry of the windows contrast with the vertical and horizontal strips of structural glazing at the windows and the dirty corridor.
- The overall form of the building is designed in harmony with the site profile.
- The atriums enhance natural lighting and act as the defining feature of the interior ambience.

b. Design Philosophy

The design philosophy takes into account the followings:

- To cater for different functional requirements of users with streamlined circulation and space planning.
- Integrated designs of electrical, mechanical and other services with structural system which should be planned with optimum cost, low maintenance and lowest consumption of energy and water.
- Climate responsive Architecture with integration of daylight and electric light, thermal comfort, ventilation.
- Water and solid waste management with waste water recycling, water conservation and rain water harvesting.
- Development of surroundings with site terrain consideration, traffic circulation, indigenous vegetation and plantation

1.4.3 Design & Development

Detailed designs to be developed from the concept plans conforming to all Norms, Bye - laws and latest versions of relevant IS codes.

BIM models to be developed for all the buildings up to level of development before commencing the construction. The Contractor shall follow:

- National Building Code of India 2016
- National Medical Commission
- Draft Document 2013 (National Disaster Management Guideline - Guidelines of a MCE Mass Casualty Event)

- National Accreditation Board for Hospital
- Nursing Council of India
- Planning a Barrier Free Environment, Office of the Chief Commissioner for Persons with Disabilities
- IGBC Green Healthcare Facilities Rating System
- All new rules & regulations for Solid Waste Management
- Latest Building rule (KMBR rule)
- MOUD Guideline for General Pool Residential Accommodation (GPRA), 2013
- Clinical Establishment Act
- Relevant IS Codes
- ASHRAE standards
- PCB norms

Note: The drawings provided along with the GBD is for study purpose and are liable to change as per the requirement during the design period. The design and drawings so developed shall be approved by the EMPLOYER before execution.

1.5 CIVIL WORKS

1.5.1 Introduction

The work shall be done on EPC basis and the Contractor shall be responsible for adequacy of any technical propriety and of upholding prevailing standard of Code of Practice according to NBC 2016 / Updated and all other relevant IS Codes on the way to accomplish the work according to requirement. The work shall in general conform to the Latest CPWD Specifications.

The new facilities shall be completed in conformity with national standards of construction and specification. The Architectural finishes shall be of such quality that will ensure better hygienic conditions. The design of building shall ensure control of noise due to movement of trolleys and banging of doors etc. The architectural design should take in to account the requirements of physically challenged patients. The planning should include landscaping and horticulture to increase the comfort & hospitality conditions inside the building along with development of parking, approach roads of (approx. 1250m) and other service requirements meant for the Building.

Based on the approved Master Plan & Concept Drawings for the buildings, the Contractor shall prepare the detailed architectural design and drawings of the Project for approval from the local bodies and statutory authorities. The structural designs of the buildings and structures shall be done by the Contractor and shall be Proof checked/vetted by the IIT/NIT/ reputed engineering institute as per directions of EMPLOYER/Authority Engineer. The Contractor should ensure that the material should satisfy the IGBC Silver rating The Contractor should also do the necessary documentation & all other requirements to achieve these objectives as referred above. The follow up work to get IGBC certification is in the scope of Contractor. Please refer Volume V: Technical Specification for details.

1.5.2 Site Clearance, Excavation & Earth Work

Before commencement of construction work at site, clearing of jungle including uprooting of rank vegetation, grass, brush wood and rubbish shall have to be removed and disposed-off outside the campus. The Contractor shall carry out replanting new plants and trees as per norms, including cutting of branches, removing the roots and stacking of serviceable material and disposal of unserviceable material as per requirement. All statutory norms shall be satisfied for felling trees including necessary approvals of competent authorities. The excavated good earth shall be used, for filling, leveling, consolidating etc. within the campus. The Contractor shall be responsible for removal/ dismantling and rerouting of services according to new planning and requirements. The work shall be done in accordance with the IS Standards and prevailing Codes.

The Contractor shall under take necessary leveling, back filling/ cutting, if required, to maintain the levels as per Master Plan. The Contractor shall bring the Good earth from outside, if any required, or disposal of excess earth from site by obtaining necessary approvals from concerned authorities to maintain the required levels and shall ensure proper compaction before the start of any construction activities.

1.5.3 Material Specification

1.5.3.1 Cement:

Cement to be used for civil finishing and civil structural works, shall be one of the following or in combination thereof. For plain and reinforced concrete works normally 43/53 grade ordinary Portland cement or Portland Pozzolana Cement conforming to IS: 8112/ IS: 12269, shall be used. Specific requirement for any other type of cement shall be as shown in the drawings or as specified in contract or as directed by Employer's Representative. All masonry and plaster work shall be with PPC or other blended cement as approved by Employer's Representative.

1.5.3.2 Water

Water used in construction for all civil & structural works shall be clean and free from injurious amount of oil, acids, alkalis, organic matters or other harmful substances which may be deleterious to concrete, masonry or steel. The PH value of water samples shall be not less than 6. Potable water shall be considered satisfactory. Underground water can also be used with the prior approval of the Engineer, if it meets all the requirements of IS: 456.

Tests on water samples shall be carried out in accordance with IS: 3025 and they shall full-fill all the guidelines and requirements given in IS: 456.

The Employer's Representative may require the Contractor to get the water tested from an approved laboratory before starting the construction work and in case the water contains any oil/ organic matter or an excess of acid, alkalis or any injurious amount of salts etc., beyond the permissible maximum limits given in IS: 456, the Employer's Representative may refuse to permit its use. In case the water is supplied by the owner, Contractor shall get himself satisfied regarding its quality before using the same in his works at his own expenses. In case there is any change in source of water, water samples shall be tested again to meet the specified requirements. The water test must be conducted periodically at least once in 3 months or as directed by Engineer.

Water shall be stored in tin barrels, steel tanks or water-tight reservoirs made with bricks/ stone or reinforced concrete. Bricks/ stone masonry reservoirs shall have RCC base slab and shall be plastered inside, with 1 part of cement and 4 parts of sand and finished with neat cement punning. These reservoirs shall be of sufficient capacity to meet the water requirement, at any stage of construction.

Water for curing shall be of same quality as used for concreting and masonry works. Sea water shall not be used for preparation of cement mortar, concrete as well as for curing of plain/ reinforced concrete and masonry works. Sea water shall not be used for hydro testing and checking the leakage of liquid retaining structures also.

1.5.3.3 Admixtures

All concrete admixtures shall in generally comply with the following Indian Standards unless otherwise stipulated in this specification.

Specification for integral cement water proofing compound	:	IS: 2645
Specification for other admixtures for concrete	:	IS: 9103

Generally, admixtures shall have ISI certification marks. However, even in case of BIS certified admixtures, Employer's Representative may require the Contractor to carry out and submit any or all the tests (as specified in relevant IS codes), from approved laboratories, over and above the manufacturer's certificate, before giving his final approval. In case, admixtures certified by BIS are not available, the Contractor shall submit to the Employer's Representative the type and/ or proprietary brand of the admixture from only reputed manufactures along with necessary test certificates from recognized and approved laboratories or any other document directed by Employer's Representative for latter's final approval. In such cases, names of at least two manufacturers shall be submitted to the Employer's Representative for his selection. In case both the names are rejected, the Contractor shall submit a fresh list of two manufacturers for approval by the Engineer.

The Employer's Representative may direct the Contractor to submit test results as required by IS: 2645 or IS: 9103 for any admixture proposed to be used in the concrete in any approved laboratory at his discretion at any stage of the work. The cost of any/all tests required to satisfy compliance with his specification shall be borne by the Contractor.

Prior approval of the Employer's Representative shall be obtained while using water reducing admixtures in the concrete (PCC/ RCC) or mortar. Other type of admixtures such as accelerating admixtures, retarding admixtures or air entraining admixtures, shall not be used unless specified on the design drawings or prior approval taken from the Head office. Once approved, utmost care shall be exercised at site by the Contractor to maintain the consistency in the quality, if admixture added to the concrete / mortar so produced.

1.5.3.4 Damp-Proof Course

The damp-proof course (DPC) shall be laid at plinth level/ or as per requirement in the brick work walls resting on brick foundations, as per approved drawings and as directed of 50mm thickness with cement concrete 1:1.5:3 (1 cement: 1.5 coarse sand: 3 graded stone aggregate 20mm nominal size) mixed with water proofing material in cement concrete work in doses by weight of cement as per manufacturer‘s specification.

1.5.3.5 Plinth Protection:

Plinth protection with 75 mm thick of cement concrete 1:1.5:3 (1 cement :1.5 coarse sand : 3 graded stone aggregate 20mm nominal size) over 100 mm bed by dry brick ballast/ stone aggregates 40mm nominal size well rammed and consolidated and grouted with fine sand including finishing all around the buildings, as per tender drawings and approval of Employer's Representative. The width of the plinth protection shall be 750 mm (Mini.) to 2000 mm (Maximum). The required brick toe wall/brick on edge shall be provided as per requirements.

1.5.3.6 Plain Cement Concrete And Reinforced Cement Concrete Work

All concrete work will be strictly done by automatic computerized batching plant of suitable capacity installed at site or from approved RMC Plant.

RCC Work (Concrete Mix Design):- The RCC work shall be done with RMC of Design Mix Concrete, unless otherwise specified. The Contractor shall carry out the concrete mix design with and without admixture through one of the following laboratories/Test houses to be approved by Employer's Representative:

a. IIT/NIT/ reputed engineering institute as per directions of EMPLOYER/Authority Engineer.
b. In the event of all the above laboratories being unable to carry out the requisite design/testing; the Contractor shall have to get the same done from any other NABL accredited laboratory with prior approval of the Employer's Representative.
c. Samples of materials (i.e. Cement, Coarse, fine aggregates & admixtures) shall be jointly sealed by Employer's Representative and Contractor before sending the same for Mix design. The design mix shall be with or without admixtures as per specifications /requirements at site.

1.5.3.7 Finishing

The surfaces of brick work, RCC, CC etc. shall be treated and finished with Cement Plaster. The use of PP Cement shall be preferred. The cement plaster shall be provided as under:

a. Plain wall faces: 12mm thickness (minimum) cement plaster 1:6 (1 cement: 6 fine sand).
b. Rough wall faces: 15mm thickness (minimum) cement plaster 1:6 (1 cement: 6 fine sand).
c. Ceiling and RCC works: 6mm thickness (minimum) cement plaster 1:3 (1 cement: 3 fine sand). In respect of RCC works, in continuation with the brick work, plastering as per brick work shall be continued over RCC works.
d. Gypsum Plaster as per IS specification.
e. All External faces: 20mm thickness (minimum) cement plaster in two coats with water proofing compound as per manufactures specification, under layer 12mm thick cement plaster 1:4 (1 cement: 4 coarse sand) finish with a top layer of 6mm thickness (minimum) cement plaster 1:6 (1 cement: 6 fine sand).
f. The junction of RCC work and AAC Brick walls shall be covered with 24 gauge GI chicken wire mesh fixed with screws/washers to avoid cracks in plaster work.
g. The trenches / open drains: 15mm plaster finished with cement plaster 1:4 (1 cement: 4 fine sand) with floating coat of neat cement & adding of Water proof compound.
h. Provide drip course/ groove in plastered surface or moulding to R.C.C. projections.

1.5.3.8 Painting

The plastered surfaces shall be finished as per the finishing schedule. This shall include Antifungal Paint/ textures paint and other paints as per finishing schedule or as approved by the EMPLOYER.

All paints shall meet the IGBC requirements for minimum 3 Star Rating. Painting on doors, windows, Grills, MS work, structural steel, rolling shutters, railing and other members requiring painting and polishing etc., wherever required, shall be treated with primer coat and finished with painting/ polishing of approved shade and manufacture, as per CPWD Specifications, to meet the functional requirements.

a. All paint work on concrete and Cement/ Gypsum plaster surfaces shall include application of white cement based or acrylic putty as base preparation, application of primer in compatibility with the respective type of paint and painting with 3 coats of paint as per technical specifications.
b. All paint work on structural components (excluding Stainless steel) shall include application of primer in compatibility with the respective type of paint and painting with 3 coats of paint as per technical specifications.
c. The soffits of all projections, jambs, parapet walls terrace (in side) shall be finished with premium acrylic smooth exterior paint with silicone additives of approved shade and make.
d. The wood work shall be painted / polished (melamine finish) as per requirements.

1.5.3.9 Door & Windows

The doors and windows shall be provided as per the requirements indicated in the joinery schedule and technical specifications or as per the approved methodology by the EMPLOYER. In case of variance, the decision of the EMPLOYER shall prevail. However the various types of Doors and Windows shall be as under:

A. ALUMINIUM WORKS

Aluminium Framed Doors, Windows, Louvers & Fixed Partition Works and frame works for work at any Height as per Drawings/ instructions of Employer's Representative. Providing and fixing in position frames and shutters for Aluminium door / composite door-window / window / casement window / Fixed Partition / Double Glazed Window (6-12Air-6 DGU Glass) / louvers as per Architectural drawings and Aluminium sections of approved make having minimum 40 micron Grey / approved colour anodizing of approved shade sections. It shall be free from defects and shall be guaranteed for 10 years. Rate shall be inclusive of providing Aluminium sections, cutting, fabrication, erection and fixing to the best workmanship manner, including Following:

1. Sheet metal screws and Aluminium angle corner cleat of minimum 3mm thickness and of full width etc. for assembling the frame, LN key with necessary SS Screws etc.
2. Glazing clips for receiving infill panel

3. EPDM R rubber gasket for glass beading
4. Anchor fasteners of approved make for fixing the frame assembly to the RCC or masonry surfaces. Minimum 1 anchor fastener shall be used for every 750mm length of section for stability of frame.
5. 10 mm GI tie rod at top and bottom to connect styles.
6. Based on the GFC drawing, frame works for Structural Glazing system shall be designed by Vendor by Contractor to withstand the seismic force, wind force, water and rain force. The same shall be approved by the structural consultants & proof structural consultant. Based on final approved Drawings, required Tests shall be carried out as per the instructions of EIC/ Drawings. INCLUDING: all material, labour, wastage, necessary scaffolding for fabrication and erection at all places and at all heights.
7. Louver Slats included size will be 50mm x 2mm thick and 40 micron grey colour anodized. Unit weight per running meter shall be worked out from actual samples of every type of Aluminium section and actual lengths shall be measured for calculating the total weight of aluminium door, window and fixed partition sections. INCLUDING: Hardware viz. locks, handles, hinges, pivot Work shall have to be carried out as per the drawings and approved sample. Actual / theoretical weight of installed Aluminium sections which are visible only shall be measured and shall be considered for the payment.

B. UPVC

Factory made uPVC white colour /coloured sliding glazed window upto 1.20 m in height dimension comprising of uPVC multi-chambered frame with inbuilt roller track and sash extruded profiles duly reinforced with 1.60 ± 0.2 mm thick galvanized mild steel section made from roll forming process of required length (shape & size according to uPVC profile), appropriate dimension of uPVC extruded glazing beads and uPVC extruded interlocks, EPDM gasket, wool pile, zinc alloy (white powder coated) touch locks with hook, zinc alloy body with single nylon rollers (weight bearing capacity to be 40 kg/as per approved), G.I fasteners 100 x 8 mm size for fixing frame to finished wall and necessary stainless steel screws etc. Also Rates are included with double glass (6mm +12 mm Air cap + 6mm) unit as per design consideration of high rise building at Kerala areas. Profile of frame & sash shall be mitred cut and fusion welded at all corners, including drilling of holes for fixing hardware's and drainage of water etc. After fixing frame the gap between frame and adjacent finished wall shall be filled with approved weather proof silicon sealant over backer rod of required size and of approved quality, all complete as pre-approved drawing & direction of Employer's Representative. The Size of Sash and Mullion shall be as recommended by manufacturer or as specified in specification.

C. MS WORKS

(i) Doors frame-pressed steel frame and T-iron as specified
(ii) Windows – pressed steel frame-Glazed /wire gauge (SS)
(iii) MS door shutter and frame at mumty and machine room.
(iv) Hardware: All hardware for doors and windows shall be Powder coated MS or as specified.
(v) M.S. Grill as specified

D. ROLLING SHUTTER (POWDER COATED) – APPLICABLE AREA FOR MEP PLANT ROOM

(i) With mechanical operation system.
(ii) With MS grill / without MS grill as required.

E. FIRE CHECK DOORS AND PARTITION

(i) All fire checks door shall be of mild steel provided.
(ii) Fire Check doors of 120 minutes fire rating confirming to BS: 476 part 22 & IS: 3614 Part II. These doors shall be provided at all fire exit points, fire fighting shafts, Service Duct and shafts. The electrical panel room shall be provided with fire resistance doors. The fire doors shall be of Metal (GI.), as specified. The fittings such as Mortise Lock, Flush Bolts, Automatic Door Closer, Pull Handle, and Electromagnetic hold open device, Fire Rated Panic exit device shall also be of 120 minutes fire rating. Smoke Seals, Acoustic Seals shall also be provided.
(iii) Fire Resistant Glazed Doors, Windows & Partitions, as per requirements, 120 minutes fire rating shall be provided.
(iv) The shafts and /or ducts, if penetrating multiple floors, shall be of masonry construction with fire damper in connecting ductwork or shall have fire rated ductwork with fire dampers at floor crossing. Alternatively, the duct and equipment shall be installed in room having walls, doors and fire damper in duct/ entering the room of 120 min. fire resistance rating. Such shafts and ducts shall have all passive fire control meeting 120min fire resistance rating requirement to meet the objective of isolation of the floor from spread of fire to upper and lower floors through shaft/duct work.
(v) Frameless toughened Glass Door / partitions of minimum thickness 12mm (with toughened glass) with SS Patch Fittings and fixtures

F. LEAD LINE DOOR

Hermetically Sealed Sliding Lead Door – Approved Make Anti-Radiation Sliding doors are hermetically sealed doors with 2mm lead inside unless otherwise standard or as per AERB requirements based on X-ray that comply with AERB requirements for X-Ray/CT Scan/MRI shielding Doors. Three sided wall frame consist of 2mm lead lining. These Doors should withstand up to 75 Pa Pressure.

1.5.3.10 Railing And Grill Work

A. GRILL WORK: The grills shall be provided in the windows as specified in tender drawings and finishing schedule.
B. RAILING:
   i. MS RAILING: The MS railing shall be provided in Fire escape staircase, Services Blocks as specified in the tender drawings/ finishing schedule.

ii. STAINLESS STEEL RAILING: The Stainless Steel 304 railing shall be provided in Common Staircase, Cafeteria, and other locations etc. as specified in the tender drawings/ finishing schedule.

1.5.3.11 Structural Steel

The structural steel shall be as per the design approved by the EMPLOYER. Provision of suitable size MS Ladders finished with Epoxy paint as per CPWD Specification shall be provided for approach to terraces the buildings, Lift Machine Rooms, Water Tanks, and Pump Rooms etc. as per requirements. Roofing System for covered pathways shall be of structural steel.

1.5.3.12 Flooring:

The flooring shall be as per the finishing schedules or as specified:

a) In order to keep the floor finish as per the drawings and to provide required thickness of the flooring as per specification, the level of top surface of RCC shall be accordingly adjusted at the time of its centering, shuttering and casting. Alternatively, for maintaining the floor finish, grading with cement concrete with nominal mix 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 10mm nominal size) shall be provided.
b) Protective layer to be provided for all types of flooring, during construction.
c) The edges of steps in the staircases, counters, kitchen platform, window sills, and similar location shall be edge moulded as required. Staircase Tread should have Anti- Skid Grooves as specified in the tender drawing or as directed by Employer's Representative.
d) Minimum Bed mortars for various types of flooring
   (i) Chequered tiles/stone flooring/kota stone flooring/granite flooring/ Ceramic glazed floor tile flooring/vitrified flooring - 20mm thick bed of cement mortar 1:4 (1 cement: 4 coarse sand).
   (ii) For skirting and risers of steps in Chequered tiles/stone /kota stone /granite/ Ceramic glazed floor tile /vitrified tiles - 12mm thick bed of cement mortar 1:3 (1 cement: 3 coarse sand).
   (iii) The vertical facia and drops shall be finished with epoxy resin based adhesive.

1.5.3.13 Anti-Termite Treatment

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

Anti-termite treatment shall be got done through approved specialized agencies only with prior approval of the EMPLOYER'S REPRESENTATIVE or his representative at the cost of Contractor. During the execution of work, if any damage shall occur to the treatment already done, either due to rain or any other circumstances, the same shall be rectified and made good to the entire satisfaction of the Employer or his representative by the Contractor at his risks and costs.

i) Chemicals

The chemicals used for the soil treatment shall be any one or a combination of the following with concentration shown against each:

Chemicals are available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the percentage of concentration specified above, chemical shall be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the required proportion to achieve the desired percentage of concentration. e.g., to dilute chemical of 30% concentration add 59 parts of water to one part of chemical to achieve 0.5% concentration.

Chemical shall be brought to site of work in sealed original containers. The material shall be brought in at a time in adequate quantity to suffice for the whole or at least a fortnight's work. The materials shall be kept in the joint custody of the Contractor and the EMPLOYER'S REPRESENTATIVE. The empties shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from EMPLOYER'S REPRESENTATIVE

Chemical to be applied as per manufacturer specification and as per approved method of statement. Proper check shall be kept that the specified quantity of chemical is used for the required area during the operation

ii) Time of application

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

The treated soil barrier shall not be disturbed after they are formed. If by chance, treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

iii) Treatment for masonry foundation and basements

The bottom surface and sides (up to a height of 30 cm. from the bottom) of the excavations made for masonry foundations and basements shall be treated with the chemical emulsion mentioned above at 5 Ltrs. per Sq.m. of surface area.

iv) Treatment to backfill earth

After the masonry foundations and retaining walls of the basement come up, the back fill in immediate contact with the foundation structure shall be treated with the chemical emulsion at the rate of 7.5 Ltrs. per Sq.m. of the vertical surface of the sub-structure for each side. The earth is usually returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete or masonry surface of the columns and walls so that the earth in contact with these surface is well treated with the chemical.

v) Treatment for RCC foundations and basements

The treatment described in (iii) & (iv) above applies essentially to masonry foundations where there are voids in the masonry through which termites can seek entry in to the superstructure. Hence the foundation requires to be completely enveloped by a chemical barrier. In the case of RCC foundations the concrete is dense being a 1:1.5:3 mix or richer, the termites are unable to penetrate it. It is therefore unnecessary to start the treatment from the bottom of excavations. The treatment shall start at a depth of 50 cm. below the ground level except when ground level is raised or lowered by filling or cutting after the foundations have been cast. In such cases the depth of 50 cm shall be determined from the new soil level resulting from filling or cutting mentioned above and soil in immediate contact with the vertical surface of RCC foundations. From this depth, the back fill around the columns, beams and RCC basement walls shall be treated at the rate of 7.5 Ltrs. per Sq.m. The other details of the treatment shall be as laid down in (iv) above

vi) Treatment of top surface of plinth filling

The top surface of the consolidated earth within the walls shall be treated with the chemical emulsion at the rate of 5 Ltrs. per sq.m. of the surface before the sand bed or sub-grade is laid. If the filled earth has been well rammed and the surface does not allow the emulsion to seep through, holes up to 50 to 75 mm deep at 150 mm centres both ways may be made with 12 mm dia MS rod on the surface to facilitate absorption of the emulsion.

vii) Treatment at junction of walls and floor

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from the ground level (where it has stopped with the treatment described in (iv) above up to the level of the filled earth surface. To achieve this, a small channel 3 x 3 cm shall be made at all the junctions of wall and columns with the floor (before laying the subgrade) and rod holes made in the channel up to the ground level 15 cm. apart and the rod moved back ward and forward to break up the earth and chemical emulsion poured along the channel at the rate of 7.5 Ltrs. per Sq.m. of the vertical wall or column surface of the sub structure so as to soak the soil right to the bottom. The soil shall be tamped back in to place after this operation.

viii) Treatment to soil along external perimeter of building

After the building is complete, the earth along the external perimeter of the building shall be roded at intervals of 15 cm. and to a depth of 30 cm. The rods shall be moved back ward and forward parallel to the wall to break up the earth and chemical emulsion poured along the wall at the rate of 7.5 Ltrs. per Sq.m. of vertical surfaces. After the treatment, the earth shall be tamped back in to place. Shall the earth outside the building be graded on

completion of building, this treatment shall be carried out on the completion of such grading. In the event of filling being more than 30 cm., the external perimeter treatment shall extend to the full depth of filling up to the ground level so as to ensure continuity of the chemical barrier.

ix) Treatment for walls retaining soil above floor level

Retaining walls like the basement walls or outer walls above the floor level retaining soil need to be protected by providing chemical barrier by treatment of retained soil in the immediate vicinity of the wall, so as to prevent entry of termites through the voids in masonry, cracks and crevices etc. above the floor level. The soil retained by the walls shall be treated at the rate of 7.5 Ltrs. per sq.m. of the vertical surface so as to effect a continuous outer chemical barrier in continuation of the one formed under (iii).

x) Treatment of soil under apron along external perimeter of building

Top surface of the consolidated earth over which the apron is to be laid shall be treated with chemical emulsion @ 5 Ltrs. per Sq.m. of the vertical surface before the apron is laid. If consolidated earth does not allow emulsion to seep through, holes up to 50 to 75 mm deep at 150 mm centres both ways may be made with 12 mm dia mild steel rod on the surface to facilitate saturation of the soil with the chemical emulsion

xi) Safety precautions

All chemicals used for anti termite treatment are poisonous and hazardous to health. These chemicals can have an adverse effect upon health when absorbed through the skin, in haled as vapours or spray mists or swallowed. Person using or handling these chemicals shall be warned of these dangers and advised that absorption through the skin is the most likely source of accidental poisoning. They shall be cautioned to observe carefully

xii) Spraying equipment

A pressure pump shall be used to carry out spraying operations to facilitate proper penetration of chemicals in to the earth

1.6 STRUCTURAL

1.6.1 General

The scope of work includes planning, design and execution of Buildings. The detailed structural design of buildings shall be done by the Contractor and vetted by IIT/NIT/ reputed engineering institute as per directions of EMPLOYER/Authority Engineer. The requirements for the structural designs are briefed here under. Only Licensed Software's shall be used for the structural design and taking prior approval of software and version with the EMPLOYER is essential.

1.6.2 Geo Technical Investigations

The Contractor shall, after award of work, carry out the required site surveys and soil investigations and obtain soil investigation report as per IS Code requirements and applicable standards, through specialized agencies, with the prior approval from the EMPLOYER. The purpose of the investigations is to determine the sub soil stratification, geo technical information & safe bearing capacity, so as to provide information that will assist the structural engineers in the design of the foundations and the relevant works for the Main block and all associated buildings. The Job is to be carried out by Registered/certified (NABL & ISO etc.) Soil Testing Laboratory/agency under the guidance and supervision of Geo technical personnel/Consultant and Engineer. The soil investigation includes drilling boreholes by using rotary drilling, conducting Standard Penetration Test (SPT) and collecting sample for soil classification and identifications. Bore holes shall be taken as per IS Code requirements and instruction by the Employer's Representative . The report need to be checked and signed off by a professional with a minimum of Post Graduate qualification in Geotechnical Engineering field and has an experience of minimum 15 years in a similar field. The Contractor may get the required site surveys and soil investigations conducted for his assessment, prior to bidding, as per his requirements, if needed. Other Geo technical Investigation as per the requirement of site shall be carried out by the Contractor at their own cost.

1.6.3 Structural Design

The objective of this report is to lay down the design basis report for the structural design of 3 Building blocks viz. MAIN BLOCK (Trauma, OPD & IPD), Laundry Block & Service Block at Government General Hospital, Trivandrum.

This report covers the minimum design requirements which will form the overall design philosophy to be adopted in the structural design of the project.

The objectives of these reports are as follows:

- Define the engineering strategy and parameters in relation to the building structure and architectural concept.
- Identify and record all input requirements as well as analysis and design criteria.
- Develop structural scheme compatible with architectural vision, MEP requirements and client's needs.

- Prepare structural design that will aim to achieve structural stability, durability and integrity.
- Ensure ddesirable structural performance under characteristic load during service life of structure.

1.6.4 Structural System – Concept of Design

Structural system adopted for Buildings is RCC Rigid Frame with beams, columns/ shear wall as per the design requirements. In addition to the requirements governed by loads and forces, the minimum structural dimensions are also governed by other considerations like size of aggregates, reinforcement detailing etc.

The structural systems are being followed as a combination of both shear walls and beam column framing system or as per the methodology approved by the EMPLOYER.

The foundation system shall be designed as Isolated Footings / Combined Footings / Raft / piled raft / pile foundations, with respect to the structural design requirement in conjunction with the recommendations provided by the Soil Investigation Report and approved by the EMPLOYER.

The walls shall be considered as per Architectural drawings with minimum of 200 mm thick block work for external walls and with minimum of 100 mm thick Block Work or Light partitions for internal Walls.

1.6.5 Lateral System

Lateral system consists of special moment resisting frames. For the purpose of stability of the structure, as a whole, against overturning, the restoring moment shall not be less than 1.2 times the maximum overturning moments due to dead load plus 1.4 times the maximum overturning moments due to imposed loads. In case where dead load provides the restoring moments, only 90% of dead load shall be considered and the restoring moments due to imposed loads shall be ignored.

The Factor of Safety against sliding shall not be less than 1.40.

Factor of Safety against buoyancy shall be not less than 1.20 considering only the self-weight of structure. For the design of R.C.C. elements, the Limit State Method will be used as per IS 456-2000. For the design of Steel members, the Elastic design approach will be used as per IS 800-2007.

Material of construction will be predominantly R.C.C structure with consideration for ductility. Cover to reinforcement shall be in accordance with IS: 456:2000 corresponding to the exposure conditions for the super-structure, sub-structure and to satisfy a fire rating of 2 hours as the latest code.

1.6.6 Design Life of Structures

The design life of the building shall be considered as per IS code recommendation for similar category satisfying the criteria of environmental conditions.

1.6.7 Design Methodology

The structural analysis and design of buildings are to be performed as per the governing guidelines of the relevant Indian Standard Codes. Applicable Dead, Live, Wind and Seismic Loads along with appropriate load combinations are to be considered. Licensed software's such as STAAD, ETABS, and SAFE etc. shall be used for analysis and design. The structural design of the footings / foundations shall be on the basis of the safe bearing capacity of soil at the foundation levels provided by approved geo technical investigation report.

The design of all structural RC elements should be based on the Limit State method of design as specified in IS 456-2000. The design of all structural steel elements like columns, beams and deck should be based on the Limit State method of design as specified in IS 800-2007.

1.6.8 Properties of Material

CONCRETE:

The following minimum grades of concrete shall be used for the construction of the structure.

- All concrete mix shall be as per IS 456-2000.
- Minimum Grade of Concrete shall be M30 considered based on exposure as per IS code or as approved by the EMPLOYER.

NOTE: The column portion of beam arrangement shall be casted in the same grade as columns/ shear walls. Higher grade of Concrete can be provided, if required as per structural requirements.

REINFORCEMENT:

High yield strength deformed bars with minimum grade Fe 500D confirming to IS: 1786 – 2008 shall be used in the project

STRUCTURAL STEEL:

The property of structural steel shall be followed as per Indian standards or relevant IS 800-2007 & ASTM.

EXPOSURE CONDITION:

Structural elements shall be designed for exposure conditions as per the recommendation of IS code.

COVER TO REINFORCEMENT

Clear cover to main reinforcement shall be considered in the design, satisfying durability & 2 hrs. Fire rating requirement, which shall be as follows (Refer: clause No. 26.4.2, Clauses 21.4-,26.4.3 and Fig 1 of IS 456-2000 or clause 21.2 of IS:456-2000 or NBC 2016 whichever is higher

FIRE RESISTANCE

Fire: The structure is designed for 2 hr fire rating, as the firefighting system and fire hydrants are available within the building. The minimum clear cover to reinforcement and minimum dimensions of RC structural members as per clause 21.2 of IS:456-2000 shall be as follows considering 2 Hr fire rating.

1.6.9 Loads

The structural members are loaded with various loads combinations during its services conditions. The loads on the structure are taken for analysis and design as per the relevant IS codes of practice.

- Dead load as per IS: 875 -1987 Part-1
- Imposed live load as per IS: 875 -1987 Part-2
- Wind loads as per IS: 875– 2015 Part 3
- Seismic Loads as per IS: 1893-2016

WIND LOADS

Coefficients	**Reference**	**Remarks**
Terrain Category = 1	IS:875 (Part 3) 2015-Clause 6.3.2.1	Building situated in open area
Wind Zone = Zone II	IS:875 (Part 3) 2015-Fig.1	Trivandrum is in zone II
Risk coefficient, k1= 1.0	IS:875 (Part 3) 2015-Table 1	
Terrain and Height factor, k2 varies with height which is calculated by ETABS software	IS:875 (Part 3) 2015-Table 2	
Topography Factor,k3= 1	IS:875 (Part 3) 2015-Clause 6.3.3	
Basic Wind Speed Vb= 39 m/sec	IS:875 (Part 3) 2015-Fig.1	For Zone II

Wind loads are assigned as exposure to the extent of semi rigid diaphragm in the software as per IS code

SEISMIC LOADS

The seismic load calculations will be carried out in accordance with IS 1893: 2016

The salient features are as under

Seismic Zone	Zone 3
Seismic Zone Factor,	Z‘ 0.16
Seismic Importance Factor _I‘	Hospital buildings, Medical College 1.5

Response Reduction Factor and Fundamental Period of Vibration	The response reduction factor and fundamental period of vibration shall be taken as per IS 1893:2016, depending upon the structure and design requirements.
Percentage of Imposed Load to be considered in calculation of Seismic Building height	
Up to and including 3.0	25
greater than 3.0	50

STOREY DRIFT:

The story drift in any story due to the minimum specified design lateral force, with load safety factor of 1.0 is restricted to 0.004 times story height as specified in IS 1893 – 2016.

CRACK WIDTH:

In view of geographic location of the project, it can be classified under moderate atmospheric condition. Based on this assumption and as per IS 456: 2000, crack width in RCC elements shall be restricted to 0.2 mm. For water retaining structures crack width shall be limited as per IS 3370.

LATERAL DISPLACEMENT LIMIT:

The lateral displacement limit to the minimum specified design lateral force, with partial load safety factor of 1.0 is restricted to H/500 (approx.) in order to ensure minimum damage to Non-structural elements (NSE) and structural elements (SE). The design of buildings shall be done so as to avoid torsional irregularity.

TEMPERATURE ANALYSIS:

The structure will be subjected to:

1. Thermal variation during construction of building
2. Thermal variation during operational life span of structure

When RCC work is completed, building will experience temperature variation during peak atmospheric conditions. In view of maximum and minimum peak temperature data available, temperature load shall be considered. Load combinations for temperature loads are followed from IS 875 Part V – 1987.

MAX. ALLOWABLE DEFLECTION – (Including the effect of temperature, creep and Shrinkage)

1.Concrete	As per IS 456 2000 clause 23.2	(for gravity load) Floors
2.Steel / composite	As per table 6 IS 800 –	(for gravity load) Floors

	2007	
Lateral (1 & 2	H/500	(for lateral load

LOAD COMBINATIONS:

All structural designs are carried out by the Limit State method of design. For this purpose the Load factor for various load combinations indicated in IS: 456-2000, IS: 1893-2016, IS 1904.2021, latest editions are to be followed.

1.6.10 Design Philosophy

To meet the design life and durability requirements, IS code provisions specified in clause 8.0 and table 5 of IS: 456- 2000 will be followed for reinforced Concrete Elements. All structural elements would be designed according to the Limit State Method as specified in IS: 456: 2000. Minimum of M 25grade concrete for RCC structural Members such as beams, slabs footings, staircase, lift walls, columns etc. with Fe 500 Grade steel may be considered for design, subject to structural/design requirements. All structural design shall be proof checked through NIT/IIT or reputed engineering institute as per directions of the Employer /Authority Engineer. Higher grade of Concrete can be provided, if required as per structural requirements, with the review and no-objection of the Employer.

A. Underground Sump /Overhead Water tank

Underground water tank would be designed to sustain the following two cases

- Tank full and No earth fill.
- Tank empty and active earth pressure acting from outside.

The walls and base slab would be designed as per the provisions of IS: 3370 (Part1 to Part4)-latest edition. Overhead water tank would be designed to sustain the water load at full tank condition as per the provisions of IS: 3370 (Part 1- Part4) –latest edition.

B. Expansion & Construction Joints:

Expansion joints are recommended when the length of the structure exceeds 45m. The width of the seismic joints are to be calculated as per IS-1893-2016, clause 7.11. In case Seismic joints are not provided, thermal analysis shall be carried out to ascertain their effect and accordingly the design shall be carried out. Construction joints will be planned with the coordination of construction agencies

C. Foundation

Type of foundation shall be finalized after conducting required soil investigation test at the construction sites as well as joint discussions done by Soil and Structural Consultant along with the EMPLOYER.

D. Detailing

The reinforcement layout should take into account the strength requirements as well as the economy of construction. Following are the requirements of good detailing.

- Reinforcement detailing should be simple for fabrication and placing.
- Cracking of concrete should be within the permissible limits.
- There should not be any free paths for propagation of cracks without being traversed by reinforcement.
- Joints and discontinuities should be capable of withstanding the same forces as the adjoining sections.
- Reinforcement should not deviate from the direction of tensile stresses.
- Reinforcement steel of same type and grade shall be used as main reinforcement in a structural member. Provisions of IS: 456-2000, IS 13920-2016 and IS: SP 34 shall be followed for the purpose of detailing of reinforcement.

1.6.11 Computation Modelling

The buildings shall be designed as 3-D frame structure with AAC Block /solid block work walls or the block work as specified in the approved drawings, for different load combinations. The slab panels are to be designed as per code provisions IS 456-2000. The analysis & design of idealized model is to be carried using approved software providing design and detailing as per IS 456-2000 and IS 13920. Seismic Coefficients are as applicable to Seismic Zone III as per IS 1893- 2016.

The analysis of the structure would be carried to:

- Ensure elastic behaviour and fulfillment of serviceability criteria for un-factored load combination.
- Ensure adequate structural integrity for factored load combinations.
- Obtain static and dynamic displacements and rotations at various nodes.
- Obtain resultant member forces like bending moments, shear forces and axial forces.
- Obtain support reactions (axial force and moment) coming on foundations

1.6.12 Code Requirements

The relevant Indian Standard Codes with latest amendments and latest version, as given below shall be followed for structural design.

Sl. No	CODE	DESCRIPTION
1.	IS-875 (Part 1) – 1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Unit weights of buildings materials and stored material
2.	IS-875 (Part 2) – 1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Imposed loads
3.	IS-875 (Part 3) – 2015	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Wind loads
4.	IS-875 (Part 5) – 1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Special loads and load combinations

Sl. No	CODE	DESCRIPTION
5.	IS: 456 – 2000	Code of Practice for Plain and Reinforced Concrete
6.	IS: 1786 – 2008	Specification for High Strength Deformed Bars and Wires for Concrete Reinforcement
7.	IS: 432 (Part 2)-1982	Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for Concrete Reinforcement – Hard Drawn Steel Wire
8.	IS:1343-1980	Code of Practice for Pre-stressed Concrete
9.	IS: 13920 -2016	Ductile detailing of reinforced concrete structures subjected to seismic forces - Code of practice
10.	IS:14268-1995	Uncoated stress relieved low relaxation seven-ply strand for pre-stressed concrete - specification
11.	IS: 2062 –1999	Steel for General Structural Purposes. Specification
12.	IS: 1161 –1998	Specification for Steel tubes for Structural Purposes
13.	IS: 800-2007	Code of Practice for General Construction in Steel
14.	IS:1893-2016	Criteria for Earthquake resistant design of structure
15.	IS: 2210 – 1998	Criteria for Design of Reinforced Concrete structures and Folded plates
16.	IS : 269 –1989	Specification for Ordinary, rapid hardening and low heat Portland cement
17.	IS : 455 -1989	Specification for Portland blast furnace slag cement
18.	IS : 1489 -1991	Specification for Portland pozzolana cement
19.	IS : 383 -1970	Specification for coarse and fine aggregates from natural sources for concrete
20.	IS : 516 -1959	Method of test for strength of concrete
21.	IS:432-1982	Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for Concrete Reinforcement
22.	IS:4990-1993	Specification for plywood for concrete shuttering Works
23.	IS : 2645 -1975	Specification for integral cement water proofing compounds
24.	IS: 2950 (Part 1) - 1981	Code of Practice for Design & Construction of Raft Foundations
25.	IS: 16700-2017*	Criteria for Structural Safety of Tall Concrete Buildings
26.	NBC-2016	National Building Code of India
27.	IS:3370 (Part 1 to 4) - 2009	Code of Practice for Concrete Structures for Storage of Liquids.
28.	IS 1904:2021	General Requirements for Design and Construction of Foundations in Soils — Code of Practice
29.	IS 4326-1993	Code of Practice for Earthquake Resistance Design and Construction of Buildings

Note: The above list of codes is suggestive and not exhaustive. Apart from these basic codes, any other relevant codes shall also be followed wherever required.

1.7 PLUMBING (WATER SUPPLY AND SANITARY INSTALLATION)

1.7.1 General

The Contractor shall carry out Design, Engineering, Supply, Installation, and Testing & Commissioning for Plumbing (Water Supply and Sanitary System). The work shall in general conform to the Latest IS Codes, NBC and CPWD Specifications. The water supply and sewerage demand shall be estimated, based on the IP populations, as recommended by NBC norms, Local bye Laws & statutory norms.

1.7.2 Basic Objectives

The basic objective is to provide all sanitary engineering services and specification in relation to:

1. High standards of materials and workmanship.
2. Leak proof plumbing for drainage and water supply system.
3. Plan the system in such a way as to minimize the energy requirements.
4. Less maintenance and automatic operation of systems.
5. Low flow fixture usage as per IGBC norms.
6. STP treated water reuse /Rain water reuse to meet IGBC norms.
7. Water metering system for monitoring water usage in various applications.
8. Storm water disposal at site as per IGBC requirements.

1.7.3 Internal Plumbing Works

(i) Sanitary fixtures & C.P brass fittings
(ii) Water Supply distribution system (domestic + flushing)
(iii) Disposal of soil, waste & rain water etc.

1.7.4 Water Distribution/ Supply System

(i) The Domestic water supply to the buildings shall be meet from municipal water supply. Secondary source will be from rain water harvesting. Flush water will be sourced from STP treated water.
(ii) Water shall be to fit for human consumption & hospital needs
(iii) Storage of Fire, Rain and Domestic treated Water.

1.7.5 Drainage/ Sewerage System

The Drainage/ sewerage system shall be planned from buildings up to the Sewage Treatment Plant.

1.7.6 Storm Water Drainage System

Collection and conveyance around the buildings & its disposal system.

1.7.7 Garden Hydrant System

External garden hydrant system to supply the water for horticulture purpose to all landscaping/ green area around the buildings.

1.7.8 Pumps & Water Treatment Equipment

Water supply pumps to Hospital & other occupancies including flushing water supply system etc.

i. Domestic water supply – water transfer pump/booster pumps along with PLC Control Panel.
ii. Flushing water Supply – water transfer Pumps along with PLC Control Panel.
iii. Dewatering System for Soil/Waste and Storm Water – Sewage Pumps
iv. Hot water supply- booster pump/recirculation pumps with PLC control panel.
v. Cooling tower water supply- water transfer pump or by gravity flow (site condition)

1.7.9 Details for Water Supply/ Waste Water Distribution System

For continuous water supply at adequate pressure, complete water supply system is designed with following type of pipe-lines.

The main water supply lines from treated water storage tank/pump room to till the main ring system to be designed via CPVC – Schedule 80 pipes conforming to latest standard. The water supply lines have been designed with different diameters as per standard installation methodology. All the operational valves/fittings also be designed as per latest IS Code.

Water supply distribution pipes ring main at terrace to down take in the shaft up to the entry into the floors shall be with CPVC SCH 80 and floor distribution shall be SCH 40. The water supply pipes from the shaft inside the floors, concealed piping and to other end points shall be of CPVC pipes of required grade/class, conforming to the requirements of IS 15778 Codes. To regulate the water supply, valves and fittings, at required places, shall be fixed as per specification.

Water distribution ring mains shall be planned at terrace floor level & further bring down to vertical shafts with individual isolation valves. Pressure reducing valve shall be fitted to maintain adequate pressure in the ring main to distribution riser lines. Each toilet shall be provided with an individual Control valve for the isolation of respective toilet for easy maintenance. The ring mains and vertical risers are painted with standard colour code for identification and easy maintenance. Minimum pressure of 1.0 kg/sq.cm shall be maintained in remote fixture. The sizing of the entire distribution network is based on the simultaneous use of fixture unit's demand as per NBC.

1.7.10 Approach to Planning

The Plumbing services for the project are designed keeping in view the following:

- The underground domestic water storage tank capacity shall be of 1.5 days of daily domestic water demand and half day of daily domestic demand will be stored at the terrace tank level.
- The underground flush water storage tank capacity shall be of 1.5 days of daily flush water demand and half day of daily flush water demand will be stored at the terrace tank level.

- Implementation of requirements of Kerala Building Rules relating to rain water harvesting, water conservation, use etc.
- Economic designs with cost effectiveness.
- Appropriate selection/recommendation of materials and equipment in terms of technology
- Water conservation using low flow fixtures according to IGBC norms.
- Water supply and Drainage provision for Landscape layout, as applicable.

1.7.11 Details of Water Supply System

Water source

Water sources through which fresh water can be made available for the building are Kerala Water Authority (KWA) water supply system, Open wells and Treated water through rainwater harvesting. Recycled water from STP shall be used for Flushing, Irrigation and Cooling tower make-up.

Water Distribution

The incoming main from municipal water is stored in domestic water tank which shall be of 1.5 day capacity. To avoid stagnation in Fire tank, corporation water input shall be first given to fire tank and the overflow from the fire tank is transferred to domestic water tank.

Rain water shall be used for domestic purpose after water treatment process. The Treated water is fed to fire tank and over flow is transferred to domestic water tank. Potable water shall be pumped to overhead fire tank by water transfer pump. Over flow from fire tank will be stored in OH domestic water tank which shall be of minimum 50% of one day water demand. From there, water is transferred to respective areas by gravity flow.

A pumping system from raw/ rain water tank to OH flush water tank shall also be installed.

STP & ETP treated water is used for flushing purpose after ultrafiltration process. A pumping system of suitable capacity shall be designed to pump treated water from STP & ETP to UG flush water tank.

Hot water system (heater)/provisions are to be considered in all the bath areas. Solar water heater /heat pump shall be used to attain the hot water demand. Heat pump will assist the solar water heater to achieve the required temperature. Hot water demand for the hospital building shall be designed and executed by the Contractor. Long body bib tap shall be considered for every WC cubicle of patient toilet

1.7.12 Projected Total Water Requirement

Water requirement shall be calculated based on NBC 2016

1. Water demand per bed for Hospital building with beds above 100 no.= 450 ltrs per day
2. Water demand per person for OPD = 15 ltrs per day
3. Domestic water demand will be 55% of water demand
4. Non domestic water demand will be 33% of water demand

5. Drinking water demand will be 12% of water demand

Tentative tank capacity for the project is mentioned below.

TANK CAPACITY REQUIRED			
TANKS	**UG TANK**	**OH TANK**	**UNIT**
DOMESTIC WATER	**400000**	**132000**	**ltrs**
FLUSH WATER	**132000**	**44000**	**ltrs.**
RAIN WATER	**305000**	**0**	**ltrs.**
FIRE TANK **Trauma,** **Laundry &** **Service**	**200000** **75000** **216000**	**20000** **20000** **20000**	**ltrs.**
COOILING TOWER MAKE UP WATER DEMAND AS PER CHILLER CAPACITY			

Note: Actual capacity has to be worked out by the Contractor after water calculation design.

1.7.13 Sanitary Works

A. Sanitary Fixtures & C.P Brass Fittings

Plumbing fixtures, Chrome Fittings and accessories will be as per IS: 781-1984.

B. Porcelain Fixtures of Fairly High Quality

(i) WCs - Low volume dual flushing system comprising concealed/exposed cistern with low flow fixture unit of 5lpm @3bar pressure shall be as per IS: 2556.

(ii) LAVATORY BASINS available in all size and shapes including wall hung, over or under counter types etc. with infra-red sensor as per IS: 2256 (Part 7) 1995.

(iii) URINALS shall be provided with Infra-red sensor battery operated as per IS: 2556 part confirming to low flow fixture unit of 2lpm@3bar pressure.(.75L /flush)

(iv) Urinal Partitions - Partitions shall be of 12mm thick toughened glass fitted to wall of required size, approved by EIC

(v) ACCESSORIES: - Soap dispensers, toilet paper holders, hand drier, grab bar, etc. shall be of Stainless Steel

(vi) CHROME FITTINGS: - Provision for additional and special hospital fittings where required shall be made as per IS: 781 - 1984.

(vii) SHOWER: - Mixer type shower shall be used with low fixture unit of 6lpm flow @ 3.1 bar pressure

(viii) PILLAR TAP/BIBTAP/SINK COCK: - Mixer type tap shall be used with low fixture unit of 6lpm flow @ 3.1 bar pressure. Sensor controlled Pillar taps may proposed to save water & confirm hygiene operation.

(ix) HEALTH FAUCET:- low fixture unit of 6lpm flow @ 3.1 bar pressure

1.7.14 Soil, Waste Pipe System (Drainage)

A. General:

- Drainage piping shall be designed on the basis of two pipe system as recommended in code of practice for soil and waste. Soil pipes shall carry the wastes from WC‘s & urinals etc. shall connect directly to the manhole outside the building and routed to STP. Necessary pumping system (if required) to be furnished. Automatic level control system with standby pumps to be provided.

- Internal buildings sanitary disposal system will be under the RCC slab (By core cutting RCC slab and suspended at bottom) for hospital buildings. The core cutting shall meet the structural requirements. Or disposal system will be above the RCC slab. Necessary sunken to be provided if services are over slab. Lab slabs to be made sunken for the services.
- Waste pipes shall carry the wastes from waste appliances (lavatory basins, sinks etc.). Waste pipes shall connect to Gully Traps outside the buildings and shall be connected to the external manholes and directed to the proposed STP. Waste water from CSSD, lab, kitchen, OT shall be routed to ETP.

B. Design Parameters

- Piping system shall be designed in accordance with Code of Practice for Installation of Soil & Waste Pipes.
- All vertical stacks will terminate as vent pipes are at parapet level.

C. Pipe Work

- Provision shall be made to provide cleanout doors and plugs for Roding and maintenance where necessary and required.

1.7.15 Materials For Soil, Waste & Vent Pipe System

Pipes used for Soil, Waste and Vent system shall be uPVC as per latest IS code. The pipes and fitting are jointed as per standard installation methodology/ specifications.

1.7.16 Details of Sewerage System

A. Type of Distribution

Sullage and Sewage from all buildings shall be transferred to the proposed STP through individual pipes. Ground floor level toilets lines should not be merged with upper level stacks. It need to be separately connected to respective gully traps/ Manholes. Sewage pumping system of adequate capacity may also be considered to pump sewage into the STP collection chamber if found necessary.

B. Manholes

The manholes are to be constructed with brick masonry as per standard specifications of NBC 2016 and shall have details as follows:

(i) Rectangular manhole of size 900 x 800 mm up to 0.89 MTR depth.
(ii) Circular manhole of size 910 mm dia for 0.9 to 1.64 MTR depth.
(iii) Circular manhole of size 1220 mm dia for above 1.65 to 2.29 MTR depth
(iv) Circular manhole of size 1520 mm dia for above 2.3 MTR depth.

C. Spacing of Manholes

(i) Manhole shall be provided with all the junctions, change of directions and change in diameters and as per connection requirement from every units.
(ii) A distance of 30 meters (maximum) on the main sewer line depending on dia. of pipes and local conditions.

D. Manholes Covers

CI Manhole covers shall be provided as per IS 1726. Capacity of covers shall be as per relevant technical specifications or as advised by EMPLOYER.

E. Sewage Collection and Disposal

The sewerage system shall be designed as per IS specifications. When fixtures about 2-2.5m away from the stack of soil pipe are flushed, they induce a negative pressure in the pipe preceding the flow. To reduce the negative pressure in the pipe lines, Anti -siphon age pipe with separate vertical stack as a vent pipe may be used or any other methodology which shall reduce the negative pressure. The soil and waste stacks also continues till roof level inside the shaft and thus provides for additional venting.

The Soil, waste and vent pipes are integral parts of the sewerage system that carries foul and ablution wastes from the building fixtures to the sewer system outside the complex thus serves for efficient and quick disposal of sewage and waste water from the building.

Sewer lines within toilets to be taken in a suspended manner from floor below & false ceiling is required for all toilets except top floor toilets. Even then, minimum slope is required in toilets i.e. at least 50mm drop from outside FFL, to maintain the slope towards the floor trap./ or buried in sunken with required slope

Deep seal traps i.e. of 65mm water seal shall be provided for floor drains and urinal traps and also floor traps shall be in clean/dirty utility rooms, Scrubbing Area & Garbage Chute etc.

Ceiling suspended individual headers are planned with clean out plugs at critical locations.

The minimum diameter of the vertical soil & waste water stack shall be 110mm. All fixtures and appliances shall be fully trapped to prevent back flow of foul gases and odour into the toilets. Ground floor appliances shall be separately connected to the external gully trap/ manhole.

1.7.17 Details of Storm Water Drainage System

A. Planning of Storm Water Drainage System

- Rain water from terrace floor level collected in the rain water tank is used for gardening purpose or flushing to meet IGBC requirement. Rain water harvesting tank is designed with KMBR rules. The rainwater first flushout filter shall be installed in the down pipe. Quantity of Vertical down pipe for rain water shall be as per NBC rules.
- The rainwater from the open surface areas is connected to the main storm-water trench along the periphery. Storm water shall be percolated at site with soak pits. Storm water should not flow out of the site as per IGBC norms. Trench with gratings of suitable size shall be designed as per the site conditions. All paved/road/green areas, the run off shall directly connected to the main storm water drains.

B. Storm Water Collection & Pumping System/ Arrangement

If the rain water drainage system in the area where free flow to external drainage system is not possible, it shall be collected in the open collection tanks and shall be pumped out to nearby Drain. Suitable capacity / head of submersible / lifting pumps (1W+ 1S) shall be provided along with necessary piping / valves / fittings / cablings (power & control) / outdoor type panel with necessary starters/ level controllers, auto start stop arrangement complete with all accessories. Rain water overflow water shall be pumped out to designated locations with connections to trench near to the boundary as per directions of Employer's Representative

C. Design Parameters

- Minimum Pipe diameters for Rain Water Pipes from Terraces shall be 110 mm.
- Min. Pipe diameters for main rain water drain will be 250 mm dia. in line with local authority requirements.
- All construction specifications with respect to the manhole sizes etc. will be respected and followed and as per CPWD specification.

1.7.18 Details of Irrigation System For Lawns And Gardens

Gardens and lawns shall be irrigated in combination of Garden Hydrant System and Sprinkler Irrigation System. The automatic pumping system shall be designed as per the water demand for the irrigation system.

1.7.19 Details of Hot Water Generation & Distribution

Hot water required certain areas like labs, toilets, kitchen, scrub et**c.**to fulfil facilities requirements. The Hot water is to be generated via Heat pump and solar water heaters.

1.7.20 Details of Solid Waste Generation And Management

A. General

The Contractor shall carry out Design, Engineering, Supply, Installation, and Testing & Commissioning for Solid Waste Generation and Management System. The Solid waste generated from the project will be collected and managed as per Solid Waste Management Rules, 2016. The project will adopt a systematic approach for solid waste collection and disposal. The domestic solid waste generated pertains to the two categories, Bio-degradable and Non-biodegradable. These solid wastes will be collected separately by putting different types of separate bins at the source of generation.

Solid Waste generated from the project shall be collected at the source of generation and segregated. Organic waste will be converted into manure using organic waste converter & inorganic waste will be disposed through designated agency. Biomedical waste will be segregated, stored in color coded bags, will be disposed through designated agency.

BIOMEDICAL WASTE: It is estimated that on an average 2 kg of waste per bed per day at occupancy rate of 60% shall be generated out of which about 0.20 - 0.25 kg / bed-day of the total waste generated is estimated to be infectious in nature and needs effective management under the Bio-Medical Waste (Management and Handling) Rules 1998.

The Bio Medical waste shall be collected, stored and handed over to the authorised agency for further treatment with standard protocol. The Contractor should design the proper system for safe handling and handing over the waste as above.

1.7.21 Sewage Treatment Plant (STP)

STP shall be designed as per the site condition. Tentative capacity of required STP will be 400KLD considering the proposed Main Block, Laundry block and Service block and the existing surgical block**.** MBBR technology based STP shall be proposed. The treated water from STP shall be used for flushing, irrigation and cooling tower make-up. The excess treated water after reuse to be disposed off suitably as per rules and standards. Parameters of STP treated water should meet the STP treated water quality requirements specified in relevant IS standards and CPCB/KSPCB norms applicable for usage of treated water mentioned above.

1.7.22 Effluent Treatment Plant

The scope of work includes Design, Supply, Installation, Testing and Commissioning of 80KLD Effluent Treatment Plant (MBBR Technology) for the below-provided inflow parameters for the Power Laundry unit including necessary civil works to successfully install the ETP plant including five (5) year DNP.

Sl. No	Waste Water Parameters (5KLD)	Values Considered	Desirable Limit as per CPCB Standards
1	BOD (mg/l)	500-600	<10
2	COD (mg/l)	700-900	<50
3	PH at 25oC	7.0 - 8.0	7.0 - 8.0
4	Colour	--	--
5	Oil & Grease, Mg/l	20-30	<5
6	TSS, Mg/l	200-250	<10

1.7.23 Water Filtration Plant (For Domestic Water)

Design parameters shall follows IS: 10500-2012 or relevant code for domestic water use.

1.7.24 RO plant

RO plant capacity shall be considered as per the water demand calculated for OT/CSSD/LAB/Kitchen etc. Design parameters for RO plant shall follows IS: 10500-2012 or relevant code for domestic water use.

RO Plant output water quality shall be suitable for Haemodialysis conforming to ANSI/AAMI Standard 13959:2014.

1.7.25 List of Codes And Manuals:

The following codes of practice and design manuals are being referred for designing the Sanitary Plumbing Systems:

NBC / CPWD	National Building Code 2016/ CPWD Specifications
IS 10446 –1983	Glossary of terms relating to water supply and sanitation
IS 1701 –1960	Specification for mixing valves for ablutionary and domestic purposes
IS1711–1970	Specification for self-closing taps
IS 3311 –1979	Specification for waste plug and its accessories for sinks and wash basins.
IS775 – 1970	Specifications for CI brackets and supports for wash basins and sinks.
IS 9763 –2000	Plastic Bib Taps, pillar taps, angle valves and stop valves for hot and cold water services.
IS 13983 –1994	Stainless steel sinks for domestic purposes – Specification
SP –35	Handbooks of water supply and drainage (with special emphasis on plumbing
SP 7 – 1983	National building code of India (Part IX – Plumbing services)
IS 2064 –1993	Code of practice for selection, installation and maintenance of Sanitary Appliances (1st revision)
IS 774 – 1984	Specification for – flushing cistern for water closets (Other than plastic cistern)
IS 1795 –1982	Specifications for Pillar taps for water supply purposes
IS 12183	Code of practice for Plumbing In Multi-Story buildings/Part 1 of Water Supply (Part I – 1987)
IS 2379 –1963	Specification of colour code for the identification of pipes
IS 15450: 2004	Specification for PE - AL -PE Composite Pipes
IS 5312 – part 1	Specification for swing check type reflux (Non-return)
IS 10446 –1983	Glossary of terms relating to water supply and sanitation.
IS 7558-1974	Code of practice for domestic hot water piping installations
IS 2401–1973	Code of practice for selection, installation, and maintenance of domestic water meters.
IS 2065 –1983	Code of practice for Water Supply In Buildings (Second Revision)
IS 778- 1984	Specifications for copper Alloy Gate, Globe and check valves for water supply purposes
IS 1172-1983	Code of Basic Requirements for water Supply, Drainage and Sanitation (Third Revision)

NBC / CPWD	National Building Code 2016/ CPWD Specifications
IS12251-1987	Code of Practice For Drainage In Basement
IS 5329 –1983	Code of practice for sanitary pipe work above ground for buildings First Revision)
IS 2527 –1984	Code of practice for fixing rain water gutters and down take pipes for roof drainage. (First Revision)

1.8 ELECTRICAL WORKS

1.8.1 General

The Contractor shall do planning, designing, preparation of drawings and execution of all electrical works. Since the hospital main functioning hours are between 8 am to 2 pm, peak load should be expected at this time as all the equipment might function simultaneously. After the main functioning hours, the load may get reduced below 40%. Two Transformers shall be provided for the entire system. DG Capacity selection criterion should be equivalent to Transformer. The main building is a four storeyed building. It consists of Operation Theatres, ICU's, X-Ray unit, MRI/CT/USG scan, Chemotherapy section, ECG, Labs, Consultation of various Medical Departments, waiting area, wards, etc. Besides this, two sub buildings which are Laundry Block and Service Building. The buildings are situated in vast area along with other main blocks such as surgical block & Medical College. Accordingly, a dedicated 11 kV (minimum) connection through 11 kV VCB HT panel for feeding all these major areas shall be provided.

The Contractor shall carry out detailed Planning, Design, Engineering, Supply, Installation, Testing & Commissioning of complete Internal & External Electrification, HT works and Extra Low Voltage (ELV) systems as required for smooth functioning of the Development of General Hospital, Trivandrum.

Design of systems, services, equipment, accessories, quality of material to be used in Electrical, ELV works, quality of workmanship, Installation, Testing, Commissioning, Safety methods are to be strictly adhered by complying with applicable codes or guidelines mentioned in the relevant systems/ services.

Primary stage of design consists of the data collection such as load details which are going to be connected in the TRAUMA Block and other buildings. The data include light loads, raw power loads, medical equipment load, common services load, HVAC, fire protection, lifts, external electrical, pumps, etc. Laundry block may contain huge machines; hence the power requirement shall be assessed in consultation with the EMPLOYER. In the case of service block, the load requirement is small i.e., only essential lighting and power load should be taken into account.

The Contractor shall provide two (2) transformers of equal capacity. The capacity of transformer, DG set and other associated elements shall be designed and finalised as per the direction of Employer’s Representative . Similarly, two (2) DG sets shall be provided for a reliable and adequate back up. The two Transformers shall be fed from a common 11 kV VCB panel through another HT Panel. Both the DGs are synchronized so that either or both can be used depending on load.

The Electrical & ELV works shall meet all the requirements for the satisfactory operation, monitoring & utilization of other services like Heating Ventilation & Air Conditioning (HVAC) system, Fire fighting system, Lifts, Bio medical equipment, Operation Theatres, Other critical care services, UPS, Water distribution System, Sewerage lifting system, Rainwater pumping system, External lighting, On-grid Roof top Solar system, all ELV works for fulfilling the smooth functioning of the hospital with trouble-free operation of utilities,

avoiding damages to equipment, and ensuring safety for the community and hospital authorities.

Note: The rating and capacity of equipment indicated herein below are minimum to be provided. However, during detailed designing, if required and found necessary, the capacity/ rating of the equipment may be upgraded by the Contractor.

1.8.2 Scope of Work

Following details shall be prepared and submitted to EMPLOYER for approval before commencing the execution work:

1. Detailed design of lighting (internal & external) by employing Dialux software
2. Preparation of room wise light fixture schedule
3. Light points fed from back up supply (DG set & UPS) shall be separately mentioned
4. Preparation of lighting layouts (both raw & emergency lights)
5. Provision of power sockets for services such as work stations, WIFI points with necessary components in pre-selected areas (to be decided in consultation with Hospital Authority), indoor AC units, Lab equipment, general purpose sockets in all rooms, power points for ELV systems and for similar services in the hospital
6. Power points fed from back up supply (DG set or UPS) shall be separately mentioned
7. Preparation of room wise power points schedule
8. Preparation of power layouts and power load calculation sheets (separately for raw & emergency power points)
9. Preparation of power supply distribution system for high power rated equipment coming under HVAC system (low side & high side), Fire fighting system, and Plumbing system, Bio medical system including cable sizing, panel board sizing, cable containment system sizing, Cable trench/ Hume pipe/GI pipe details and voltage drop calculation of each feeder in the panel boards.
10. Preparation of power distribution system including Panel board/DB sizing, cable sizing, tray sizing, voltage drop calculations, Rising main/ Bus duct sizing, UPS sizing, UPS battery backup calculation, Single line diagrams, DB schedules, floor wise power distribution layouts (lighting & power).
11. Capacity calculations of substation equipment like transformers, DG set, Main LT panel sizing, Capacitor cum Harmonic panel sizing, connected load calculation sheets, single line diagrams for the submission for KSEB/KSEI approval, Substation & DG set equipment layout, Exhaust piping/Fuel pipe line layout, External and internal cable trench/Hume pipe details, Earthing system, Power supply intake arrangement etc.
12. Preparation of earthing system based on soil resistivity value for the location, Fault calculation, Earthing pit & earthing conductor sizing calculations, Internal and external earthing system layouts.
13. Preparation of lightning protection system design based on risk analysis complying IEC guidelines, LPS layouts calculation sheets.
14. Surge Protection Devices as per risk analysis as applicable

15. On-grid Roof top mounted Solar PV system – Sizing of PV system based on KSECBC: 2017/ IGBC and KMBR standards, Terrace layout showing PV cell/PDU arrangement, structural support details, power distribution system from PDU including cable sizing, containment system sizing etc.
16. Detailed electrical load breakup of the project including connected load (essential & non-essential separately) of each equipment/item (light, power points, AC points, load of all mechanical & biomedical equipment, UPS, any other service equipment' load etc.
17. Single line diagrams of floor wise distribution boards/ panel boards, Main LT panels/Essential/AMF/capacitor panel details, cable/bus duct/rising main details, Transformers/DG sets/UPS/Solar PV station capacities, HT panel/RMU details, HT cable, Metering panels etc.
18. Relevant documents supporting the electrical load details of mechanical/biomedical equipment/other essential equipment from OEM shall be submitted to EMPLOYER along with above.
19. Voltage drops calculation sheet & other design sheets for cables and rising mains
20. External service layout of electrical services (routing of cables from sub stations and DG sets to building, RCC trench/Hume pipe/GI pipe/Manholes, etc, Street light/landscape/facade layout, details of cable & trench for street light, location of light control panels etc.
21. Material make approval & procurement may be done after getting approval from EMPLOYER for the above.
22. Preparation of GFC drawings/Shop drawings/Light & Power conduit layouts of all Electrical/ELV services
23. Preparation of make approval requests, work inspection requests etc. as per approved construction program
24. Preparation of as-built drawings
25. Preparation of O & M manuals

1.8.3 Source of Electrical Power Supply & Load Calculation for Selection of Transformer & DG

KSEB will provide designed capacity HT supply for the new buildings. However, designed capacity supply shall be taken from KSEB's RMU including supply, laying, rerouting and termination of HT cable and associated civil works up to substation.

If required, RMU of suitable incomer/ outgoing and outdoor HT metering panel shall be considered depending on the requirement by authorities. In such case, the location of RMU and metering panel shall be finalized after discussion with KSEB authorities.

Incomer VCB panel and HT panel shall be placed in the Ground floor of Service building. VCB panel will have 3 outgoing feeders, one for new TRAUMA block, one for existing Surgical Complex and one for existing Medical College.

Existing load details of Surgical Complex and Medical College are as given below as obtained from Hospital Authorities, which may be corroborated by Contractor:

	Connected Load	Maximum Demand
Surgical Complex	320 KVA	170 KVA
Medical College	500 KVA	400 KVA

The total connected load for the Trauma block including Service block and laundry block is approximately 2401 KW; Maximum Demand is 1769 KVA at a Demand Factor of 0.7 & 0.95 PF. Considering 90 % loading, 2 nos. 1000 KVA dry type transformers are selected.

11 kV HT cable, re-routing of existing HT cable, including trenches as required and terminations are in the scope of the Contractor for connecting existing Surgical Complex and Medical College to the new 11 kV VCB panel of the project.

The DG sets shall be working on load sharing & synchronising pattern on power failure. The DG sets shall cater all electrical loads of Operation Theatres (100%), ICUs (100%), Medical Gas supply system (100%), Lifts (100%), Water supply system (100%), Drainage system (100%), Fire Fighting system (100%), HVAC in critical areas, all ELV works (100%), Emergency lighting (100%), other critical services in Biomedical systems (partial). In addition to above, there shall be minimum 220 kVA UPS with 30 minutes back up time to cater critical services such as Operation Theatres, BHPs in ICUS, work stations, WIFI points, Emergency light fixtures (to comply NBC guidelines) and all LV services. The UPS capacity (220kVA) mentioned shall not be a single unit. The Contractor shall provide separate UPS for emergency light & power points, Operation theatres, ICUs etc. as per the actual requirements. The location of UPS in this case shall be at load centres and to be placed conveniently in an air-conditioned room.

Note: The capacity of Transformer, DG set and UPS are indicative only. The Contractor shall conduct detailed design for each service as per the standard procedures to arrive at the actual capacities of equipment.

The Contractor’s scope of works related to Electrical services is mentioned as under:

a. SITC of designed capacity cable from KSEB’s RMU to substation in the service building
b. HT metering panel
c. RMU/FP structure
d. 11kV/433V electrical sub stations which includes:
    - 11kV/433V (indicative) dry type transformers
    - Indoor HT panel
    - Main LT panel
    - Bus duct or cable from transformer to main LT panel
    - Hybrid capacitor cum Harmonic panel
    - HT cabling between metering panel, RMU, HT panel &Transformers from source of supply
    - LT cables between Main LT panel, other panels, various services in the Trauma/Laundry/Service blocks
    - Control cable for the smooth functioning of protection system/ change over functions/ metering & indicating functions

- Necessary RCC trenches within and outside sub stations for incoming HT/LT cables
- Hume pipe/GI pipe for Cable entry to Substation building/ Main Electrical room of the building
- DG sets, Fuel tanks, Fuel piping & Exhaust piping including supporting structure work
- AMF panel / Load sharing cum Synchronization panel
- Bus duct/Cabling from DG set to AMF panel
- Back up auxiliary power supply within the substation
- Energy management system for substations (existing substations for Surgical Block and Medical College. (The Contractor shall include the cost of EMS in the item of substation mentioned in the financial bid under the head of electrical works).

e. Internal & External electrification work
f. Electrical panels catering Light & Power (Raw & UPS), Indoor AC units
g. Power supply arrangement for Bio medical equipment such as ICUs, OTS, MGPS, PTS, Centralized RO plant etc.
h. Power supply arrangement to HVAC system (high side), Lifts &Fire fighting systems
i. Power supply for Water supply system / Drainage system / Sewerage / Rain water lifting system as required
j. Power supply for ELV works
k. Vertical & Horizontal Distribution Boards for various services
l. Cables from floor panel boards to Distribution Boards
m. Cable tray / Trunking
n. Rising mains for Lighting, Power & UPS services
o. Energy efficient LED Light fixtures
p. Energy efficient 5 star rated ceiling fans, Exhaust fans (wall / window mounted)
q. Wiring Devices – Different colour switches and sockets for RAW & UPS power services
r. UPS & SMF Battery system
s. Roof mounted On-grid Solar PV stations
t. Earthing system
u. Lightning Protection System
v. External lighting for roads & parking areas
w. Lighting automation for common area like corridors, toilets using occupancy/movement /PIR sensors
x. Liaison work with authorities in obtaining approvals/ permissions/ sanctions /NOCs for energization of power supply for the project
y. Liaison work to obtain NOC from Local Fire dept./PCB
z. Liaison work for obtaining NOC from KSECBC:2017

Contractor’s scope of works related to other works / services shall include:

a. Providing suitable size Electrical rooms/UPS rooms/Central Control Room to install electrical panels, DBs, UPS, Head End equipment of ELV systems respectively.
b. Providing suitable size shafts, slab/wall cut outs, openings to facilitate the installation of cables, cable trays, rising mains
c. Provision of closing cut outs with suitable fire sealant
d. Provision of necessary foundations for DG sets, RMU, Transformers, Street lights, Feeder pillar, Stack for DG set's exhaust piping etc.

1.8.4 Substation Design

1. The substation shall be indoor type and located in the ground floor of the Service block building.
2. The equipment in the substation comprises of following:
    - Indoor type 11 kV VCB panel
    - HT panel
    - Dry type transformers
    - Main LT panel
    - AMF/Synchronizing/Load sharing panels
    - Hybrid capacitor cum Harmonic panel
    - Essential panels
    - HT cables between RMU/HT panel/Transformer
    - Bus duct / Cables from Transformers/DG sets to AMF/ LT panels
    - Control cabling between substation equipment for smooth functioning of metering, controlling and protection systems
    - RCC trenches/Hume pipes
    - Cable trays

UPS of adequate capacity and back up time to be provided as backup supply for the functioning of protection and metering equipment in all panels/equipment located in the substation. Part of lights and sockets in the substation shall also be fed from same UPS. This is in addition to the UPS serving the essential services in the main building.

Transformer shall be 11kV/433V, 3 phase, 50 Hz, Delta star, DYn11, Dry type, cast resin, indoor, naturally cooled, copper double wound transformer with off-load tap changer from +5% to -10% in steps of ±1.25%, class F insulation, complete with WTI and scanner for alarm & trip, unidirectional rollers, cable end box for termination of HT cables & Bus duct / LT Cable complete with rating and technical name plate, earthing terminals with lugs, lifting lugs in all respect with all necessary standard accessories and as per IS codes.

Maximum allowable transformer losses shall comply with BEE /ECBC norms.

Indoor HT panel shall comply with IEC 62271-100 for breakers and IEC 62271-200 for Panels and shall be manufactured by OEM or OEM certified/authorised system integrators as per approved make list.

LT panels shall comply with IEC 61439 Part 1 & 2 guidelines (Design Verified Assembly) and shall be manufactured by OEM or OEM certified/authorised system integrators as per the approved make list.

LT panels shall conform in design, material, construction and performance to the latest editions of the International recommendations (IEC standards) and its corresponding British / European standards (BSEN standards) and in particular to the following standards:

- Low Voltage Switchboard IEC 61439-1 & 2

- Degree of protection IEC 60529

- Over Voltage Category II

- Mechanical impact IEC 62262

- Internal arc containment test in accordance to IEC 61641 (85kA for 0.4 Seconds)

- Seismic test zone- 4 as IEC 60083 as per IS 1893

In addition to the above listed standards, the local authority regulations shall also be adhered to.

The boards shall be manufactured to comply with the requirements of the Kerala State electrical inspectorate. This implies that the manufacturer shall be aware of the latest standards and practice stipulated by the Electrical Inspectorate of Kerala State with respect to switchboards. The Contractor shall obtain approval from the Electrical Inspectorate for all the equipment supplied.

All control wiring shall be carried out using 1100V grade, single core PVC wires with fine-stranded copper conductors. Following shall be the minimum sizes of copper conductor for control cables:

Voltage circuits	-	1.5 Sq.mm
Current transformer circuits	-	2.5 Sq.mm

All MCCBs shall be with thermal magnetic release up to 400Amps rating and microprocessor based above 400Amps rating, unless specified otherwise.

Both HT panel & LT panels shall have facility to connect BMS either through Modbus/RS485/Back net connections.

The automatic switching between KSEB power and DG power shall be achieved by means of providing necessary PLC relays/CTs/Interlocks/change over in LT side.

The Contractor shall ensure that the AMF system shall function properly to ensure uninterrupted power for the smooth functioning of the Trauma block.

Power factor shall be corrected between 0.95 lag to Unity. APFC capacitor shall be provided in the substation to meet this requirement.

Trenches with suitable width & depth shall be provided for installation of HT/LT/APFC Panels etc. and for laying of HT/LT Power cables & Control Cables.

Suitable size MS Chequered Plates, duly painted of minimum thickness 6 mm shall be provided for trenches inside the panel room as required.

Hot Dip Galvanized Cable trays/ cable trays made with angles, channels etc. of suitable size shall be used for cable laying (within the trench/ in ceiling/ wall etc.) as required.

All Substation/HT/LT Panel Rooms/Floor panel Rooms shall be provided with safety equipment/items like suitable elastomeric mat (as per relevant IS codes), fire buckets, fire extinguishers, emergency lighting, required power sockets, hand gloves, danger plates (HT/LT rating), safety charts, framed Schematic/SLD as per electrical inspectorate, electricity board etc.

All Electrical panel boards and DBs shall be provided with suitable SPDs as per the risk analysis criteria.

Suitable civil foundation/trenches etc. for all substation equipment shall be provided as per design load of respective equipment/ manufacturer recommendations.

Necessary Safety equipment, fire extinguishers, tools, spares, charts, single line diagrams and O & M manuals shall be fixed at designated place inside the substation as per KSEI guidelines.

In order to prevent storm water entering the substation and DG set area through the soak-pits/ trenches, the floor level of the substation area/ DG set shall be at suitable height above the highest flood water level that may be anticipated in the locality or as directed by Employer’s Representative .

1.8.5 DG Set for Backup Supply

Diesel Generator sets for back up supply in case of failure of KSEB’s supply. DG Back up supply shall be provided for the following services/ equipment:

1. Lifts
2. Water supply system
3. Drainage system
4. Fire fighting system
5. Medical gas system
6. Operation theatres
7. ICUs
8. Lighting
9. Power outlets
10. HVAC system (partial depending on the criticality of area to be served)
11. ELV systems

The DG set shall be of silent type, water cooled, radiator type, four stroke, electric start types with acoustic enclosure and standard control panel and as per latest CPCB emission mandates. The engine shall be capable of taking 10% overload for one hour after 12 hours

of continuous operation. The DG shall be suitable for AMF operation. The alternator shall be brushless, self-excited, self-regulated, brushless, SPDP enclosure, class H insulation, suitable for continuous operation at 1500 rpm, generating 415 V +/- 5% at 0.8 p.f, 50Hz, 0.85 load factor, 3 phase, 4 wire system generally conforming to BS: 2613 & IS: 4722.

DG Sets shall be provided with suitable PLC and Synchronizing relay/ PCCM controller for achieving automatic start/stop, automatic load sharing and synchronization function.

Additional provision for manual start/ stop of DG Sets shall also be provided.

Transformer incomer ACB, DG Incomer ACBs/ MCCB and Bus Couplers shall be PLC based interlocked with provision of auto and manual mode operation.

Necessary control cabling/ wiring in HT Panel, Transformer, DG set, LT Panel etc. shall be provided as per requirement/ OEM recommendations.

DG Sets shall be outdoor type with Hospital Type Silencer and acoustic enclosure as per latest CPCB and other relevant norms.

DG Sets shall be provided with adequate shading with Aluminium/ Galvanized Iron roofing sheets supported with robust MS tubular structures.

Independent exhaust pipe from each DG Set shall be taken out and exhaust Stack height of the DG Sets shall be as per CPCB/ CPWD/ Local Bye-Laws standards.

Self-supporting MS Exhaust stack structure of suitable height as per CPCB norms, duly painted with synthetic enamel paint, shall be provided to support the exhaust pipes with expansion bellows as required.

All exhaust pipes and silencers shall be insulated and clad with Aluminium sheets, mineral wool/ rock wool 75mm thick, wire mesh etc. as per CPWD Specifications and Technical Specifications.

DG Sets shall be provided with individual Day tank of suitable capacity. Foundation for DG set shall be done as per recommendations of OEM.

All accessories required for real time monitoring of the electrical parameters like voltage, current, power, ON/OFF/Trip status etc. incoming breaker of the Main LT panel, Main DG panel shall be obtained.

1.8.6 Power Factor Improvement & Harmonics Suppression

Harmonic study of the electrical system shall be conducted by expert agency and harmonic filter requirements shall be finalized.

Real time Hybrid Automatic power factor control panels with ultra-heavy-duty capacitors, IGBT/ Thyristor switched, Hybrid harmonic filters (Active & Passive) shall be provided in the substation to achieve overall power factor in between 0.95 lag and unity from existing power factor, as per ECBC guidelines, operating in both Auto and Manual mode.

Power factor Correction Panel shall be suitable to monitor all parameters in BMS.

Multiple capacitor units with real time automatic power factor compensating relay panel shall be provided. The capacitor panels with Hybrid Harmonic filters shall be provided in each substation to achieve THD less than or equal to 5%.

Connection from Main LT Panel to Capacitor Panel is to be provided through Aluminium/ copper sandwich bus duct/ LT cable based on the current carrying capacity.

Automatic switching off for Capacitor Panel is to be considered during power supply availability from DG sets (starting). Once the load of DG set is stabilized, the capacitor panel shall be put into operation.

Hybrid capacitor cum harmonic panel shall conform to IS 16636:2017, IEC 61921, IEC 61439.

The maximum capacity of capacitor panel shall be limited to the connected inductive load on each transformer in each substation. The connected inductive load shall be derived after doing detailed design of electrical services.

The Contractor shall work out the capacity of capacitor panel to achieve a power factor between 0.95 lag and unity from the power factor of all inductive loads in each transformer. The calculation of capacitor panels and harmonic filters with all supporting documents shall be submitted to EMPLOYER and approval shall be taken before proceeding with material approval and procurement.

1.8.7 Electrical Power Distribution

Main electrical room will be in the ground floor of Service block to receive power from the KSEB substation through HT cable and distribute power for the entire project from the panels located in this room.

The electrical room shall have RCC trench to accommodate the incoming/outgoing cables from HT/LT panels. Chequered plates of minimum 6 mm thickness shall be provided to cover the trenches. Electrical power to other buildings/floors shall be distributed from this electrical room by means of providing feeders/trenches/rising mains of suitable capacity (designed to connected load + 20% spare capacity) for light & power services.

Rising mains shall be sandwich type and have Tap off box at each floor feeding the floor panels with incoming & outgoing MCCBs of required capacities and numbers. From Floor panels suitably sized armoured cables shall be laid in cable tray or directly fixed on wall as per site conditions to VTPN DBs catering different services (light, power, low side HVAC equipment). Additional 40% spare provision shall be provided in the rising mains for taking tap-off in each floor. From VTPN DBs to HDBs, suitably sized armoured cables or single core copper wires pulled through PVC conduits shall be laid.

All Floor panels/VDBs/HDBs shall have 20% spare capacity in the outgoing side to accommodate future provision. The power cabling shall be sized so that the distribution losses do not exceed 3% of the total power usage in buildings.

Voltage drop for feeders shall not exceed 2% at designed load and for branch circuits it shall not exceed 3% at designed load as per ECBC norms.

The power cabling shall be sized so that the distribution losses do not exceeds as per NBC 2016.

1.8.8 Earthing Network

The Contractor shall get the soil resistivity test done (at his own cost) of the area, prepare fault calculation, earth pit and conductor type & size design calculations as per relevant regulations/guidelines.

Based on these calculations, the Contractor shall submit the earthing system drawings to Local Electricity Authority/Kerala State Electrical Inspectorate and get the approval before commencement of material procurement.

Copy of all documents shall be submitted to Employer's Representative .

Copper Earth strips and GI/CI/Copper Electrode Earth Pits shall be provided for Structural, Body & Neutral Earthing of all electrical equipment as per IS 3043:2018 and CPWD Specifications.

Copper Earth strips and Copper Electrode Earth Pits shall also be provided for all utility equipment or as per OEM recommendations.

Earthing shall be carried out for all power distribution system and effectively bonding the equipment. Separate and distinct earthing with copper/ GI electrode earth pits and suitable size copper/GI earthing strips (as recommended by OEM) shall be provided for critical equipment.

The net earth resistance of the earth grid shall meet the specified value as per IS 3043:2018

Earthing system for the following equipment shall be done as per OEM's recommendations:

- UPS system – Body & Neutral
- EPABX
- LV works
- Medical Equipment
- Laboratory & Operation Theatre

However, GI strip shall be employed to achieve earth continuity between main LT panel and floor electrical panels to be fixed in the cable tray connecting main electrical room with other floors.

For Lifts, Copper/GI strip earthing with Copper/GI electrode earth pit shall be provided as per OEM requirements.

Suitable sized Elastomeric Safety Mats with suitable thickness shall be provided for all HT & LT Panels installed in the substations and all buildings, as required.

All 3-phase electrical installations shall be provided with double earth connection and 1-phase electrical installations with one Earth connection as per CPWD specifications & NBC 2016.

1.8.9 Cables and Laying Method

H.T. CABLE (XLPE) 11 kV

The cross-linked polyethylene (XLPE) cable shall be aluminium conductor PVC outer sheath steel strip armoured over inner sheath construction. XLPE cable shall conform to testing in accordance with IS: 7098 (latest amended). The screening shall be done on individual cover. The armouring applied over the common covering shall be flat steel wires. Each and every length of cable shall be subjected to routine test.

The termination and jointing techniques for XLPE cables shall be by using heat shrinkable or push-on cable jointing kits.

Insulation tests shall be done before and after laying of cables.

After laying and jointing work is completed, a high POT test shall be performed in presence of Employer's Representative and test results submitted for approval in order to ensure that they have not been damaged during or after the laying operation. In case, the test results are unsatisfactory, the cost of all repairs and replacement and all extra work of removal and relaying will be made good by the Contractor without any extra cost.

L.T. CABLES & WIRES
Wires

The design, manufacture, testing and supply of single core LEAD FREE FRLS PVC insulated 1.1 kV grade multi-stranded twisted wires under this specification shall comply with latest edition of following standards.

- IS: 3961 Current rating for cables.
- IS: 5831 PVC insulation and sheath of electric cables.
- IS: 694 PVC insulated cables for working voltage upto and including 1100 volts
- IEC: 754 FRLS PVC insulated cable.

Copper multi-stranded twisted conductor FRLS PVC insulated wires shall be used in conduit as per item of work.

The wires shall be colour-coded R Y B, for phases, Black for neutral and Green for earth.

Progressive automatic in-line, indelible, legible and sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of wire. The material & insulation of wires shall be ROHS compliant (Reduction of Hazardous Substance) and shall comply the following directives

Cables

The design, manufacture, testing and supply of the cable under this specification shall comply with latest edition of following standards:

- IS: 8130 Conductors for insulated electric cables and flexible cords.
- IS: 7098 XLPE insulation and sheath of electric cables.

- IS: 3975 Mild steel wires, strips and tapes for armouring cables.
- IS: 7098 Current rating of cables.
- IS: 7098 XLPE insulated (heavy duty) electric cables for working voltage up to and including 1100 volts.
- IS: 424-1475(F-3) Power cable-flammability test.

Specification for cross-linked polyethylene insulated XLPE sheathed cable for working voltage up to 1.1 KV.

Specification for XLPE insulated (heavy duty) electric cables for working voltages up to and including 1100 volts.

External laying method

All armoured HT/LT power cables, control cables, telephone cables, signal cables and cables for other LV system etc. shall be laid in suitable size separate RCC trench (with suitable size hot dipped galvanised cable tray –optional), removable cover at required distances for pulling of cables etc. (50% area of the trench shall be kept for laying of cables in future) besides the roads & pathways at suitable depth as per CPWD specifications. Cables shall be fixed with GI clamps.

Road crossing

Adequate no. of DWC/HDPE Pipes/Hume pipes /GI pipes having suitable class & diameter with required quantity spare pipes shall be laid across the roads / pathways for all the cables under electrical & ELV system.

Suitable size manholes hall be provided at regular intervals. The RCC trenches shall have all necessary provisions for draining of water during the rainy season. The trenches shall be designed & made such that it should be made neat & tidy free from accumulation of debris, water stagnation etc.

1.8.10 Internal Electrification Work

Following works shall be carried out in coordination with civil works within the buildings complete in all respects as per the latest CPWD Specification, IS Codes, NBC -2016 etc.

1. Wiring & Conduit (Non-metallic conduits) for internal electrification, LV & Allied works.
2. Fire Survival Cable shall be used for the Fire Alarm system
3. LED Light fixtures, Brushless Direct Current (BLDC) ceiling Fan operated with electronic regulator, Wall fan & Exhaust Fans
4. Light Point/6A or 16A Socket Outlets (UPS or RAW), Different colour plate or switches / sockets shall be used for the UPS points.
5. 16A/ 20A Power/ UPS Modular Switch & Socket Outlets. Different colour plate or switches / sockets shall be used for the UPS points.
6. L.T. Cables and Sub main wiring, circuit wiring.
7. Cable Tray & Raceways
8. Sandwich type Rising Mains/ Bus Trunking
9. Floor Panels, VTPN DBs& Horizontal DBs

10. Earthing & Lighting Protection system
11. Surge Protection Devices as per requirement
12. Extra Low Voltage system like Telephone/EPABX, LAN & Wi-Fi, Fire Detection & Alarm System, IP CCTV System, Public Address system, Access control system

Following points shall be generally followed for internal and external electrification of various areas:

1. Internal areas like rooms, corridors, lobbies, staircases, terraces, washrooms etc. of buildings shall be adequately illuminated conforming to provisions stipulated in NBC 2016, ECBC and CPWD technical specifications maintaining the indicated Lux levels
2. and Light Power Density
3. The Internal Electrification work shall be carried out in recessed /surface with non-metallic conduit only in accordance with CPWD General Specifications for Electrical Works Part-I (Internal)-2013 with latest amendments and revisions.
4. MS Conduits shall be surface mounted or laid on GI angle/ channels with suitable hanging GI supports in areas wherever there is false ceiling provision. In case there is no provision for false ceiling, Non-metallic conduits shall be concealed in concrete during slab casting. Wiring for lighting/power & ELV work wiring shall be done in non-metallic conduits when installed in surface.
5. FRLS PVC insulated Copper conductor wires will be used for points, circuit & sub-main wiring conforming to relevant IS-Codes. Wiring shall be carried out with PVC insulated FRLS multiple stranded single core copper conductor wire / cable considering the connected load of each circuit/ sub-main etc, voltage drop, future provision etc.
6. The Contractor shall execute the work after obtaining necessary approval of the layout for internal electrification of Trauma block including common area, staircase etc. The staircase lighting shall be in group control system meeting the requirement of NBC-2016.
7. Modular type switches, sockets and stepped type electronic fan regulators, bell push button & bell along with matching mounting boxes of the same make shall be used.
8. Colour Coding of the conduits, switches, sockets shall be provided for Normal & UPS power supply as per NBC 2016.
9. TV outlet point wiring shall be terminated in suitable size GI/ polycarbonate box along with splitter at each floor / room based on the requirement. The interconnection of all splitter boxes shall be designed and done properly with conduit/ cable tray/ race way etc. to form proper distribution system with the prior approval of the Employer's Representative.
10. LED Type Lighting fixtures with inbuilt harmonic suppression mechanism and surge protection shall be provided and all internal & external LED light fixtures shall have THD less than 10%.
11. Suitable size & capacity BLDC ceiling fans, wall fans, exhaust fan shall be provided in all the areas and in all buildings as required and as directed by Employer's Representative.

12. Separate shafts shall be provided for laying of pipes for Electrical, ELV, Mechanical and Fire Services. The electrical shaft for the rising main & cables shall be separate or partitioned as per the requirement of NBC-2016, IS code, CPWD specification etc.
13. Laying of DWC HDPE/ Hume pipes for road crossing for electric/ telephone/ LAN/ street lighting cables complete with adequate number of cable chambers shall be provided by the Contractor.
14. After completing the work, necessary test results as envisaged in CPWD General Specifications Part-I (Internal) - 2013, Part -II (External) & Indian Electricity Rules 1956, NBC-2016, NEC etc. with latest amendments shall be recorded and submitted. The results shall be within the permissible limits.
15. Aviation Lights (LED Type) shall also be provided as per prevalent norms & IS Codes.
16. Suitable illumination with LED light fixture shall be provided on terraces of all buildings, utility buildings etc. as per the requirement.
17. Power Points, LAN points, UPS power point, Telephone Point shall be provided for all the places as required.
18. For areas with grid type false ceiling, recessed type LED Light Fixtures of size 600 mm X 600 mm shall be provided as per directions of Employer's Representative unless otherwise stated based on the required lux level. The down light fixtures can also be provided in the grid type false ceiling meeting the lux level for areas like corridor, toilets etc. For areas having false ceiling with gypsum board, down light type fixtures of suitable size shall be provided as per directions of Employer's Representative unless otherwise stated. Surface mounted light fixtures shall be provided in the areas without false ceiling based on the beam layout. Light fixture schedule is attached for reference.
19. Proper coordination shall be done with all the utility services coming in the ceiling before fixing each device in the ceiling for obtaining maximum aesthetic appeal.
20. Industrial weather proof sockets (single phase & three phase) shall be provided in all the required areas like kitchen, sterilization room, for other utility rooms for HVAC, plumbing services etc.

1.8.11 Lighting Design & Lighting Fixtures

LED light fixtures shall be provided with inbuilt harmonic suppression system (to achieve harmonic distortion less than 10%) in all areas & buildings to achieve the illumination levels conforming to latest IS Code, NBC-2016, KSECBC: 2017 latest with all amendments and as per technical specifications.

Generally, all indoor LED lights shall have luminous efficacy minimum 100 L/w and outdoor

LED lights shall have luminous efficacy minimum 120L/w.

Lighting Power Density (LPD) for various areas shall be as per lighting simulation requirements as per IGBC & KSECBC: 2017 norms.

Sufficient number of light fixtures connected UPS backup power (depending on the requirement / criticality) shall be provided in all locations of the building to comply with NBC/CPWD guidelines.

The Contractor shall prepare the illumination level calculation (based on CPWD/NBC/KSECBC:2017/ IGBC norms), selection of light fixture, room wise/ floor wise light fixture schedule to Employer's Representative for approval.

The lighting layout shall be prepared only after the approval of illumination data sheet from EIC.

Automation shall be achieved by means of occupancy/ movement sensors/ day light sensors and light dimmers for common spaces like corridors, toilets and other spaces stipulated in relevant sections of NBC-2016, KSECBC:2017 etc.

External light fixtures mounted on GI octagonal pole shall be for internal roads, parking areas etc. Illumination in these locations shall be done such that there shall be no blind spot in the roads and parking areas.

Street light fixture shall be weather proof type with minimum IP66 & Ik08 protection.

Height and spacing of GI pole shall be decided on the basis of CPWD/NEC code.

Power supply of the street lighting shall be fed from the dedicated street lighting control panel located in the electrical substation. ON/OFF control shall be achieved by means of timer & contactor arrangement within the street light control panel itself.

Minimum number of all-in-one hybrid type solar street lights shall also be provided in parking areas and roads.

The material approval and procurement shall be followed after getting approval from EMPLOYER for illumination design, preparation of room wise/floor wise lighting layouts.

1.8.12 Lightning Protection System

Lightning protection shall be provided as per IS/ IEC 62305-1:2010 (latest as amended), CPWD Specifications and NBC 2016 norms. The main and most effective measure for protection of structures against physical damage is considered to be the lightning protection system (LPS).

An external LPS which consists of air-termination system, down-conductor system and earthing system is intended to:

- Intercept a lightning flash to the structure (with an air-termination system)
- Conduct the lightning current safely towards earth (using a down-conductor system), and
- Disperse the lightning current into the earth (using an earth-termination system).

Accordingly, a standard lightning protection system will be provided as per IS/ IEC – 62305: 2010 &NBC 2016 Standards using single prone finials, horizontal and down comer earthing

strips of suitable size, terminating in the earth pits, test link in suitable box, interconnecting all the earth pits with suitable size SS/ copper / GI earth strip laid underground etc.

Surge protection system as per IEC 62305-1:2010/NBC-2016/ Electrical Inspectorate/ Electrical Board norms shall be provided in the electrical system (electrical panels, distribution boards (DBs) etc). The surge protection system has to effectively intercept the lightning current entering the electrical system through underground systems & services and the surge occurring within the electrical system.

The Contractor shall design lightning protection system as per relevant standards and submit the system drawings and calculation to Local Electricity Authority/Electrical Inspectorate for their approval.

Material procurement shall commence only after getting approval for the same. Copy of all documents shall be submitted to Employer's Representative .

Aviation Obstruction Light (AOL) shall be provided as per Civil Aviation regulations, NBC2016 norms & CPWD Specifications as applicable. All Aviation Obstruction Lights shall be fed with UPS/ emergency power supply.

1.8.13 Uninterrupted Power Supply

UPS units suitable for 3-phase power supply IN/OUT, True online, modular type, 3 Level IGBT Inverter Technology shall be provided to cater power supply for Computers points, WIFI points, Bed Head panels in ICUs, Operation Theatres, Essential lighting as mentioned in NBC/ECBC/CPWD/IEC guidelines, all ELV systems and other essential loads as required.

Minimum features of UPS are mentioned below:

1. Input/Output	: 3 phase
2. Characteristic	: true online
3. Technology	: 3 level IGBT
4. Battery management system	: Required
5. Input power factor	: > 0.99
6. Output power factor	: Unity
7. UPS efficiency	: > 95%
8. No load losses	: As per IEC rules
9. Input THDi at any load	: < 5%
10. AC volt accuracy	: +/- 1%
11. Transient voltage regulation	: +/- 5%
12. Transient recovery time	: < 20 milli seconds
13. Total voltage distortion	: < 1% for linear load

14. Total voltage distortion : < 5% for non-linear load

15. Isolation transformer : required and to be BIS certified manufacturer

16. Acoustic noise level : < 55dBA

17. BMS : Back net / Modbus / similar connectivity

UPS back up shall be provided for the following:

Lighting - Lobby/Entry/Exit/Corridors/service Rooms of each floor/ minimum points in all other rooms, utility buildings (substation, HVAC plant, WTP plant etc.)

Power points - Sockets catering Computer points, Lab equipment, Devices/equipment in LV works

ICU and Operation Theatres - As per requirement

Sub stations/Service buildings - power points and essential lighting (as per requirements)

The requirements mentioned have to be verified during detailed design and the Contractor shall consider and include any other essential services which require back up power.

The Contractor shall submit the load calculation sheet of each UPS units assigned for building or specific service as per the design including details of load of each equipment/item connected to UPS to EMPLOYER for approval.

The Contractor shall propose UPS units separately for lighting & power and other critical care services like OTs & ICUs to avoid interruption of power supply due to break down of a single UPS unit catering many services in the building.

Number of UPS units and its location shall be decided based on the concentration of load as per detailed design.

NOTE: UPS for bio medical equipment such as X ray, CT scan, Cath lab etc. (for which the power requirement is high) is not included in this scope.

Procurement of all materials/equipment shall be made only after getting EIC's approval of Supplier/Make.

The UPS shall be Modular Fault Tolerant Redundant Double conversion type and shall provide a regulated and uninterrupted three-phase AC power, within specified tolerances, to critical station loads during normal and emergency operations with latest 3 Level IGBT Inverter Technology and UPS input to be provided for uninterrupted power supply for all Emergency requirements.

The UPS power supply catering OTs & ICUs (as per OEM recommendations) are to be provided with Isolation transformer. Isolation transformer shall be with copper winding, external type, enclosed in a separate enclosure of suitable size and the product shall be BIS certified.

UPS with separate Power distribution system (comprising of distribution panels, rising mains, distribution boards, incoming isolators etc.) shall be provided.

The UPS System shall be for 30 Min Backup (on 100% capacity of UPS) with Heavy duty Sealed Maintenance Free batteries with highest efficacy for latest sophisticated UPS system. The UPS system shall have Bypass system also. The system shall have the incoming and outgoing switchgear panel.

The following works fall in the scope of UPS supplier: -

- Cables for input and output power supply from raw power panel & to UPS fed panels
- Isolator in the incoming & outgoing side of UPS
- Communication card for data monitoring on BMS System
- Cables shall be single core multi strand copper flexible type

1.8.14 Solar Photovoltaic Power System

The Contractor shall perform detailed design, supply, installation testing and commissioning of on-grid connected, roof top mounted on-grid solar PV station including obtaining KSEB/KSEI approvals. Direct on-line grid-connected Solar Photo Voltaic Power system of suitable capacity (minimum 50 KWp) shall be provided as per KSECBC: 2017/NBC 2016 and relevant KMBR rules as amended.

Solar PV station consisting of Mono/ Poly (as per latest design) Crystalline silicon solar cells, net metering facility, necessary protections, earthing, mounted on Aluminium/ GI structure of suitable strength with following components complete as required:

PV module

- Solar Photovoltaic Module of capacity: 50 KWp minimum Country of origin: India
- Standards: IS 14286/IEC 61215, IS/IEC 61730-Part-1, IS/IEC 61730-Part-2.
- Conversion efficiency: minimum 16.5%.
- Output peak watt capacity: minimum 90% at the end of 10 years and 80% at the end of 25 years.
- Glass: Tempered Ingress protection: minimum IP67

Power conditioning unit

Power Conditioning Unit (PCU) of 350-800 V DC Input voltage range and 400 V AC, three phase, 4 wire, 50Hz +/- 2.5 Hz, output voltage suitable to generate AC Power with efficiency not less than 97%, total harmonic distortion less than 3% and suitable for ambient temperature from 0 to 50-degree C. The PCU shall adjust the voltage and frequency level to suit the Grid Voltage Frequency.

Synchronization with DG power

Solar power shall be synchronized with DG power using a controller, ensuring efficient and reliable operation, especially during grid outages, optimizing load sharing, maximising solar utilisation and minimising DG fuel consumption.

Walkways, ladders, lifeline wires, facilities for connecting harnesses, and water supply connections for the maintenance of the solar plant shall be provided by the Contractor.

Data Monitoring System complete with accessories

Array junction box & Main junction box with IP 65 protection and termination arrangement for incoming and outgoing cable along with glands, lugs and other accessories etc. as required.

Lightning and surge voltage protection

Interconnecting cables

Connections & Interconnections by supplying & fixing required size XLPE insulated copper conductor 1.1 kV grade armoured power and control cables between solar modules, main power cable to grid supply PCU unit along with supplying & fixing of necessary channel/conduit lugs and other accessories etc. as required.

The generated power will be directly connected to the power grid/distribution panel for load sharing during day time.

The solar power system to be provided shall feed the electrical loads to comply with KSECBC:2017 guidelines.

The Contractor has to provide suitable capacity solar power system to achieve silver rating of IGBC and meet all requirements as per statutory authority.

Solar cables shall be used for interconnection of various equipment like Solar PV Panels, Inverter etc suitable for outdoor installations.

1.8.15 External/ Street Lighting

External street lighting design shall comply with CPWD/ECBC/IGBC/NBC 2016 specifications.

Location to be as follows:

- Parking areas
- Internal roads

Hybrid all in one solar street lights shall be provided to comply with IGBC guide lines. The lighting control/operation for external Lighting shall be controlled by street lighting panel working on timer and contactor arrangement operated from control panel itself.

There should not be any dark area for the hassle-free movement of vehicle/ people after the completion of construction work in this scope of contract. Light fixtures shall be weather proof type minimum (IP-66) and tamper proof IK08 having anti yellowing diffuser. Street Light Poles shall be made out of Galvanized Iron (GI) Octagonal tubes. Poles will be suitable for single/ double side arms or as required. Poles shall have a service window at the bottom comprising connector terminal & MCB. Poles shall be mounted on foundation with Anchor bolts of suitable size & quantity. RCC foundation design shall be submitted for EIC's approval considering wind load also. The height & spacing of the LED street light poles pole will be designed to achieve illumination level as per NBC guidelines. The poles shall be earthed with suitable size GI / copper SWG wire and necessary earth pits shall be

provided. The height & spacing of pole and illumination level shall comply CPWD Specifications, NBC 2016 and other relevant norms. The cable to be used for external lighting shall be armoured XLPE type and to be laid underground.

1.8.16 General Requirement of Lighting & Small Power Points

a. Type of light fixture and quantity of light fixtures may be arrived on using dialux software.
b. Schedule shall be prepared based on the architectural layouts issued for tender purpose.
c. The Contractor may select suitable light fixture to match the final requirements at the time of execution.
d. In toilet blocks, centralized exhaust fan may be provided where window mounted fan is not feasible
e. At least one no of light inside toilet block shall be connected with backup power supply
f. In corridor & lift lobby, provide lights fed from backup power to comply with NBC guidelines
g. In staircase, ramp & fire escape routes, provide lights fed from backup power to comply with NBC guidelines
h. In air-conditioned areas, provision of ceiling fan (point wiring & fan hook) shall be provided on need basis
i. In general wards & ICUs, provide lights fed from backup power to comply with NBC guidelines
j. In areas where false ceiling is shown with combination of metallic grid and calcium silicate, 2ft x 2ft recess mounted and down light, round recess mounted down lights are mentioned.
k. 2nos of UPS fed 6A sockets shall be provided wherever work stations are required
l. Except for common areas like corridor, lobby, staircase, minimum no of 6A sockets for general duty (mobile charging or similar) shall be provided
m. UPS sockets of required ampere rating shall be provided for all equipment of ELV system
n. Generally, Power points (6A & 16A) shall be provided as per the furniture layout to connect portable or fixed equipment. Mounting height to be as per standards
o. Sockets in ICU beds shall be provided by BM equipment vendor. However, wire size shall be decided as per actual power requirement or quantity of sockets
p. Sockets in ICU beds (BHP) shall be fed from UPS only
q. Raw power points may be provided near each ICU bed for general purpose
r. In corridors, sockets at every 15 mtr interval may be provided for cleaning equipment
s. Power points for low side HVAC machines may be provided as per HVAC design wherever required
t. Energy efficient LED light fixtures, modular type switch & sockets shall only be used
u. Minimum size of wire to be used in 2 x 1.5 sq mm + 1 x 1.5 sq mm FRLS single core copper wire.

1.8.17 Technical Specifications For Light Fixtures

TYPE 1 - 4FT BATTEN EXTRUDED ALUMINIU M BODY, SURFACE IP20

Surface type, IP 20, LED, slim Extruded Aluminium batten fitting with following minimum requirements: - System Lumen > 2000 lm, Luminous efficacy >100 lumen/ watt, CRI >80, Beam Angle: 120 Deg, Input Voltage: 220-240Vac, 50/60Hz, CCT 5700K, Operating voltage range 90-300V, THD

TYPE 2 - 2FT BATTEN EXTRUDED ALUMINIU M BODY

Similar to TYPE 1, but 2ft long and THD< 15%

TYPE 3 - 2FT X 2FT RECESSED MOUNTED

Recessed type LED of 595 x 595 mm size with aesthetically designed Pressure Diecast alloy/CRCA housing & injection moulded PC component diffuser with following minimum requirements: - Luminous efficacy > 100 lumen/ watt, CRI > 80, UGR 5000K, Inbuilt protection against short circuit, over voltage protection and surge protection of minimum 2 KV including connections etc, THD 85%, Service life of 50,000 hrs @ L 70, Driver compliance IEC 62384, IEC 61547, IEC 61347-2-13.

TYPE 4 - 2FT X 2FT RECESSED MOUNTED, SUITABLE FOR CLEAN ROOM

Recess mounted Bottom opening clean room flat LED panel of 595 x 595 mm size fully lit diffuser with following minimum requirements: - CCT 5700K/6500K suitable for clean room applications, luminous efficacy >100 Lumen/watt (minimum total lumen delivered package 5000), CRI> 80, THD 90%, Service life of 50,000 hrs @ L 70, Driver compliance IEC 62384, IEC 61547, IEC 61347-2-13 etc. complete as required.

TYPE 5 - ROUND TYPE RECESSED MOUNTED, ALUMINIUM BODY

Recessed type LED down lighter neutral white (4000 K) with LED having pressure die cast aluminium hang body with following minimum requirements: - High efficiency diffuser with more than 85% transmittance, Rated life of L-70 @50000 hrs, lumen output better than 1150 lumens, luminous efficacy>100 lumen/ watt, CRI>80, Surge Protection >2 kV, Driver efficiency > 90%, PF>0.98, THD

TYPE 6 - MIRROR LIGHT, 2 FT POLY CARBONAT E BODY

LED slim polycarbonate decorative batten fitting with following minimum requirements: - Minimum System Lumen 1000 lm, Luminous efficacy>100 lumen/ watt, CRI >80, 120 Deg Beam Angle, Input Voltage: AC 220-240V, 50/60Hz, CCT 5700K, Operating voltage range 90-300V, THD

TYPE 7 - ROUND TYPE SURFACE MOUNTED, ALUMINIU M BODY

Similar to TYPE 5

TYPE 8 - 4FT BATTEN EXTRUDED ALUMINIU M BODY, IP54

LED weather proof, opal diffuser in polycarbonate IP 65, 1100+/-100 mm fixture system lumen output of 3500 lumens, CCT >4000K, efficacy >100 lumen/ watt, CRI> 80, THD 90%, Service life of 50,000 hrs @ L 70, Driver compliance IEC 62384, IEC 61547, IEC 61347-2- 13 etc complete as required.

TYPE 9 - BULK HEAD LED LIGHT, IP66

LED Bulkhead with a nominal system lumen output of 1000 lumens and following minimum requirements: - system efficacy >100 lm/W, rated system life time of 50,000 burning hours at L70, color temperature of 5700K/6500K, CRI > 80, SDCM< 10% at full load, PF > 0.9, 2 KV Internal surge protection, Driver compliance IEC 62384, IEC 61547, IEC 61347-2-13. The luminaire housing shall be made of High pressure die cast Aluminium with HET front diffuser.

TYPE 10 - STREET LIGHT

LED weather proof, potted driver, rated voltage:220-240V, operating voltage: 150V - 270 V, in built surge protection: 6kV, power factor:0.95, operating temperature: up to 45deg, aesthetic and robust with pressure die cast aluminium body, UV stabilized IP PC lens, Luminous efficacy >110 lumens/watt, lamp life:50000 hrs, Driver compliance IEC 62384, IEC 61547, IEC 61347-2-13.

General requirements:

- Wattage of each light fixtures shall be decided based on the dialux design
- LED & Driver shall be BIS approved
- All fixing accessories and hardware shall be included in the rate of the light fittings
- For street lights, double or single arm, cut out, anchor bolts, heat resistant wire from cut out to light fixture etc to be supplied along with GI octagonal poles.
- The above are minimum requirements and the Contractor shall assess the actual requirements and finalise type of fixtures and specifications as per NBC and IEC regulations.

1.8.18 Design Codes & Standards

Following codes and standards shall be followed during design, execution and procurement of the project:

a. Central Public Works Department (CPWD) 2013 Part I / IS codes – Internal wiring regulations
b. Central Public Works Department (CPWD) 2003 Part III – for Lifts & Escalators
c. Central Public Works Department (CPWD) 2013 Part IV – for substation design
d. National Building Code (NBC) 2016
e. Indian Electricity Rules (IER)2010
f. National Electric Code (NEC) 2011
g. Kerala State Electrical Inspectorate guidelines latest version
h. Kerala State Electricity Board guidelines latest version
i. IEC regulations for wiring & installations, 7th Edition

j. BEE guidelines – Energy conservation
k. KSECBC:2017 guidelines – Energy conservation
l. IGBC guidelines – Energy conservation
m. IS 3043 2018 – Earthing system design and materials
n. IEC 62305-1:2010 – Lightning protection system design and materials
o. Indian Electricity Act 2003
p. IEC /CPRI/ERDA guidelines – Circuit breakers/ Electrical Panel Board design, Fabrication & Testing
q. CPWD/PCB guidelines – DG set design & Exhaust system
r. UL guide lines/NBC-2016/NFPA 72/ IS – 2189 – Fire alarm & control system
s. UL/FCC /CE /BIS /IEC/ONVIF standards – IP based CCTV system
t. Energy management system – ISO 50001 CERTIFIED OEM
u. IS Codes:
    - IS:732 (1989) - Code of Practice for Electrical Wiring Installation
    - IS:3043 (1987)- Code of practice for Earthing. IS:3070 (1993)-Lightning arrester for Alternating Current System.
    - IS:900-Installation and maintenance of Induction motors.
    - IS:1271-Classification of insulating materials for electrical machinery.
    - IS:1646-Fire safety of buildings (general) electrical installation.
    - IS:1886-Installation and maintenance of Transformers.
    - IS:1913-General and safety requirements of electric lighting fittings.
    - IS:2032-Graphical symbols related to electrical technology.
    - IS:2274-Electrical wiring installations where system voltage is more than 658 volts.
    - IS:3034-Fire safety of industrial buildings (Electrical generation and distribution stations).
    - IS:3072 (part-1)-Installation and maintenance of switchgear where system voltage is less than 1000 volts.
    - IS:3646-Practice for interior illumination.
    - IS:3716-Guide for insulation coordination.
    - IS:3842-Guide for electrical relays for AC system.
    - IS:4004-Guide for lightening arrestors (non-linear) for AC system.
    - IS:4146-Guide for voltage transformers. IS:4201-Guide for current transformers.
    - IS:5571-Selection of electrical equipment in hazardous area.
    - IS:5572-Types of hazardous areas for electrical installations.
    - IS:5780-Intrinsically safe electrical apparatus and circuit.
    - IS:5908-Measurement of electrical installations in buildings.
    - IS:375-Making and arrangement for switchgear bus-bars, main connections and auxiliary winding.
    - IS:694(part-1)-PVC insulating cables with copper conductors (where voltage is up to 100 V).
    - IS:1248-Direct acting electrical indicating instruments.

- IS:2147-Degrees of protections for enclosures for switchgear and control gear (low voltage).
- IS:2208-Guide for HRC fuse (up to 650v). IS:3202-Guide for climate proofing of electrical equipment.
- IS:3231-Guide for electrical relays of power system protection.
- IS:4047-Guide for heavy duty air brake switches and fuses for voltage less than 1000V
- IS:4237-Requirements for switchgears and control gears for voltage up to 1000V IS:5987-Selection of switches where voltage is up to 1000V
- IS:335-Insulating oil for transformers and switch gear IS:2516(part-1, sec-2)-AC circuit breakers (Tests for the voltage range 1000V to 11000V)
- IS:3427-Metal enclosed switch gear and control gear for voltage within 1000V to 11000V
- IS:722-AC electricity meters for 415 volts
- IS:1951-PVC Sleeving for electrical works
- IS:2516(part-1sec-1 & part-2sec2)-AC circuit breaker (Tests for voltage within 1000v)
- IS:2419-Guide for dimension of electrical indicating instruments

1.9 ELV WORKS

1.9.1 Fire Alarm System

Addressable Intelligent fire detection and Alarm system of latest technology with modular type fire alarm panels, multi sensor detectors, smoke detectors, heat detectors, beam detectors, response indicators, manual call point and hooters, light strobe, control modules, monitor modules, isolator modules etc. shall be provided by the Contractor.

The system shall meet the requirements of UL / NBC-2016 / CPWD Specifications/ State By laws. License/ Approval of Local Fire Authorities shall be obtained by the Contractor, provided for the complex.

It shall be possible to integrate public address system with fire alarm control panel.

There shall be the proper Zoning within the building considering the non-critical & critical areas (critical area like OT, ICUs Labs, sterilizer zone etc). Appropriate Fire Alarm Panel (expandable up to 10 loops and 20% spare capacity in each loop) and repeater panel shall be provided as required.

The monitoring of whole complex shall be in the Main Fire Control room located in the ground floor of Trauma block.

For Central Monitoring, necessary devices like PC, Printer, modules & Software with required license etc. of latest technology with minimum 1 TB hard disk (SSD) shall be provided in the Control room.

Fire Alarm control Panel shall be modular type and has capability to accommodate minimum 125 devices and 125 detectors in one loop or combination of 250 numbers of both detectors and devices per loop.

The system features shall be as following:

1. The system and its components shall comply with UL standards.
2. The devices/detectors of the system shall be hard addressing type
3. The fire alarm control panel shall be addressable type, Alpha numeric QWERTY key pad type, with battery backup for 24 hrs normal operation and 30 minutes alarm operation on main power failure, microprocessor modular type, loop cards shall be as per site requirement with 10% spare loop, communication card, BMS interface module (BACKNET/MODBUS or any other means).
4. GUI software
5. Server PC with suitable software and hardware to view building architecture in Auto CAD format and to view the fire alarm devices' location in normal and alarm conditions.
6. Detectors shall be installed as per coverage defined in NBC-2016/ NFPA 72/ IS – 2189 code. It should include all rooms, halls, storage areas, basements, attics, lofts, and spaces above suspended ceilings including plenum areas utilized as part of the HVAC system.

7. Suitable numbers of input/output (C/M) relay modules are to be provided for connecting other equipment like lifts, fire fighting system, AHUs, Ventilation system, PA system etc.
8. Monitor modules shall be provided to supervise the operation of tamper switches fitted in the fire fighting shafts.
9. Spacing between two detectors shall not be more than 8m in corridors of width up to 3 mtrs and for other areas as per NBC 2016/CPWD guidelines.
10. Cabling shall be with Fire Survival armoured category armoured copper cable as per NBC-2016.
11. Addressable manual call boxes/Sounders/Strobes shall be provided near all exits, staircases lift lobbies etc. as per NBC 2016/NFPA guidelines. The distance between different locations of manual call points/Sounders/Strobes shall be comply relevant norms.
12. The response indicator shall be used as per the norms and requirement.
13. The fire alarm control panel shall be located in the fire control room.
14. Fire Alarm System shall be integrated with PA system and with BMS also at central Control room.
15. Two Way communication Fire Fighters Telephone Jack & Handset with necessary accessories are to be provided. Location of Fire fighters telephone jacks shall comply with NBC 2016/NFPA guidelines.
16. The fire alarm system shall have facility to integrate talk back Fire Fighter telephone System.
17. Fire signage shall be provided at the appropriate locations satisfying all the norms & requirements.
18. Integrations with other services like (HVAC, Lifts etc) shall be provided with the Fire Alarm System as per NBC 2016/NFPA guidelines.
19. The Contractor shall submit floor wise fire detection and alarm system layouts of the building to EMPLOYER and get it approved before commencement of material approval and procurement.
20. The Contractor shall submit “cause and effect matrix” of the system for the entire campus and submit the same to EMPLOYER for approval.
21. The Contractor shall forward the system drawings to local fire department and get it approved at his cost.

Scope of works related to ELV services shall include:

- Addressable type Fire Alarm System
- Public Address System
- Fire fighting talk back system
- CCTV System
- Access Control System
- Nurse Call System
- Telephone System
- EPABX
- Network System
- Intelligent Building Management System (IBMS)

1.9.2 Fire Fighting Talk Back System

The system shall consist of fire fighters telephone jack, fire fighters telephone hand set, control console and cabling.

The system components shall comply with EN 54 standards.

The location of FF telephone jack shall be generally at the landing of every fire escape staircase and FF telephone handsets shall be in the control room.

The system shall be made operational in case of a fire incident happens in the building.

1.9.3 Data Network System

The scope of work shall include providing data RJ45 sockets with back boxes, CAT 6 UTP wiring in appropriate conduits, patch panel, Ethernet switches, both Fibre & CAT 6 patch cords, PDUs, LIUs network racks, interconnection between network racks of different floors to ground floor, cable support system etc.

RJ 45 data outlets points shall be provided for network points (wherever work stations are required in all floors), Wi-Fi points, Access control system, Information Display system, BMS, etc. as per requirement in rooms and other areas at various floors of the Trauma block.

Apart from above, CAT6 cable shall be laid from nearest network rack to Bed Head Panels, Nurse Stations and OTs to meet with Bio medical equipment vendor’s requirement. RJ 45 sockets may be provided as per BM vendor’s requirement in these locations.

The Data outlet points shall be connected to nearest network rack by using 4 pair UTP CAT-6 wire laid in Raceways, recessed / surface conduit as required.

Conduit of 25 mm dia. minimum size shall be used for laying CAT6 cable in data system.

Maximum 3 nos of CAT6 cables are allowed in a single 25 mm dia conduit.

UPS Power supply shall be provided wherever Data outlet points are to be provided.

The maximum length of the CAT-6 cable from end user point to the Network rack / Edge switches shall not be more than 90m. Beyond 90 mtrs, optical fiber cable shall be used

Sufficient number of network racks (including Patch panels, Ethernet switches, PDUs etc.) have to be located in each floor based on the maximum possible length of CAT6 wire from the utmost data outlet located in each floor.

The network panel at various floors will be connected individually to Main rack of the building/ block with OFC cable through conduit or raceways on surface/ recess. LIUs, Fiber patch cords shall be provided as per requirements.

The network panel comprising of jack/Patch panels, Network switches, patch cords, power supply units, cooling fans, wire managers, LIUs, Trans-receivers, Fiber patch cord etc. in each floor shall be provided as per the requirement.

Service provider for network system shall terminate their cable and other equipment in the central control room.

The Contractor shall submit floor wise data system layouts/Riser diagram mentioning location of Data points provided for different services as well as other LV systems, location of racks details of patch panels, Ethernet switches, connectivity of floor racks to main rack, details of main rack in ground floor, server etc to Employer's Representative for approval.

Material procurement may commence on approval of these layouts from the EMPLOYER.

1.9.4 Telephone System

The scope of work includes RJ11 telephone sockets with back boxes, 2 pair telephone wire from outlet to terminal blocks (TTB) in each floor, TTBs with terminal block in each floor, multi pair unarmoured telephone cable from each floor to Main Distribution Frame in central control room located in ground floor.

EPABX shall be provided in the central control room having sufficient no of PRI lines to establish two-way communications within and outside the building.

Analogue telephone points with 2 pair telephone wire shall generally be provided for the following locations:

- Reception /Registration/Offices - As per no of seats
- Labs /pantry/MGPS/substation - Minimum one number
- Semi private rooms - one number
- Nurse station - one number
- Dept office/duty room/help desk/pantry lab - one number
- Office with multiple occupancy – sockets to be as per requirement
- Faculty room - one number
- Enquiry - one number
- Surgeon room/nurse room/duty room/nurse station/enquiry/OT- one number

2pair telephone wire shall be laid from each telephone outlet to the floor telephone terminal block (TTB) located in each floor of each building.

Terminal block shall be installed in lockable metallic boxes with proper tagging/labelling.

Multi pair telephone wire shall be laid in appropriate type raceways through LV shaft from each floor to main terminal block (MDF) to be located in control room.

EPABX

Minimum requirements of the system are mentioned below:

- 250 nos of Analogue Extensions with CLI Expandable to 500 Ports
- 2 nos of PRI cards
- 8 nos of Analogue trunk lines
- 1 no of Operator Console.
- 2 nos -500 pair MDF
- 1 No - Call Billing and monitoring Software

- Charger/UPS with Batteries for backup of 1 hour
- The system should be highly reliable and should ensure an uptime of 99.99%
- System should have hot standby duplication.
- The system should be equipped with hot standby PSU, CPU and all other control cards with duplicated Software.
- System shall be a fully digital switch based on PCM/TDM technique of 32-bit microprocessor or higher. The system offered should be TEC approved.
- Telephone sets are not included in the scope of work

1.9.5 Public Address System

The System shall be catering the public address and emergency announcement for building.

The PA system comprise of voice control station, call station with key pad, micro phone at control station, amplifiers, ceiling or wall mounted speakers, zone selector, two-way speakers for fire fighters, speaker cabling, Rack etc.

The system distributes background music, live speech, and evacuation messages.

The PA system shall be public address sound management system with system objective to allow announcement from more than one location having facility to play music during idle time. Paging facility shall also be provided to facilitate Zone wise announcement or ALL CALL as the case may be.

The system shall be public address cum emergency sound systems compliant to international standards for Public Address, Evacuation and emergency sound systems.

The Centralized PA / BGM System with suitable SPL of 75 dB - 80 dB +/- 3dbA should be considered. The complete area should be divided in suitable zones and zone wise announcement shall be possible from central control station.

The PA system shall comprise of the following:

- Call station with Microphone and zone selection Keys.
- Voice alarm controller
- Voice alarm router
- Speakers, ceiling or wall mounted type in waiting areas, corridors, lobbies, nurse stations etc.
- Amplifiers
- Zone selectors
- Rack housing the control system distribution network / cables and required components and accessories

1.9.6 Closed Circuit Television System

The scope of work includes IP Based Dome Cameras, Bullet Cameras and PTZ cameras for surveillance, PoE switches, NVR, Video management system software, Storage hard

disks, LED display units, Racks, Server PC, Joy stick for PTZ functioning, Cabling using CAT 6 UTP cable, cable containment system etc.

The minimum requirements of the system are 30fps and 2mega pixel for the video management system at the control room.

The system offered must be capable of simultaneous viewing, recording and playback facility.

All components to be used must be compatible for high definition & high-resolution capability. The system shall be IP based and capable of viewing from multiple locations using appropriate web-based applications for remote monitoring apart from viewing in the monitor provided in the control room.

The types of cameras & locations of various cameras indicated herein are minimum to be provided. However, during detailed designing if required and found necessary the type/ rating of the Cameras shall be upgraded.

Locations of cameras are mentioned below:

- Entry/Exit/lift lobby /Staircase/reception/Registration/Enquiry counter of all floors – Dome camera
- Corridor/Waiting area/Ramp /Cafeteria/Terrace – Bullet camera
- PTZ camera – External area/Parking/surrounding roads

Codes and Standards are as follows:

- Products shall comply with UL/ FCC /CE /BIS /IEC/ONVIF standards Design & Installation guide lines shall be referred from latest NBC/CPWD regulations.
- Dome cameras shall be minimum 4MP, 30 FPS, CMOS type, IP 66, vandal proof, night vision IR LED type, minimum IR distance of 30 mtrs.
- Bullet cameras shall be minimum 4MP, 30 FPS, CMOS type, IP 66, vandal proof, night vision IR LED type, minimum viewing distance of 40 mtrs.
- PTZ cameras shall be CMOS type, minimum optical zoom 30X, vandal proof, IR LED type and minimum viewing distance of 300 mtrs.
- Sufficient number of LED display units shall be provided with minimum resolution of 1920 x1080 pixels and size of display to be minimum 44 inch.
- Network Video Recorders shall be used considering the total number of cameras with minimum 10% spare capacity and shall support simultaneous recording, playback and viewing without compensating the picture quality shall be embedded with video management software to fulfil the smooth functioning of the system.
- The software shall be from OEM only.
- Cabling shall be done by using UTP 4 pair CAT 6 cable for cameras drawn in 25 mm conduits.
- Cable shall be terminated in PoE switches installed in the rack.
- The maximum distance of CAT6 cable shall be limited to 80 mtrs.
- Number and location of network racks shall be selected such that the minimum distance of CAT6 cable is maintained from each camera to the network rack.
- 30 days' storage capacity shall be designed for calculating hard disk size.

1.9.7 Nurse Call System

An IP based Nurse Call System shall be provided for all ICU/observation beds and toilets of ICUs.

The System shall be approved in accordance with VDE guidelines/ international guidelines.

The Nurse Call System shall be designed to provide most effective communication between Patient, Nursing Staff, Doctor & management staff in the least possible time.

Architectural layouts may be referred for getting exact quantity of ICU/Observation beds and toilets of ICUs.

The system components and its features are mentioned below:

Main Controller

Controller shall be IP based & all the nurse station/ patient handset & other equipment shall be connected to main controller through CAT6 cable. Main controllers shall be networkable with other controllers through IP/ CAT6. Fault in one controller shall not have the effect on working of another controller. Each controller shall be able to work independently in case there is problem in network.

Nurse Station

Number of nurse stations can be taken from architectural layouts. Nurse station shall have large LC display capable of showing multiple patient call at a time with bed/ ward no., type of call, date & time. There shall be scroll down feature as well in case no. of patient call increase at a given time i.e. there shall not be any chance of missing any patient call. There shall be feature to priorities patient call depending upon patient condition, type of call & location (Bed or WC).

Nurse station shall be user friendly & have good aesthetic looks. All Nurse Stations shall be networked with other nurse station with facility of call forwarding/ diverting/ escalating calls in between nurse station. Nurse station shall be programmable so that emergency calls shall always be on top priority. The system shall be interfaced with IPBX to use as a telephone also.

Patient Handset without voice facility

Whenever the patient needs the attention of any Nurse, patient just press the button provided at his/ her bedside. On pressing the button, the alarm shall be enunciated at the Nurse Station by local sounder having volume & tone adjustment informing the nursing staff about the bed no. / Room no. along with type of call (Bed call or WC call) for their necessary action. Patient handset shall be connected to bed head unit through plug in cable. There shall be call cancel/ reset button either on bed head unit or separate button.

Lamp Module

Lamp module shall be installed outside the room/ ward above the door for visual indication of different type of call. Once the patient annunciates the alarm, the signal shall go to the

nurse station. The lamp outside the patient room/ ward shall also glow simultaneously red provide a visual alarm.

Pull cord Button for room/ ward toilet with shower/ bath facility

There shall be nurse call button with suitable length of pull cord with colour/ symbol for nurse call from the toilet. It shall be installed above shower head preferably in such a way to access from bath area as well as WC. Pull cord shall be detachable & replaceable without changing the unit. The buttons shall be moisture protected & suitable for bath areas.

Central Monitoring Station

Complete nurse call system shall be centrally connected to a PC having a software recording of all the different type of call & cancel with date & time. The software shall record the date & time of call generated by patient & call cancel by nurse with type of call. Software shall be able to generate report on daily, weekly or monthly basis as per requirement. It shall also be possible to put reminder/ highlighted on calls if nursing staff do not attend/ cancel the patient call with in specific time decided by the hospital management.

1.9.8 Access Control System

The access control system shall be IP based and provided to restrict the traffic in some areas for public and entry for designated hospital staff only.

- The system consists of biometric/magnetic card readers at entry/exit of doors, emergency push button for exit, electromagnetic lock, door controller, master controller, software and server, printer etc. the system shall be IP based.
- Access control system is generally provided for following locations:
- Central control room/labs/back office
    - Main doors connecting faculty offices to corridor
    - Main doors connecting OT complex to corridor
- Each Controller will have magnetic locks of single or double leaf door
- The centralized control will be managed through a server to be installed in central control room
- For overriding purpose, Push Button will be provided inside the rooms near the access-controlled doors.
- The Contractor shall prepare a riser diagram showing position of doors to be controlled, door controller, server etc. to EIC's approval.
- Material make approval & procurement may be proceeded only after EMPLOYER approval

1.9.9 Building Management System

State-of-the-art Building Management System (IBMS) will integrate multiple building functions including equipment supervision and control, alarm management, information management and historical data collection and archiving.

The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of field devices / programming.

The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

The BMS system shall be logically structured into three 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 shall be modular in structure to allow straight forward extensions.

BMS shall be hooked for Monitoring and controlling for the following system/ equipment:

- HVAC system Chiller plants/AHUs – Controlling and Monitoring
- Lifts - Controlling and Monitoring
- Firefighting system – Monitoring
- Fire Alarm system – Monitoring
- Substation/DG sets – Monitoring
- UPS – Monitoring

- Water tanks – Monitoring

The IBMS system will consist of the following:

- Central control station for monitoring, control and alarm through operator interface station (OIS)
- Software for building management system and energy management system
- System integration unit consisting of gateways, interface units etc.

Portable operator terminals, Sensors and field devices consisting of but not limited to the following:

- Immersion type temperature sensors
- Duct type temperature sensors
- Outside air and humidity sensors
- Water flow meter
- Differential pressure switch across the AHU
- Level switches for indicating water level in cooling towers, tanks etc.
- Water flow switches
- pH Sensor
- TDS Sensor
- Differential pressure transmitters
- Current transducers
- Voltage transducers Stand-alone intelligent 32-bit Direct Digital Controller (DDC), Line/Field Devices etc. for but not limited to the following:
    - Chilled water system / AHU
    - Water supply system
    - Firefighting system
    - Fire alarm system
    - Lifts, Escalators (if any)
    - UPS
    - Substation / DG sets

The plant will operate automatically as per programmed schedule the controllers will estimate the actual requirement on any particular day depending on outside temperature and accordingly decide the lead time required to achieve design inside conditions, in all areas, at the start of offices.

The BMS system shall consists of computer system with LED monitor, printer, mouse, switches, software, system integration units, field instruments, cabling etc. of latest version.

The Contractor shall prepare the comprehensive I/O summary with relevant A/I, A/O, D/I, D/O details for all equipment and systems covered under BMS, System Architecture and Interconnectivity between buildings etc. during detailed engineering & as per directions of Employer’s Representative .

Material make & procurement may be preceded after getting approval from EMPLOYER for System Architecture, I/O summary, Interconnectivity details.

1.10 ELEVATOR

1.10.1 General

The Contractor shall carry out Design, Engineering, Supply, Installation, and Testing & Commissioning of Machine-Room-less Type Elevator/Lift Works for Passenger-cum-bed lifts, Visitor Lifts, Service lifts and Dumb Waiter. The installation shall be carried out as per rules & regulations of local bodies and IS Codes that governs the requirement of installation of the lift. The voltage and frequency of the supply shall subject to variation permissible under Indian Electricity Act and Rules.

Passenger-cum-bed lifts, Visitor Lifts and Service Lifts shall be provided as per details given below which is indicative. Dumb Waiter is not added in this document; however, the Contractor shall consider it as per client/service requirement.

- Lift Well, Car Size, Lift Pit Depth, Overhead, and Clear Entrance Width & Height dimensions shall conform to NBC 2016 or OEM Standards/ recommendations.
- All lifts shall be Gearless Type without Machine room & Centre Opening
- Passenger Lift Speed: All building 0.75 TO 1.00 mtr/sec
- Car enclosure & doors shall be made out of SS 304 sheet of required thickness
- All lift shall have necessary provisions & door opening as required for physically challenged person

1.10.2 General Requirements

a. Elevator equipment shall be furnished and installed in accordance with either ASME A17.1 or EN 81 including the latest supplement. No degradation of ASME / EN 81-1 requirements is acceptable simply on the basis of the local code requirement. It is acceptable only when the ASME A17.1 / EN 81 is in direct conflict with local code requirements and where the latter is more stringent than the former. In any case the completed equipment shall more than fully comply with applicable and prevalent IS codes and Local Lift Acts and / or Rules.
b. The equipment and the work shall be in line with the best available international standards of Engineering, Design and Workmanship for the particular category of equipment. All materials, tools and tackles incorporated in the Works shall be suitable for the duty concerned and shall be new and of best commercial quality, free from imperfections, and selected for long life and minimum maintenance under the local and installation site conditions.
c. Power Supply Conditions: The Contractor shall verify the power supply and assess the quality of power. Any voltage stabilizer / UPS required shall be provided by the Contractor. Free Service costs and maintenance contract quote shall cover this requirement.
d. Weather / Temperature / Humidity: If Air-conditioning is required in machine room, same shall be included in quotation.
e. All materials incorporated in the Works shall be suitable for the duty concerned and shall be new and of best commercial quality, free from imperfections, and selected for long life and minimum maintenance under the local and installation site conditions.

f. All aesthetic requirements including and not restricted to claddings, false ceilings, floorings, colour, fixtures, lighting arrangements, grills etc. shall have to be approved in writing by the EMPLOYER. All equipment visible from the lobbies, corridors shall be aesthetically integrated with the surrounding finishes to the EMPLOYER's satisfaction. All signage / notices shall be aesthetically acceptable to the EMPLOYER.

1.10.3 Basic Technical Requirements

MACHINE: Unless specified all machines shall be energy efficient permanent magnet gearless traction machines with ACVVVF drives and shall be full control closed loop. Every machine shall have the provision of manual rescue operation in addition to any electrical battery back-up arrangement. Alternatively, the battery back-up device shall have a battery monitor that gives adequate audio / visual warning in case of inadequate charge. Machine for machine room less elevator shall always be located at the top of the shaft

DRIVE SYSTEM: It shall be ACVVVF with converter / inverter drives. Design unit to limit current, suppress noise and vibration transmission. The units shall be provided with internal heat sink cooling fans for the power drive portion of the converter panels.

CONTROLLER: The Controller shall be Microprocessor based. The controller shall be designed specifically for elevator application and shall be designed and manufactured by the Contractor in his premises. It shall on minimum operate with at least 3 feedback parameters of distance, speed and load. The controller shall have a dispatch system capable of ensuring traffic management. Controllers shall be equipped to handle grouping requirements and when specified up-peak and down peak requirements. The controller shall on a minimum provide protection against a) Phase sequence reversal of the power supply b) Overload c) Leakage current d) Earth leakage e) Short circuit f) Failure of one or two phases. The Control system shall be such that the lifts can be divided into as many groups as risers without any additional cost. The controller shall have self-diagnostic capabilities. It should also have event logging capabilities with a memory to store data of at least 3 months duration.

AUTOMATIC UP PEAK OPERATION: This shall detect the up-peak traffic pattern and shall park all cars at the main lobby level. B5 AUTOMATIC DOWN PEAK OPERATION: This shall detect the down peak traffic pattern and shall divide the served floors above the main floor into equal sectors and park itself accordingly. While the down peak condition applies, the system shall cancel automatic allocation of lifts to the main terminal landing.

ATTENDANT CONTROL: All lifts shall be provided with attendant control. This shall allow semi-automatic operation with manual control.

ANTI-NUISANCE: All lifts shall be provided with anti-nuisance features. This option shall avoid unwanted elevator operation caused by mischievously or mistakenly registered calls. It shall prevent the car from answering car calls when no one is in the car.

OVERLOAD: All lifts shall be provided with overload detector, warning indicator and buzzer. In case an overload is detected the car shall remain rest with the doors open. The elevator operation shall resume only upon removal of overload.

CAR VENTILATION: Adequate Blowers / Fans shall be provided for every lift. The arrangement shall ensure at least 15 air changes every hour to the satisfaction of the Client.

CAR LIGHTING: The car lighting shall be commercially available energy efficient, low heat emitting and long life integrated CFL/LED type. The combined lighting available in the car measured at a meter above the floor shall not be less than 100 lux.

DOOR DETECTORS: All lifts shall be provided with door detectors and shall be the light curtain type with at least 100 beams.

HALL LANTERN AND CAR ARRIVAL CHIME: All lifts shall be provided with hall lanterns and arrival chimes notifying passengers visually and audibly of the arrival of an elevator in advance. The international norms shall be adhered to.

EMERGENCY ALARM, LIGHT, FAN: The emergency alarm, light and fan shall be operational for a minimum period of 60 minutes. The emergency car lighting provided shall be a minimum of 50 lux.

INTERCOM: Intercoms shall always be provided for every unit. The intercoms shall be hands free 3-way communicator capable of connecting to building emergency room and machine room. All wiring within machine room and hoist way shall be by the Contractor. Additionally, the Contractor shall supply and install required cables and conduits from the hoist way to the designated location, the length of which shall not exceed 40 meters. The Contractor shall interface with the EMPLOYER to establish the routing.

FIREMAN OPERATION: Fireman's operation shall be as defined by NBC 2016 or as required by the local fire authority. The system shall ensure that all lifts are grounded on operation of the fire man switch / input. The designated fire lift(s) shall then operate under fire man operation.

AUTOMATIC RESCUE DEVICE: Each lift shall be provided with its own battery- operated automatic rescue device. The automatic rescue device shall facilitate rescue on power failure. The equipment shall be so designed to execute at least 3 rescue operations between the floors with the maximum travel in a 60-minute period without recharging irrespective of load condition. The automatic rescue device shall execute a rescue operation if one, two or all phases of supply fail.

DIFFERENTIALLY ABLED FRIENDLY: All lifts shall be " differently abled friendly " and shall comply with IS15330:2003. The building shall be designed as differently abled friendly as per NBC for both physical as well as visually challenged people.

ACCESS CONTROL INTERFACE: Secure access can be card readers, keypad readers or biometric fingerprint readers and shall be confirmed by EMPLOYER. The supplier shall readily interface with the Access Control Contractor at no extra cost.

BUILDING MANAGEMENT SYSTEM: When required by specification, the Contractor shall provide dry contacts of the following output signals for each elevator installation future connection by others: 1. Status - Normal / Maintenance / Fireman operation 2. Direction of

travel 3. Status of door - open / close 4. Car position 5. Passenger trapped alarm / intercom.

ALL AESTHETICS: Final decision on all Finishes, buttons etc. shall be by the Architect / EMPLOYER. No additional price increase shall be considered. It shall be the responsibility of the Contractor to interface with the Architect and the EMPLOYER to obtain written approval of aesthetics, finishes, fixtures etc. The written approval and samples shall be submitted to the EMPLOYER at their Office.

Position Indicators in the car or the lobby shall be at least 2.5 cm high indicating car position and direction of travel. The indicators shall be capable of indicating alpha-numeric signage depending on the floor designations selected for the particular building.

Service lifts shall be rugged and the finishes shall be easy to clean and repair. The flooring of the service lift shall be replaceable. The flooring shall be of granite/marble as advised by EMPLOYER. These lifts shall also be provided with wall protection pads and bumpers as a measure for protection of walls. The bumpers shall be mounted at a suitable height to absorb the impact of trolleys, loading pallets etc.

CAR SIZE: The relation between the Net car area and the Car rated capacity shall be accordance to the Indian Standards' reduction of up to 100mm in one dimension (either in width or in depth, not both) is acceptable to accommodate the Contractors' standard product line provided it does not hinder any special requirement of the EMPLOYER. In any case a deviation of more than 5% in the net car area is not permissible. Unless a deep car has been specified the width of the car shall be greater than the depth.

COUNTERWEIGHT: All counterweight blocks shall be in cast iron or iron ore. Suitable metallic counterweight guard of required height and width shall be provided at the bottom of hoist way. Counterweights shall be provided with safety gear for the lifts with the floating pit.

GUIDE RAILS: The guide rails shall be cold drawn steel or machined steel T- sections, with a sectional area sufficient to withstand the compressive forces resulting from the application of the car or counterweight safety device. The guide rails surfaces used for guiding a car or counterweight shall be sufficiently smooth and true to operate properly with the guiding member. The face of the car guide rail shall not be less than 9 mm. The fixing arrangement of the rails shall be such that vibrations shall not be transferred to walls of adjoining rooms.

GUIDE RAIL BRACKETS: The bracket shall be designed such that it can safely withstand the application of the car or counterweight safety when stopping the car and its rated load or the counterweight and shall be capable of resisting the horizontal forces imposed by the class of loading with a total deflection not exceeding 3 mm. Guide rails shall be secured to their brackets by clips specifically designed for the application. The distance between adjacent 2 brackets of a guide rail shall not exceed 2.5m.Guide rail brackets shall be secured to their supporting at a minimum of 2 points and shall be square with the rail. Slotted guide rail brackets having a single bolt fastening shall be provided with an additional means to be preventing lateral movement of the rail bracket.

WIRE ROPES: Car and Counterweights shall be suspended from steel wire ropes of best quality, the size and the number. The number and size of the ropes shall be selected to ensure proper factor of safety as mentioned in IS codes and adequate traction of the lift. The ropes shall be procured from a reputed manufacturer of wire ropes specific for elevators. Test certificates shall be made when requested. Ropes shall be selected such that it ensures proper traction and minimum sheave wear. The minimum diameter of ropes shall be 8mm and number of ropes shall not be less than 3, in case the ropes are 10mm in diameter the ropes shall not be less than 4 in number. When elastomeric coated steel belts are used, monitoring equipment for the belt there shall be a minimum of 3 belts.

ELASTOMERIC COATED STEEL BELTS: When elastomeric coated steel belts are used, continuous operating monitoring system shall be provided and installed with each lift. The criteria for replacement of the belts shall be defined and adhered to as part of the maintenance cycle and indicated in the maintenance manual. Each lift shall have at least 3 belts.

COMPENSATING CHAIN / ROPE: The chain / ropes when provided shall be procured from a reputed manufacturer of chain / ropes specific for elevators. The design of the chain / ropes shall ensure noiseless operation. Elevators with travel of over 30 meters shall be provided with compensation chains. Elevators with travel over 100 mts shall be provided with compensating ropes. Test certificates shall be made available when requested.

GLASS: Glass when specified for the cars or doors shall be a) Designed specifically for the elevator applications and designed to withstand all load and stress of a normal elevator. b) Laminated toughened glass to the required thickness as obtained from detailed design and calculations. c) Unless specified it shall be clear glass. d) Scratch resistant and heat resistant e) Glass shall be tested for pendulum shocks f) Handrail provided for support shall be fastened independently from the glass. g) The fixing of the glass in the wall shall ensure that the glass cannot slip out of the fixings h) The glass panels shall have markings giving the following information: i) Name of supplier and trademark ii) Type of glass iii) Thickness

Unless otherwise specified commonality of all buttons and fixtures used in a building shall be ensured. The position of all hall fixtures shall be approved by EMPLOYER. While establishing positions adequate care shall be taken to avoid puncturing or cutting any concrete.

All moving parts and high voltage contacts shall be adequately guarded against accidental contact. All car tops shall be provided with sturdy and well anchored barricades. The arrangement of equipment, troughs, trunking etc. shall be such that tripping hazards are minimized.

a. When oil buffers are provided, buffer switches shall be provided.
b. In the eventuality of a power disruption the elevator shall not lose its position. On resumption of power the elevator shall not require to go on a correction run to the terminal floor or require manual intervention before returning to normal operation.
c. Unless specified otherwise all doors shall be 2 panel center opening. Landing doors shall be 60 minutes fire resistant defined as resistant to collapse, resistant to penetration of flame and gases and resistant to temperature rise on the unexposed face. Test certificates shall be submitted on demand.

d. All equipment provided shall be energy efficient including provision for regeneration of power

e. Wiring and cabling shall be carried out in a neat and systematic manner and secured. Identification ferrules shall be fitted on all wires at both ends as identified on the appropriate wiring diagram.

1.10.4 Applicable Codes and Standards

- NATIONAL BUILDING CODE 2016
- INDIAN ELECTRICITY ACT AND RULES
- IS CODE 14665 – 1/2/3/4/5
- KERALA MUNICIPALITY BUILDING RULES 2019

1.10.5 Technical Specifications of Elevators

ELEVATOR TYPE	**Passenger/Bed Lift**	**Visitor Lift**	**Service Lift**
USAGE OF ELEVATOR	Patient shifting	Visitors	Fire/Patient/staff
TYPE	MRL	MRL	MRL
QUANTITY			
• 3 nos 20P Passenger-cum-bed lifts in Trauma block • 3 nos 20P visitors' lifts in Trauma block • 1 no 20P Fire lift in Trauma block • 2 nos 15P Service lift in Trauma block • 1 no 15P Service lift in Laundry block • 1 no 15P Service lift in Service block			
SPEED (METERS/SEC)	MAX 1.00	MAX 1.00	MAX 1.00
CONTROL	AC-VVVF	AC-VVVF	AC-VVVF
OPERATION	TWO CAR GROUP COLLECTIVE SELECTIVE	TWO CAR GROUP COLLECTIVE SELECTIVE	TWO CAR GROUP COLLECTIVE SELECTIVE
APPROXIMATE TRAVEL (METERS)	AS PER DRAWING	AS PER DRAWING	AS PER DRAWING
STOP	AS PER DRAWING	AS PER DRAWING	AS PER DRAWING
CABIN ENTRANCE DOOR OPENING ARRANGEMENT	CENTER/SIDE	CENTER/SIDE	CENTER/SIDE
CLEAR CABIN ENTRANCE SIZE	1200 X 2100 (minimum)	1200 X 2100 (minimum)	1200 X 2100 (minimum)
CAR SILLS & LANDING SILLS	EXTRUDED HARD ALUMINIUM	EXTRUDED HARD ALUMINIUM	EXTRUDED HARD ALUMINIUM
CAR OPERATING PANEL TYPE	AS PER CODE/APPROVED BY CLIENT	AS PER CODE/APPROVED BY CLIENT	AS PER CODE/APPROVED BY CLIENT
POWER SUPPLY	415 V 3 PHASE 50	415 V 3 PHASE 50 Hz	415 V 3 PHASE 50

ELEVATOR TYPE	Passenger/Bed Lift	Visitor Lift	Service Lift
FOR TRACTION MACHINE	Hz WITH VOLTAGE VARIATION OF + 5 ~ - 10 %	WITH VOLTAGE VARIATION OF + 5 ~ - 10 %	Hz WITH VOLTAGE VARIATION OF + 5 ~ - 10 %
POWER SUPPLY FOR CABIN LIGHTING	415 V 3 PHASE 50 Hz WITH VOLTAGE VARIATION OF + 5 ~ - 10 %	415 V 3 PHASE 50 Hz WITH VOLTAGE VARIATION OF + 5 ~ - 10 %	415 V 3 PHASE 50 Hz WITH VOLTAGE VARIATION OF + 5 ~ - 10 %

Note: The number of lifts, capacity and other parameters are indicative and may increase or decrease as per the design.

1.11 ELECTRICAL WORKS FOR HVAC AND FIREFIGHTING

1.11.1 Equipment Specifications

Main HVAC Panel

1. Panel shall be fabricated out of preferably CRCA Sheet Steel with reinforcement channels and angles.
2. The main electrical panel, distribution board & chilled water/ condenser water pumps will be located in the respective plant rooms
3. Panels shall be treated with all anti-corrosive process before painting with 2 coats of red oxide primer and final shade of powder coated paint
4. All outgoing & incoming shall be provided with Stop/Manual/ Auto/selector switch to facilitate operation through BAS. All starters shall be provided with potential free Contact for Connections to Building Automation System
5. A separate set of CTs to be provided for BAS and wiring from CT's and voltage transducers to be brought on to separate set of terminals.
6. Main HVAC Panel should cater to Chiller Motors, Primary and Secondary Chilled Water Pump Motors and Pump Motors, Condenser Water Pumps Motors, Cooling Tower Fan Motors etc
7. Panel should have sufficient number of Incoming and Outgoing feeders.

Control Panels for OT & Isolation Room with Heat Recovery Unit/OT AHU (Recirculation)

1. Should be preferably cubicle type, wall mounted control panels including anchoring into the wall
2. All outgoing shall be provided with Stop / Manual /Auto selector switch to facilitate operation through BAS. All starters shall be provided with potential free Contact for Connections to Building Automation System
3. MCB with over-load relay, suitable for motor duty and able to withstand suitable fault level. Sufficient number of incomers and Outgoings depending upon the load and requirement
4. Suitable exhaust arrangement within electrical panel shall be provided to avoid overheating
5. Control Panel catering to VFD operated Motors. Suitable rating starter required as a bypass arrangement in case of VFD failure.

Control Panel in Air Handling Unit With VFD

1. Should be preferably cubicle type, wall mounted control panels including anchoring into the wall
2. All outgoing shall be provided with Stop / Manual /Auto selector switch to facilitate operation through BAS. All starters shall be provided with potential free Contact for Connections to Building Automation System
3. Phase indicating lights and indicating light for ON/OFF/TRIP status phase sequence relay shall also be provided
4. Digital voltmeter and ammeter with selector switches.
5. Suitable rating starter required as a bypass arrangement in case of VFD failure.

6. Time delay relay for delayed automatic restart of air handling unit motor.
7. Wiring for micro switch for starting / stopping the fan when fire damper closes / Power supply for fire damper control panel.
8. For on/off/remote and local operation, 3 pole single throw switch shall be provided in each AHU panel to facilitate override of the automatic operation.
9. All starters shall be provided with suitable potential free contract for connections to the Building Automation System
10. Catering to Three phase Motor with VFD. Each of these compartments shall contain indicating lamp with ON/ OFF/ TRIP status of motors.

Control Panels for Fan Sections, Inline Fans & Axial Fans

1. Should be preferably cubicle type, wall mounted control panels including anchoring into the wall
2. All outgoing shall be provided with Stop / Manual /Auto selector switch to facilitate operation through BAS. All starters shall be provided with potential free Contact for Connections to Building Automation System. DOL/Star delta starters to be provided depending upon H.P rating of fans.
3. Over-load relay, suitable for motor duty and able to withstand fault level of suitable kA rating.
4. Single phase preventer (Electronics type) ¬ Terminal block for power distribution. ¬ Power Contactor.
5. Phase indicating lights and indicating light for ON/OFF/TRIP status phase sequence relay shall also be provided.
6. Voltmeter and ammeter
7. Time delay relay for delayed automatic restart of motor
8. Wiring for micro switch for starting / stopping the fan (in case of fire) / Power supply for damper control panel.
9. For on/off/remote and local operation, 3 pole single throw switch shall be provided in each panel to facilitate override of the automatic operation.
10. All starters shall be provided with suitable potential free contract for connections to the Building Automation System.
11. Three phase star delta starter with overload relay and single-phase preventer. Each of these compartments shall contain indicating lamp with ON/ OFF/ TRIP status for fan sections/axial fans.

Cables

Power and Control Cables should be preferably XLPE insulated and PVC sheathed Aluminium/Copper conductor armoured/un-armoured depending upon need and requirement, 1.1 KV grade conforming to IS: 7098:1988

Glands and Lugs

Glands and Lugs suitable for Power and Control Cables XLPE insulated and PVC sheathed Aluminium/Copper conductor armoured/un-armoured (depending upon need and requirement), of 1.1 KV grade confirming to IS: 7098:1988.

Cable Tray

Preferably perforated G.I cable trays with perforation not more than 17.5%, in convenient sections, joined with connectors, suspended from the ceiling with G.I. suspenders including bolts & nuts, painting suspenders etc. complete with bends, reducers, Tees, cross members etc. as required.

Earthing

Earthing requirements to be in conformity with IS -3043 (latest).

Suitable capacity makeup water tank shall be provided. The tanks will be placed on terrace at least one meter above cooling tower base; the makeup tank will be filled twice in 24 Hours with treated water

DESIGN PARAMETERS:

Design parameter for selection of Air Handling Unit and its components shall be:

Maximum face velocity across pre/fine filters : 2.54 m/sec (500 fpm)

Maximum face velocity across cooling coils : 2.54 m/sec (500 fpm)

Maximum fan outlet velocity : 9.14 m/sec (1800 fpm)

Maximum fan speed:

a) Fan above 450 mm dia. : As per OEM standards
b) Fan up to and including 450 mm dia. : As per OEM standards

Maximum fan motor speed : As per OEM standards

Design parameter for Duct design shall be:

Maximum flow velocity in ducts for air conditioning : 1500 fpm.
Maximum flow velocity in ducts for ventilation in pump room, boiler room, generator room, toilet exhaust & Kitchen exhaust. : 7.5 m / sec – 12.5 m / Sec (1500 – 2500 FPM)
Maximum friction : 1 cm WG/100 m run

Ventilation fan

Maximum fan outlet velocity for fan up to 450 mm dia. : 9.14 m/sec (1800 fpm)

Maximum fan outlet velocity for fan above 450 mm dia. : 12 m/sec (2400 fpm)

Maximum fan speed for fans : As per OEM standards

1.11.2 Electrical Works for Fire fighting

1. Fire fighting panel of suitable size incomer & sufficient nos. of outgoing feeders for all pumps along with spares/spaces to be provided. Panel open should have protocol communication enabled on Modbus/RTU
2. Power cabling of suitable size to be laid from LT panel to fire fighting panel. Power cabling of suitable size from fire fighting panel to fire pumps to be laid. Control cabling from fire pumps to fire fighting panel & fire fighting panel to pressure switch to be done.
3. Suspenders and/or cable trays for laying cables to be used.
4. For sprinkler system, fire annunciation panel needs to be considered.
5. Motor shall be TEFC squirrel cage AC induction type. The motor shall be suitable for continuous duty & rating necessary to drive the pump at 150% of its rated discharge with at least 65% rated head. Motor shall be with class F insulation & IE-2 class efficiency. DOL/star delta starter to be provided as per H.P rating of motors.
6. Adequate no. of NO/NC contacts for interlocks, indicating lamps, remote operation etc. shall be provided on starter/contactor.
7. Metallic body of all motors, medium voltage equipment etc. shall be connected by 2 separate & distinct earth conductors to the earth stations of the installations. Looping of such body earth conductors is acceptable from one equipment to another.

1.12 HVAC WORKS

The Contractor shall carry out Design, Engineering, Supply, Installation, and Testing & Commissioning of HVAC Works.

i. Heating, Ventilation & Air Conditioning System shall include validation of entire HVAC areas
ii. The entire HVAC works should conform to specifications provided & as per directions of Employer's Representative.
iii. The ratings and capacities of various equipment's are indicative and subject to upgradation/ revision during detailed designing stage.
iv. The scope shall include below mentioned features but not limited to:-
    a. The design shall be done in accordance with Norms established by IGBC for HVAC System design, provisions stated in NBC 2016, latest ECBC and conforming to the latest ISHRAE, ASHRAE and NABH Standards and CPWD standards.
    b. Objective of HVAC System Design is to ensure proper Indoor Air Quality, Energy Efficiency, Flexibility of Operation, Cost Optimization, BMS Compatibility and IGBC Rating Compliances.
    c. Heat Load is to be computed for individual rooms of required buildings which are to be air conditioned. All required parameters /factors like geographical location, orientation of building, ambient conditions, glazing factor, lighting/equipment load, occupant load, area & height of room, fresh air ACPH, CFM/person, ADP of coil, shall be considered as per ASHRAE/ISHRAE/NBC 2016/ECBC standards.
    d. Equipment sizing of HVAC system shall take into account factors such as geographical location, climatic conditions, water availability & quality etc.
    e. Suitable size shafts, cutouts, Niche, openings etc. shall be provided to facilitate installation of Pipelines, Ducts etc. in all floor slabs for various service areas, as required. All shafts, cutouts, Niche, openings etc. provided on floor slabs shall be suitably closed after laying of services lines as per fire safety norms as per NBC 2016. Doors shall be provided for all shafts at all floors as per fire safety norms as per NBC 2016.
    f. All Services as required like raw/ soft/ hot water supply, drainage, plumbing, HVAC provisions, ducting etc. shall be adequately provided by the Contractor for all Medical Equipment, Modular OT Rooms, CSSD, Laundry, Kitchen, MGPS etc.

INDOOR AIR QUALITY:

i. Emphasis on maintaining desirable Indoor Air Quality by setting and controlling parameters of Temperature, Air Flow, Humidity Levels and Air Changes per Hour (Total & Fresh Air) for each room/zone/area.
ii. Conformity of Indoor Quality parameters with ISHRAE, ASHRAE and NABH Standards.

1.12.1. Special Considerations for Critical Areas

i. All Critical Areas shall be designed on air recirculation and outside air intake system as per standards specified by ASHRAE, ISHRAE and NABH etc.
ii. Burn OTs/ Orthopedic OTs shall be design for 100% fresh air with heat recovery
iii. Orthopedic OTs shall be design for 18º+2ºC with RH 50% to 60%. Rest all OTs shall be design for 21º+1ºC with RH 50% to 55. Appropriate devices to monitor and display these conditions inside the OT shall be installed.
iv. ERCP, All critical areas (such as ICU, CCU, Pre-operation, Post-operation, Minor OT except NICU) shall be design @ 22+1ºC inside temperature and RH 50% to 55%.
v. BMT, Burn ICUs and Molecular Biology labs shall have HEPA filters
vi. Operation theatres and Cath labs: ASHRAE codes to be followed
- All AHU for OTs shall be fitted with devices so that during periods of inactivity the air changes can be reduced as per the standards of ASHRAE.
- Active humidity control is to be instituted in all operation theatres and cath labs.

vii. vii. Burns ICU in accordance to National Programme for Prevention & Management of Burn Injuries (NPPMBI)
viii. Each isolation patient room shall be ventilated by HEPA filtered air (Common AHU is permitted for upto two rooms. There should be mechanism for reducing air changes if the unit is not occupied.
ix. Burns dressing room shall be ventilated by 100% HEPA air and all air shall be exhausted. It should have facility for reducing air changes during periods of inactivity.
x. Entire complex of burns ICU shall have air supplied at 1 micron filtration and the complex shall be positively pressurized in relation to the hospital corridor.
xi. Immuno-compromised ward (including Bone marrow transplant unit)
- All air shall be 1 micron filtered.
- The department shall be positively pressurized in relation to the adjacent hospital corridor.

xii. NICU (Neonatal Intensive Care Unit)
- Air shall be supplied through 1 micron filtration.
- Temperature should be controllable from 22OC to 280C.
- All other areas 24+1ºC with RH 50% to 60%.

xiii. Laboratories:
a) Following areas shall require all air to be exhausted. It should have provision to reduce air changes when not in use.
- Grossing room
- Clinical pathology lab
- Washing and decontamination
- Media preparation
- Sample receiving

b) Biosafety cabinets: following labs are to be having provision to connect bio safety cabinets and as such the design should cater to balance air exhausted from these

devices or if required. Provision for Two cabinets each in the flowing sections of the laboratory

- parasitology,
- mycology;
- tuberculosis,
- bacteriology,
- serology,
- biochemistry and immunology
- hematology
- 24 hr laboratory
- Specimen preparation lab in molecular biology section

c) Fume hoods: to be provisioned for or if required

- all lab work surfaces in histopathology lab
- one in media preparation lab
- one in hematology and biochemistry section
- one in each microbiology section
- One in centrifuge room

d) Autoclaves will be installed in medic preparation, washing and decontamination. Towards this end, provision for exhausting the heat generated should be provisioned.

e) Molecular biology labs:

- These are to be provisioned with HEPA air, with recirculation.

f) Laminar air flow cabinets are to be installed in the labs. Provisioning of installation requirements for these should be considered. Locations are as follows:

- Reagent preparation in molecular biology
- Media preparation

xiv. Compartmentalizing and Zoning of Areas in Hospitals to restrict air movement and prevent cross contamination.

xv. Ventilation Design and Air Filtration to dilute and remove contamination in the form of odour, airborne microorganisms and viruses, hazardous chemical and radioactive substances. Magnehelic Gauges/ Electronic Pressure Gauges to be installed for critical areas for measuring differential pressure between zones.

xvi. High Efficiency Filtration system to prevent bacterial contamination whether it is from Outdoor Air or from re-circulated air within space.

xvii. Two Stage Filtration comprising of MERV-14 and HEPA Filters for Critical Areas.

xviii. Pre-insulated CFC Free 'PUF/PIR' (Polyurethane Foam/Polyisocyanurate Foam) Panel/ Board shall be used for supplying air to operation theatres to reduce the risk of bacterial formation in the air handling equipment and the ducts.

xix. For OTs, the Supply and Installation of HEPA Filters at Terminals, Laminar Flow Diffusers and Inside supply/return OT Ducting shall lie within the scope of Modular OT vendor.

xx. Waiting halls (areas with high occupancy) shall have Mechanical ventilation systems as per relevant norms.

1.12.2. Pressure Maintenance & Operational Philosophy

Pressure Maintenance: The patient care areas requiring air pressure to be

1. Higher than ambient pressure (Viz: All ICU, Isolation P.E. (Protected Environment) Rooms, Operation theatres, etc or
2. Lower than ambient pressure (viz A.I.I. isolation rooms (Airborne Infection Isolation rooms), microbiology laboratories, emergency etc. are installed with
   a) Pressure sensors that shall indicate the differential pressure maintained.
   b) Alarm to alert the nurse in case the differential pressure fails.
   c) AHU with VFD devices
   d) Pressure Actuators
   e) Motorized dampers
   f) Self-closing Doors with door seals

The pressure actuators are triggered when pressure falls below (for areas identified at point 1 above) or higher (for areas identified at point 2 above) to

- Speed up the AHU and open up the dampers to enable more air to be supplied in case of area considered at point 1 above, or,
- Speed up the exhaust for areas considered at point 2 above while closing the supply dampers.
- The air extractors and supply dampers for A.I.I. rooms have been installed with interlocked system so that, should the extract fail, the supply will cut out.

In addition, the A.I.I. Isolation and P.E. Isolation rooms are designed with ante room to enable an airlock condition to be obtained when one of the doors is opened

The doors are with ‘Patam’ and open in the direction of lower pressure.

1.12.3. Air Conditioning System

i. Centralized Chilled Water Air Conditioning System being considered for Hospital. All areas will be with 2 pipe system (cooling only).
ii. Precession AC shall be considered for Server Rooms with N+1 configuration.
iii. Provision of energy efficient units shall be considered. Energy Efficient Air
iv. Conditioners with Inverter driven compressors (min. 3 star rated) may be considered wherever necessary depending upon the suitability and applicability.
v. All the equipment’s etc. shall be suitable for 415 V, three phases or 220 V, Single phase, 50 Hz A.C. supply.
vi. The chilling machines shall be AHRI/ Eurovent certified with eco-friendly refrigerant and with best possible COPs as per latest ECBC code, Fans shall be AMCA certified for fan efficiency & Noise, Fire dampers shall be UL certified
vii. All pumps including Secondary Chilled Water Pumps, Primary Chilled Water Pumps and Condenser Water Pumps will be with unit mounted/ field mounted Variable Frequency Drives (VFD) circulating water in the chilled water circuit.

viii. Provision of specialized equipment like Vacuum Degasser/Air and Dirt Separator/Dirt Separator /Descalar in the Plant Room to ensure smoother operation, enhanced efficiency of system and longevity.
ix. viii.u-PVC Pipe for drain with suitable insulation for chilled water system
x. Ceiling Suspended and Floor Mounted Air Handling Units, chilled water Fan Coil Units to Convey Chilled Air in case of Chilled Water System
xi. Fresh air provision for FCU Indoor Units shall be considered as per relevant codes & standards. Double Skin (25 mm thick casing with inner and outer sheet shall be of GI thickness 0.63) FFU (Fan Filter Units with MERV-8) shall be used to supply fresh air for the areas which are fed through FCU.
xii. Pressurized Expansion Tank to adjust and regulate the pressure of water in the Chilled and Hot Water Circuit shall be provided
xiii. Ducting System comprising of GI Ducting with Insulation/Pre-Insulated Ducting depending upon the requirement. Aluminium duct shall be provided for OTS. Duct Construction and suspension Standards must conform to CPWD/SMACNA, IS 655 and ASME.
xiv. CTI certified Cooling Tower with VFD driven Fan Motors for Chilled Water System.
xv. Chilled Water flow Modulation by means of Manual/Motorized Butterfly, Non Return Valve, Ball Valve, Automatic Balancing Valve, 2 WAY PIBCV with insulation. Allthe valves must be minimum PN16 rated and suitable for Chilled Water applications.
xvi. Insulation of valves shall be the same as that of pipe
xvii. Chiller plant Manager shall be provided in the plant room
xviii. Air Flow Modulation by means of Air Distribution devices like Volume Control Duct Dampers, Collar Dampers, CAV/VAV Boxes conforming to ASME and SMACNA Standards.
xix. Colour scheme for equipment like Chillers/Pumps/AHUs/Cooling Tower etc. shall be as per manufacturer's standard color scheme or as per directions of EIC.
xx. The scheme of colour code painting of pipe work services for AC installation shall be as per NBC/CPWD specifications.
xxi. Provision of trap door of suitable material & size shall be considered for easy accessibility of moving parts of the concerned equipment/dampers.
xxii. BMS Compatibility to all Air Conditioning (3 phase equipment) High Side and Low Side Equipment.
xxiii. Heat recovery units shall be provided wherever 100% fresh air required, All AHU shall have demand control ventilation.
xxiv. Chemical Dosing system on both close loop and open loop. Close loop shall consist corrosion inhibitor Nitrite base dosing system &Ph stabilizer Alkaline/acidic base dosing system. Open loop shall consist corrosion inhibitor Nitrite base dosing system, Ph stabilizer Alkaline/acidic base dosing system & shock dosing of biocide dosing system.

1.12.4. Ventilation System:

i. Mechanical Ventilation System to be considered for Basements, Toilets, Kitchens, Laundry, Dining and Individual Floor Smoke Extraction, MGPS, Fire/WTP Pump House, ETP Plant & other areas as per requirements.

ii. Emphasis on maintaining adequate Fresh Air supply, Removal/Exhaust of stale air, particulate matter, fumes and noxious gases.
iii. Fan Design, selection and sizing in accordance with Provisions stated in NBC 2016, ASHRAE, ISHRAE, ECBC 2017 and Fire Bye-Laws.

1.12.5. Heating System:

No comfort heating shall be used for any areas.

Design and Layout Considerations:

The Design and Layout Considerations for HVAC System in a Building must strictly conform to the provisions stated in NBC, ECBC, ISHRAE , ASHRAE and CPWD.

The system shall be designed to cater air conditioning requirement to the different areas of the building. The brief design concept report for HVAC works in the buildings is as below:

General:

This report outlines the Design Considerations Basis of Design for estimating Heat load and HVAC system design.

Outside Conditions:

Outdoor Design Conditions for Thiruvananthapuram (Kerala) are based on Weather data:-

	Summer (Deg C)	Monsoon (Deg C)	Winter (Deg C)
DB	37.3	29.4	22.2
WB	29.3	26.7	18.3
RH	55.8	80.1	65

- Inside Conditions. As per ASHRAE & NABH standard.
- Lighting Load: As per ECBC
- Equipment Load: As per Actual
- Acceptable Indoor Noise Levels for Hospital: 35-40 dBA (Table 4.1 of NBC part 8 section 4)
- Fibrous acoustic insulating material shall not be used. Supply air ducts shall be externally insulated as required.
- Non critical spaces not having downstream terminal filters will have internal acoustic lining till first bend or 3 metre length of duct from inside in the Air Handling Units and Treated Fresh Air Units.
- Building Construction Data
    - The building shall be designed for IGBC Green Healthcare Facilities Rating System, for ECBC compliance following are the details
    - Climate Zone as per ECBC: Composite
    - All U value, SHGC, VLT etc of Glazing, Roof/Wall Insulation etc. shall conform to ECBC norms.

- Active smoke control systems shall be used along with fire and smoke partitions to limit the spread of smoke in the event of fire. 11.4 Exhaust outlets shall be located at a minimum height of 3 m away from ground level and away from doors, occupied areas and operable windows.

Plant Room Layout:

- The HVAC Plant shall be located at the terrace floor
- The terrace slab shall be structurally designed to take loads of various equipment. Also, dimensions of plant room shall conform to CPWD norms & other relevant codes so as to have proper distance between chillers/pumps/other equipment.
- The HVAC Plant Layout must be planned in such a manner so that it enables easy movement of personnel to conduct daily routine and maintenance procedures. Additional space for circulation shall be considered as per relevant codes. Provision shall also be kept for anticipated future requirements. Minimum clear height of plant room (approx. 4.5 m) shall be maintained as per relevant codes. Sheet roofs can be used as ceiling for plant room.
- Proper spacing must be ensured between the foundations of Pumps, Chillers and other equipment to enable repairs and easy replacement of parts.
- The Plant Room must be adequately ventilated with Fans maintaining optimum Air Flow and ACPH level. The design and sizing of Fan must be in conformity with the CPWD & NBC norms for the same.
- Floor loading of approx. 2000 kg/sqm shall be considered for HVAC Plant Room. The Plant Room should have a fresh water connection & drain trap.
- The floor shall have suitable drain facilities.
- Adequate level of illumination must be ensured to enable smooth maintenance and repair procedures.

HVAC Shaft:

- Sufficient number of shafts shall be provided so that piping length is optimized.
- The HVAC Shaft must be adequately sized to enable smooth passage of pipes &ducts with insulation along with its supporting arrangement through it and also for easy movement of personnel for maintenance
- The walls of the HVAC Shaft must be lined with Fire Rated Material capable of withstanding 250 degree Celsius for a period of 2 hours.

AHU Rooms:

- AHU Room slab shall be structurally designed to take loads of various equipment.
- The AHU Room Layout must be planned in such a manner so that it allows easy movement of personnel to conduct daily routine and maintenance procedures.

- AHU foundation shall be proper (PCC/RCC/Steel frame) in conformance to relevant standards. All measures shall be taken including providing vibration isolation pads etc. should be used to dampen noise generated at source itself.
- AHU Room shall be acoustically insulated with suitable material (density, K value) as per CPWD provisions & site requirements.
- Floor loading of approx. 800 kg/sqm shall be considered for AHU Room. AHU Room should have a fresh air opening, water connection & drain trap. Arrangement for adequate Natural Ventilation must be made in the AHU Rooms conforming to CPWD and NBC norms.

Mechanical Ventilation: (Air Changes per Hour)

SL. No.	Description	Fan type
1.	Toilet (Public)	6 to 10 ACPH
2.	Stores	6 ACPH
3.	AC Plant/Other Plant Rooms/LT/HT Panel Room/MGPS	12 ACPH
4.	Kitchen (In Dining/Cafeteria)	30 ACPH assumed for exhaust air scrubber sizing & fans Air Washer capacity @90% of Exhaust capacity
5.	Bio Medical Waste	25 ACPH
6.	Smoke Exhaust for any Public area	12 ACPH Exhaust &12 ACPH Make up air
7.	Car parking Ventilation	12 ACPH Exhaust &12 ACPH Make up air

Note: Separate exhaust duct shall be provided for toilets, pantries, and dirty utility areas. These shall not be combined with each other or with any other exhaust ducts of AC System**.**

Sl. No.	Description	Fan type
1.	Basement/ smoke management system for escape route – fresh air intake	Long casing Tube/ Vane Axial fans with Class F motor insulation & with BMS compatible with VFD capable of receiving signal from fire panel/ CO sensor controller
2.	Basement/ smoke management system for escape route – exhaust	Long casing Tube/ Vane Axial fans with Class H motor insulation & with BMS compatible with VFD capable of receiving signal from fire panel/ CO

		sensor controller.

Note: - Basement Ventilation (Fresh Air/exhaust) Fans shall be with IE-3 Rating. Pressurization Fans (Lift Well, Lift Lobby, Stairwells etc.), Floor Smoke Extraction Fans shall be with IE-2 Rating. Adequate Static shall be considered for Fans.

Sl. No.	Description	Fan type
1.	Fresh Air & Exhaust (Smoke Extraction System)	Long casing Tube / Vane Axial fans with Class H motor insulation
2.	Toilet Exhaust	Centrifugal Inline/Propeller as per requirement
3.	DU/ Isolation Room Exhaust	Centrifugal Inline.
4.	Service/ Utility area	Wall mounted propeller type
5.	Air Washer/Dry Scrubber	Plug Fan
6.	Bio Medical Waste Room	Cabinet Type with SISW Blower
7.	Plant Room/Pump Room/ ETP etc.	Cabinet Type Blower (SISW/DIDW meeting functional requirement

DU Isolation, Bio Medical waste fans, Air washer, Scrubber, Pump Room fans shall be with IE-3 motors & Pressurization Fans / Exhaust shall be with min. IE2 rated motors.

Estimated Refrigeration Load

Detailed heat load estimation sheet shall be prepared during detailed engineering stage for all the seasons (Summer/Monsoon) in which, the specified conditions are to be maintained based on above design parameters

Brief Equipment Specifications (High Side)

Chillers:

- Chillers shall be VFD driven screw chillers with single / multi stage compression Chiller Motors must be equipped with unit mounted/ field mounted VFDs and active harmonic filters to limit THDi level till 5 % at chiller source at all load conditions . THDi levels shall be displayed at main chiller control panel or AHF panel.
- Water cooled Chillers shall be with hermetic/semi hermetic/open, single/multiple compressors, Flooded/ Falling Film type chillers.
- Chiller shall be Factory Assembled and Tested – Eurovent / AHRI certified.
- Equipment shall meet or exceed minimum efficiency requirements of COP/ IPLV/ IKW per TR as per latest ASHRAE/ ISHRAE/ ECBC Standards.
- The total capacity of chillers shall be 410TR (3 Nos x 170TR) (2W +1S)
- Minimum requirement of both COP and IPLV requirement of ECBC /NBC provisions shall be met. Preferably, COP of min. 5.5 at AHRI conditions & IPLV of min. 9 to be met with (K-adjustment factor to ascertain COP, IPLV, IKW at Site Conditions and NPLV is not allowed).

- The chiller capacity shall be as per following parameters:
  - Chilled Water Leaving Temperature: 6.70 Deg. C
  - Chilled Water Entering Temperature: 12.2 Deg. C
  - Chiller Fouling Factor: 0.0005FPS
  - Chiller Water Flow Rate: @2.4GPM / TR
  - Condenser Entering Temperature: 28.47 Deg. C
  - Condenser Leaving Temperature: 34.03 Deg. C
  - Condenser Fouling Factor: 0.001FPS
  - Condenser Water Flow Rate: @ 3GPM/TR
  - COP at AHRI Conditions: min. 5.5
  - IPLV at 100% load at above duty conditions: 6.5 max.
  - Noise at 1 m as per AHRI 575, shall be less than 85dBA.
  - Chiller should operate without hot gas by pass/envelop stability control.
  - VFD shall be factory fitted unit mounted/Free Standing, liquid/refrigerant/Air cooled.
- Motors shall be energy efficient must conform to minimum IE-2 Class Efficiency.
- Full compatibility with BMS System.
- Both Working and Stand-by provisions for Chillers has to be considered. Minimum One Chiller shall be considered in addition to the no. of chillers as per requirements.
- Refrigerant of chiller shall be CFC free, zero ODP& as per ASHRAE safety classification of A1.
- Chillers/Cooling Tower foundation shall be proper (PCC/RCC/Steel frame) in conformance to relevant standards. All measures shall be taken including providing Cushy Foot mountings/vibration isolators etc. should be used to dampen noise generated at source itself.

Refrigerant:

- Refrigerant selected must possess the following properties:
  - Low to zero Flammability
  - Low to zero Toxicity
  - Low to zero Flame Propagation
- Depending upon the specific suitability and applicability, a desirable refrigerant R410A/R134A//R1233 shall be selected for chiller System.

Pumps:

- Chilled/ Condenser water pumps shall be Horizontal split case/Vertical Inline long coupled Centrifugal type with outside type mechanical seal for ease of maintenance and rugged usage.
- Suitable Pump Head shall be selected while sizing of pump depending upon the piping length, fittings, friction factor etc. and other requirements.

- Both Working and Stand-by provisions for Pumps has to be considered. Minimum. One standby pump shall be considered in addition to the no. of working pumps as per requirements.
- Pump casing shall be cast iron, impeller shall be bronze/gunmetal, shaft shall be of Stainless steel with S.S mechanical seal and rigid coupling. The pump shall be designed for PN-16 rating.
- The thermal insulation of Chilled Water Pumps shall be with same material & thickness as that of pipe.
- Pump shall be complete with all accessories like pressure gauge, butterfly valves at pump suction and discharge, suction guide, reducers (if reqd.) etc. All the valves and fittings shall be PN-16 at 50 Deg C and suction guide has to be sourced from pump manufacturer only
- All variable pumps including Secondary Chilled Water Pumps will be with Pump mounted Variable Speed Drives sensorless based circulating water in the chilled/hot water circuit with build in DC choke for reduction in harmonics and IP-55 Protection, the VFD outer material shall not be made in plastic. The variable pump VFD shall display dynamic Flow and head o for better & precise control of the pumping system offered to capture the unpredictable variations of the circuit installation and system quadratic curves can be optimized at site as per system requirement.
- The VFD shall be multi-color 4.3" back-lit touch-screen Variable Pumps must be provided with a cloud-based subscription service that enables Active Performance Management. It must proactively track and manages pump performance and provides early diagnostic messaging, web accessible trends and analysis along with automated reports helping end customer to make performance-based decisions and take immediate action to deliver the best possible HVAC pump performance. The cloud based subscription should deliver real-time alerts, such as Alarms & warnings on excessive vibration, Pump in hand, Dead head, Cavitation, Broken Coupling. The connectivity kit supplied by OEM/ authorized representative should have ability to connect upto 8 pumps in a single plant room.
- Suitable Foundation (PCC/RCC) or as per OEM standards needs to be constructed for mounting of these pumps along with anti-vibration pads.
- Efficiency of Pumps shall be preferably 70% or best efficiency as per OEM standards. Motor shall be TEFC Type, with Class F insulation.
- Operating speed shall not exceed 1500 RPM. 2 Poles motor shall be allowed as per designer discretion if there is due advantage in terms of efficiency of the pump.
- Pumps must be Energy Efficient and the Motor shall be rated preferably for IE-3 Class Efficiency.
- The variable pumps shall have an independent/ standalone IP-54 controller and should not be an integral part of any of the pump VFD's. The controller shall be designed to control up-to 6 pumps

Cooling Towers:

- Cooling Towers must be CTI Certified Induced Draft Cross/Counter Flow two side suction. Cooling tower shall be CTI for thermal performance and tower shall be tested in accordance with CTI ATC-128 for sound. The Cooling Tower Fan Motors shall be rated for preferably IE-3 rated and equipped with VFDs. Each VFD shall be installed in a dedicated external IP-65 enclosure
- Range of Cooling tower shall be 4.2 degree C & wet bulb approach of 2.77 degree C. Cooling tower shall have fan controls based on wet bulb logic.
- Cooling Tower shall be designed in such a manner that the total losses (drift + evaporation + bleed off etc.) are minimized. The drift loss shall be limited to 0.0009% only.
- Cooling Tower shall be located at a well-ventilated space of building. The structural loading of terrace shall be considered. Cooling towers shall be installed preferably on columns (raised by 3 feet at terrace) so that load is transferred directly to columns. For this, MS sections/beams shall be provided. Sufficient space shall be left all around for efficient operation of cooling tower.
- It should be complete with FRP (Fiber Reinforced Plastic) water basin, FRP casing, distribution system, PVC fills(min 13mill thickness) with integral louvers, drift eliminators, combined inlet shields, spray nozzles or self-rotating sprinklers, statically, dynamically balanced axial flow type fan & hand rail at top for inspection and maintenance. All structure shall be HDG (G-235 grade) and ladders, make up quick fill arrangement, overflow & drain connections with necessary valves. It should be complete with cement concrete foundation, steel/masonry supporting structure, anti-vibration mountings etc.
- The cooling tower fills shall have fire spread rating 5 as per ASTM std E-84-77a and O2 index 32. The cooling tower shall withstand wind pressure of 19 psig & seismic load of 0.9 g on the external surface.
- Minimum. One Cooling Tower shall be considered in addition to the no. of working cooling towers as per requirements.
- The cooling tower sound shall not be more than 75 Dba at 3mt on suction side of the cooling tower. Software generated data shall be submitted by the manufacturer.
- Power consumption of the cooling tower shall not be more than 50 HP. Software generated selection shall be shared by the manufacturer.

Brief Equipment Specifications (Low Side)

Air Handling Units (For Comfort Areas):

- Factory fabricated Double skinned construction with Thermal Break Profile with GI Sheet of Suitable thickness (0.8 mm) pre plasticized outside & plain GI (0.63 mm) on inside with PUF Insulation of suitable thickness (40 mm) and density (min. 32 kg/cum) between them. AHU may be floor mounted/ceiling suspended & should be of sufficient Tonnage, CFM & static pressure as per requirements.
- Maximum flow velocity across filters/Fans/Coils, motor /fan speed etc. shall be in conformance to relevant standards.

- Velocity & friction factor for Pipe Sizing shall be in conformance to relevant standards.
- Volume control dampers to be provided in ducts as per requirements.
- Fire Damper must be provided at the Supply and Return of AHUs room fire walls.
- Motor must conform to preferably IE-3 Class Efficiency and must be Squirrel cage induction type / BLDC type.
- All AHUs shall be equipped with VFDs.
- Fan Blower should be Plug fan (Direct driven) for supply/exhaust. Fans must be selected for suitable Static Pressure, CFM & shall be AMCA Certified for sound & performance.
- All AHUs shall be with MERV-14.
- Cooling Coil of required OD & thickness preferably made of Copper with Fins preferably made of Aluminum with suitable fins/inch. Cooling Coils Row deep should be considered meeting the functional requirements.
- Drain Pan of AHUs must be made of Stainless Steel of Suitable thickness (18 G) duly insulated with required thickness & density of insulating material & drain slope on both sides.
- Suitable number of modulating valves like Butterfly/Ball/ PICB/Drain etc. must be positioned at the inlet and Outlet along with other accessories like Thermometer, Pressure Gauge, Thermostat, and Humidistat etc. Strainers shall also be considered at the inlet of AHUs.
- Suitable Foundation for Floor Mounted AHUs /Hanging Arrangement for Ceiling Mounted AHUs should be considered with anti-vibration pads.
- Water Supply provision must be considered for AHUs with Built-in Humidifier wherever required.
- Fireproof double canvass connection should be considered.
- AHU shall be Eurovent certified each component as a whole.

Air Handling Units (For Critical Areas):

- Factory fabricated Double skinned construction with Thermal Break Profile with Aluminium Sheet of Suitable thickness (1 mm) pre plasticized outside & Aluminum Sheet (0.8 mm) on inside with PUF Insulation of suitable thickness (40 mm) and density (min. 32 kg/cum) between them. AHU may be floor / Celing mounted & should be of sufficient Tonnage, CFM & static pressure as per requirements.
- All OT/ICU AHUs shall have 3 damper arrangements – one for by passing return air to recirculation, second for exhausting return air and the third for fresh air intake.
- Maximum flow velocity across filters/Fans/Coils, motor /fan speed etc. shall be in conformance to relevant standards.
- Velocity & friction factor for Pipe Sizing shall be in conformance to relevant standards.
- Volume control dampers to be provided in ducts as per requirements.
- Fire Damper must be provided at the Supply and Return of AHUs.

- Motor must conform to preferably IE-3 Class Efficiency and must be Squirrel cage induction type / BLDC motor.
- All AHUs shall be equipped with VFDs.
- Fan Blower should be Plug Type for supply/exhaust. Fans must be selected for suitable Static Pressure & CFM & shall be AMCA Certified for sound & performance.
- Cooling Coil of required OD & thickness preferably made of Copper with Fins preferably made of Aluminum with suitable fins/inch. Cooling Coils Row deep should be considered meeting the functional requirements.
- Drain Pan of AHUs must be made of Stainless Steel of Suitable thickness (18 G) duly insulated with required thickness & density of insulating material & drain slope.
- Suitable number of modulating valves like Butterfly/ Ball/ PICB/Drain etc. must be positioned at the inlet and Outlet along with other accessories like Thermometer, Pressure Gauge, Thermostat, and Humidistat etc. Strainers shall also be considered at the inlet of AHUs.
- Suitable Foundation for Floor Mounted AHUs /Hanging Arrangement for Ceiling Mounted AHUs should be considered with anti-vibration pads. Water Supply provision must be considered for AHUs with Built-in Humidifier wherever required.
- Fireproof double canvass connection should be considered.
- The air handling units shall be powder coated in approved colour as per OEM standards or as per directions of E-I-C.
- Pressure differential Operating rooms where highly infectious patients are treated and isolation is required, all air from operating rooms and from all airborne infection isolation rooms, shall be exhausted directly to outdoors and if this is not possible, the room shall be ventilated with re-circulated air supplied through high efficiency particulate air (HEPA) filters. Such rooms shall be maintained at a minimum negative pressure of 2.5 N/m2 with respect to surrounding areas.
- Protective environment rooms, such as, bone marrow transplants and organ transplants, shall be maintained at a positive pressure of 2.5 N/m2 with respect to surrounding spaces.
- All operation theatres shall have independent air handling unit to prevent cross contamination.
- The laminar flow air distribution system shall be followed. Air shall be supplied from ceiling level to flow unidirectional up to the operation table. The return air shall be collected from four corners of the room to prevent the contamination from recirculation in space.
- Return to be collected near floor level approximately 200 mm above the floor level for OTs.
- The area of laminar flow grid shall extend by a minimum of 450 mm beyond the foot print of the operating table on all sides.
- Both supply and return air shall be ducted.
- Two level filtration shall be adopted with MERV-14 and HEPA filters of following filtration efficiency:
- HEPA Filters 99.97% down to 0.3
- All these filters shall be with aluminium frame to prevent formation of bacterial colonies. Epoxy resin shall be used to seal filter media with the framework. OTs shall

be maintained at positive pressure by supplying about 15% more air than return air to prevent any contamination from entering OT space. AHUs with HEPA filters shall be designed for high static pressure to overcome high pressure drops.

- A unidirectional air flow pattern at a velocity of 0.45 ± 0.10 m/s should be maintained.
- Magnehelic gauge to be provided in each OT between OT & Corridor and across filter bank.
- HEPA Filters to be provided preferably at terminals. However, if not, then same needs to be provided in the AHUs.
- AHU shall be Eurovent certified each component as a whole.

Fan Coil Units:

- Must be preferably of GI powder coated construction of suitable thickness.
- Fans must be selected for suitable Static Pressure.
- Coil of required OD & thickness preferably made of Copper with Fins preferably made of Aluminum with suitable fins/inch. Cooling/Heating Coils Row deep should be considered meeting the functional requirements.
- Motor must be energy efficient and must be 3 speed type. This shall consist of two lightweight aluminum impellers of forward curved type, both statically and dynamically balanced. The two impellers shall be directly mounted on to a double shaft, single phase multiple winding motor capable of running at three speeds.
- Drain Pan of FCUs must be made of Stainless Steel (18 G) of Suitable thickness duly insulated with required thickness & density of insulating material.
- The filter shall be pre- filter (MERV-8).
- It should consists of 2-Way Modulating type valve, Y strainers, Ball valves, wall mounted BMS compatible thermostat containing three speed and on/off control for fan, speed and temperature control for summer/ Monsoon/winter air conditioning.
- The fan coil units shall be powder coated in approved colour as per OEM standards or as per directions of EIC.

Split Air Conditioner Units:

- Air cooled split air conditioner Unit comprising of an Indoor unit and outdoor Unit.
- Must be Energy Efficient min 3 star rating & refrigerant R 32 or R 410 used should be CFC free & low, preferably zero ODP.
- Refrigerant piping and fittings interconnecting compressor condenser shall be all copper and valves shall be brass / gunmetal construction.
- Fan motor shall be suitable for 415 ± 10% volts or 230±10% volts, 50 Hz, A.C. Supply, Single phase, motors shall be provided with permanent capacitor. Motors & fan shall be especially designed for quite operation and motor speed shall be as per OEM standards

- Cooling coils shall be of fin and tube type having aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame / Multi channel.
- Inverter Driven Compressor Air Conditioner depending upon suitability and applicability. Non Inverter driven AC must conform to minimum 3 Star Rating.

Pressurized Closed Type Expansion Tank:

- Pressurized Cold Water Closed Type Expansion Tank must be equipped with Air Separator & should be preferably mounted in the plant room.
- The tank and air separator must be constructed in accordance with relevant standards.
- The tank shall be preferably pre charged steel expansion tank with replaceable heavy duty butyl rubber bladder.
- The expansion tank will be complete with safety relief valve, pressure reducing valve, pressure gauge & other accessories.

Chilled Water piping:

- The Pipes of sizes 150mm & below shall be M.S. 'C' class as per IS : 1239 and pipes size above 150mm shall be roll grooved black steel pipe heavy class as per IS: 3589, from minimum 6.35mm thick M.S. Sheet for pipes upto 350 mm dia. and from minimum 7mm thick MS sheet for pipes of 400 mm dia. and above.
- Pipe fittings from 20 NB & Above shall be with Grooved joints.
- For cooling applications, the pipe may be sized accordingly in conformance with relevant ASME and CPWD Codes for the same.
- Pipe insulation for Plant /Terrace pipe shall be with PUF preformed pipe section having standard density after strong bond adhesive and the pipe section insulation shall be finished with two coats of 500 micron (0.5 mm) WFT Fire Retardant weathering resistant coating conforming to ASTM 6695 and having excellent rainwater resistant, high level water primality resistant and must be Anti-Fungal and Anti-Mold(both properties) conforming to relevant internationally acclaimed std. such as ASTM D 6904, ASTM D 2842, ASTM D 5590 and ASTM D 5589 the coating has to confirmed to ASTM E 96 for water vapor permeability and coating fire resistance properties such ASTM 4804 and ASTM E 84 sandwiched with 11 Mil Class E Glass Cloth.
- For buried pipe, Pre-insulated chilled water pipes shall be with EPS (Expanded Polystyrene-TF Quality) moulded pipe section of density min. 20 Kg/cum with HDPE jacketing.
- The pipe within the building (in shafts, inside building etc.) shall be insulated PUF preformed pipe section having suitable density between after strong bond adhesive and two coats of 500 micron (0.5 mm) WFT Fire Retardant coating conforming to UL 723 Class A and ASTM 4804, sandwiched with 7 Mil Class E Glass Cloth.

- Riser for each building will have a butterfly valve & a balancing valve for isolating the building.
- Single Pot strainer will be provided for each cooling tower to remove impurities in condenser circuit.

Valves:

- All the Valves like Butterfly, Ball, Balancing, PICB must conform to PN 16 Pressure Rating.
- Valves must be duly insulated with suitable Insulation of suitable thickness and density.

Thermostat:

- Proportional type for AHUs and for FCUs
- Should be Microprocessor based with LED display
- Should have Fan Speed and Heat/Cool Change Over Switch options
- Automatic Heat / Cool Changeover option through external temperature sensor
- Should have high accuracy, fast response, Long Life and must be easy to operate
- Thermostat and digital programmable Humidistat, both BMS compatible to set the desired temperature and relative humidity.

Control Philosophy:

Both Thermostat & Humidistat shall enable the user to define the set points for Temperature & Humidity in absence / breakdown of BMS System. Thermostat considered shall be suitable for 2 Pipe system with dual Analog Outputs for Cooling & Heating. However humidistat shall be having single On/Off output. Outputs of these thermostat & humidistat will go to controller which in turn shall modulate chilled water control valve & switch on/ off the Humidifier for maintaining Temperature & Humidity.

Following shall be the conditions possible:

- When both Temperature & RH are high with respect to Set Point: Chilled water valve shall be modulated.
- When Temperature is high & RH is low with respect to Set Point: Chilled watervalve shall be modulated & Humidifier shall be switched on/ off.

Drain Piping:

- High Strength uPVC /PVC Pipe to be considered.
- The pipes shall be insulated with suitable material depending upon the requirement.
- The pipe material properties like density, thickness, K-Value and R-Value must be in conformity with relevant IS Codes, NBC, ISHRAE, ASHRAE& ASME.

Air Distribution (Ducting)-Air Conditioning:

- All ducts shall be fabricated either from galvanized sheet steel (GSS) confirming to IS 277 or Al sheets confirming to IS 737. The steel sheet shall be hot dipped galvanized with matt finish with coating of min. 120 GSM of zinc, GI sheet shall be lead free, eco-friendly & RoHS compliant. The sheet thickness shall be as per CPWD specifications.
- Ducting shall be selected factory pre-fabricated to achieve the high quality workman ship and specifications, end pieces can be site fabricated.
- All non-critical areas supply & return ducting shall be with GSS Ducting of suitable gauge thickness & pressure rating as per requirements.
- All critical areas supply & return ducting shall be with Aluminium Ducting of suitable gauge thickness & pressure rating as per requirements.
- Duct Construction and suspension Standards must conform to IS655/ SMACNA and ASME.
- Acoustic Duct Lining of suitable thickness and required length shall be provided at the commencement of ductwork from the respective Indoor Unit.
- Fire proof double canvass connection of suitable thickness and required length shall be provided at the outlet of the Indoor Equipment connecting it with the plenum.
- GSS Duct Construction standards must conform to CPWD/SMACNA Standards.
- SMACNA Certified wire rope hangers system with lock(s) and pre-crimped end fixing(s) shall be used for supporting all ducts. For safety, the lock should not have inbuilt unlocking mechanism; separate key to be used to unlock it. To avoid wire slippage, locking mechanism should be wedge type, self-locking and double channel type. Ball bearing(s) based or circular gear(s) based locking mechanisms are not acceptable. The wire rope hangers should have a minimum safety factor of 5:1.
- GSS ducting shall be complete with all relevant accessories like splitters, vanes etc. complete in all respect as per directions of Employer's Representative. Proper jointing (EPDM lining/cleats etc.) shall be done to prevent air leakages.
- Acoustic lining for AHU room shall be with acoustic board having thickness 25 mm and density 70 to 80 kg/m³ and laminated with FSK on one side and with glass cloth on other side.
- All internal ducts shall be provided to be insulated by use of Closed Cell Elastomeric Nitrile Butadiene Rubber insulation thickness 19mm having density of 40-60 kg/m³ after strong bond adhesive

THERMAL / ACOUSTIC INSULATION

Material:

- Insulation material shall be Closed Cell Elastomeric Nitrile Butadiene Rubber.
- Insulation material shall have anti-microbial product protection. The antimicrobial product protection shall be an integral part of insulation that is built-in during the

manufacturing process and the product protection should not allow the microbes to function, grow and reproduce.

- Resistance towards microbiological growth on insulation surface should confirm to following standards: Fungi Resistance – ASTM G21 where the fungal growth on the surface is NIL after 28 days of incubation at 28 – 30° C and Bacterial resistance – ASTM E 2180 where the reduction of bacterial growth is minimum 99.9% after 24 hours of incubation at 34 – 38° C
- Thermal conductivity of Elastomeric Nitrile rubber shall not exceed 0.035 W/m°K at an average temperature of 20°C in accordance to EN12667
- 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.
- Water vapour permeability shall not exceed 1.74 x 10-14 Kg/m.s.Pa, i.e. Moisture Diffusion Resistance Factor or 'μ' value should be minimum 10,000 according to EN 12086
- Density of Material shall be between 40 to 60 Kg/m3.

Duct Insulation:

- External thermal insulation shall be provided as follow:
    - The thickness of Nitrile rubber shall be as shown on drawing or identified in the schedule of quantity. Following procedure shall be adhered to:
    - Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work. Measurement of surface dimensions shall be taken properly to cut closed cell elastomeric rubbers sheets to size with sufficient allowance in dimension.
    - Material shall be fitted under compression and no stretching of material shall be permitted. A thin film of adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface. When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond. All longitudinal and transverse joints shall be sealed as per manufacturer recommendations. The adhesive shall be strictly as recommended by the manufacturer.
    - The detailed Application specifications are mentioned separately.
    - Insulation of Ducts Exposed Directly to Sunlight
- For installations exposed to sunlight, after giving 36 hours curing time for the adhesive apply manufacturer's recommended UV/Mechanical Protection. Please refer the separate detailed guidelines on UV/Mechanical Protection.

Supply/ Return Air Grilles:

Preferably powder coated extruded aluminium construction with preferably aluminium volume control dampers.

VCD/Fire Damper with Actuators:

- VCDs to be provided at ducts at suitable places. Fire Dampers with actuators to be considered for floor mounted AHUs at supply/return duct.
- The material of VCDs & dampers shall be GI.
- Fire Dampers shall be 90 min. rating against collapse & flame penetration as per UL 555 & 555S. Fire dampers shall be compatible with fire detection system.
- For fire safety motorized fire dampers with electrical actuators interlocked with the air blowers shall be provided in supply and return air paths. All materials used for insulation shall be fire proof type. The air handling unit's motors shall also be interlocked with the central fire alarm system such that in case of detection of smoke or fire by the fire alarm system, the air handling units shall automatically shut off.
- VAV/ CAV Boxes to be used as per requirements.

Brief Equipment Specifications (Ventilation/Pressurization):

Ventilation system should be considered for Toilets, Kitchen/Pantry, Basement, floor smoke extraction, plant room & other utility areas etc. as required. Pressurization system for lift well/staircase/lift lobby etc. should be considered.

Axial Fans:

- Axial Fans for Fresh / Exhaust air suitable for installing in any position in Horizontal or vertical, and must be AMCA certified.
- Casing of Fans shall be constructed of heavy gauge sheet steel and preferably be powder coated. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Threaded Rod of sufficient dia. /channel should be considered for hanging of fans.
- Fan Sizing (CFM & Static Pressure) for Basement Ventilation (Fresh Air/Normal Exhaust / Smoke Exhaust) must be done considering the required ACPH levels in the Basement as specified in NBC 2016/ECBC or relevant codes.
- The plenum of the fans must be lined with Acoustic Lining to ensure proper sound absorption.
- Axial Fans for Basement Smoke Exhaust and Smoke Extraction purpose must be Fire Rated (H Class), able to withstand a temperature of 250 degree Celsius for a period of 2 hours.
- Fan-motor assembly (as whole) shall be statically & dynamically balanced, conforming to ISO and AMCA Standards.
- Should be suitable for 415 V ± 10% volts three phase 50cycle, AC supply.
- The speed of Fan shall be as per OEM standards
- Provision of all necessary accessories such as Wire Guard on inlet side and bird screen on outlet, Gravity operated louver shutters, Canvass Connection for connecting Fan assembly and Plenum should be considered.

- Sizing of Fans must be done in accordance with provisions sated in ISHRAE/ ASHRAE/ NBC 2016 and relevant IS Codes.
- Noise Level of Fan (in decibel) should conform to NBC 2016/ASHRAE/ ISHRAE/ CPWD and relevant IS Codes.

Fan Section

- Utility of Fan Section preferably for Pressurization of Lift Lobbies, Lift Well, Staircase. Fan must be AMCA certified.
- Fan Sections for Pressurization purpose must be H/F Class as per requirement.
- Fan-motor assembly (as whole) shall be statically & dynamically balanced, conforming to ISO and AMCA Standards.
- Should be suitable for 415 V ± 10% volts three phase 50cycle, AC supply.
- Provision of all necessary accessories such as Canvass Connection for connecting Fan assembly and Plenum must be considered.
- Sizing of Fans must be done in accordance with provisions sated in ISHRAE/ASHRAE/NBC 2016
- Noise Level of Fan (in decibel) should conform to latest NBC 2016/ ASHRAE/ISHRAE/CPWD and relevant IS Codes.

Propeller & Inline Fans

- Propeller and Inline fans AMCA Certified with its construction standards conforming to CPWD, NBC 2016/ ISHRAE/ ASHRAE and relevant IS Codes.
- Propeller Fans shall be direct-driven, three or four blade type. It should be of Steel/GI/PVC construction as per CFM requirement & dia. Of fan.
- Fan-motor assembly (as whole) shall be statically & dynamically balanced, conforming to ISO and AMCA Standards.
- Should be suitable for 415 V ± 10% volts three phase 50cycle, AC supply.
- The speed of Fan shall not exceed 1000 RPM for Fans with impeller diameter above 310mm and 1440 RPM for fans with impeller diameter of 310mm and less.
- Provision of all necessary accessories such as Wire Guard on inlet side and bird screen on outlet, Gravity operated louver shutters, Canvass Connection for connecting Fan assembly and Plenum should be considered.
- Noise Level of Fan (in decibel) should conform to latest NBC 2016/ASHRAE/ISHRAE/CPWD and relevant IS Codes.

Ventilation Duct:-

- GSS Duct Construction standards must conform to SMACNA Standards.
- Wire rope of sufficient dia. with sleeve should be considered for hanging of duct of suitable dimensions. The sizing, suspension/hanging arrangement must conform to standards and specifications stated in relevant ASME/SMACNA/ CPWD/NBC 2016 Codes.
- GSS ducting shall be complete with all relevant accessories like splitters, vanes etc. complete in all respect as per directions of Employer’s Representative. Proper jointing (EPDM lining/cleats etc.) shall be done to prevent air leakages.

- Acoustic Duct Lining of suitable thickness and required length shall be provided at the commencement of ductwork from the respective Indoor Unit.
- Fire proof double canvass connection of suitable thickness and required length shall be provided at the outlet of the Indoor Equipment connecting it with the plenum.

Air Distribution Products (ADP) -Louvers / Grills with or without Dampers

- Sizing of Ventilation Louvers should be done considering the capacity of Fans. The Ventilation Louver for Fresh Air shall have manually operated dampers along with bird screen wire mesh and Ventilation Louver for exhaust air shall only have bird screen wire mesh. Material of Construction of louvers shall be preferably extruded aluminum with powder coated finish or as per OEM requirements complying codes & standards.
- Grills with dampers for supply/fresh air & grills without dampers to be considered exhaust/return air. MOC of grills shall be preferably extruded aluminum with powder coated finish or as per OEM requirements complying codes & standards.

Brief Equipment Specifications (HVAC Electrical)

Main HVAC Panel

- Panel shall be fabricated out of preferably CRCA Sheet Steel with reinforcement, channels and angles etc.
- The main electrical panel, distribution board & chilled water/ condenser water pumps will be located in the respective plant rooms
- Panels shall be treated with all anticorrosive process before painting with 2 coats of red oxide primer and final shade of powder coated paint.
- All outgoing & incoming shall be provided with Stop/Manual/ Auto/selector switch to facilitate operation through BAS. All starters shall be provided with potential free Contact for Connections to Building Automation System.
- A separate set of CTs to be provided for BAS and wiring from CT's and voltage transducers to be brought on to separate set of terminals.
- Main HVAC Panel should cater to Chiller Motors, Primary and Secondary Chilled Water Pump Motors and Pump Motors, Condenser Water Pumps Motors, Cooling Tower Fan Motors etc.
- Panel should have sufficient number of Incoming and Outgoing feeders.

Control Panels for OT & Isolation Room With Heat Recovery Unit/ OT AHU (Recirculation)

- Should be preferably cubicle type, wall mounted control panels including anchoring into the wall
- All outgoing shall be provided with Stop / Manual /Auto selector switch to facilitate operation through BAS. All starters shall be provided with potential free Contact for Connections to Building Automation System.

- MCB with over-load relay, suitable for motor duty and able to withstand suitable fault level. Sufficient number of incomers and Outgoings depending upon the load and requirement.
- Suitable exhaust arrangement within electrical panel shall be provided to avoid overheating.
- Control Panel catering to VFD operated Motors. Suitable rating starter required as a bypass arrangement in case of VFD failure.

Control Panel in Air Handling Unit With VFD

- Should be preferably cubicle type, wall mounted control panels including anchoring into the wall
- All outgoing shall be provided with Stop / Manual /Auto selector switch to facilitate operation through BAS. All starters shall be provided with potential free Contact for Connections to Building Automation System
- Phase indicating lights and indicating light for ON/OFF/TRIP status phase sequence relay shall also be provided.
- Digital voltmeter and ammeter with selector switches.
- Suitable rating starter required as a bypass arrangement in case of VFD failure.
- Time delay relay for delayed automatic restart of air handling unit motor.
- Wiring for micro switch for starting / stopping the fan when fire damper closes / Power supply for fire damper control panel.
- For on/off/remote and local operation, 3 pole single throw switch shall be provided in each AHU panel to facilitate override of the automatic operation.
- All starters shall be provided with suitable potential free contract for connections to the Building Automation System.
- Catering to Three phase Motor with VFD. Each of these compartments shall contain indicating lamp with ON/ OFF/ TRIP status of motors.

Control Panels for Fan Sections, Inline Fans & Axial Fans

- Should be preferably cubicle type, wall mounted control panels including anchoring into the wall
- All outgoing shall be provided with Stop / Manual /Auto selector switch to facilitate operation through BAS. All starters shall be provided with potential free Contact for Connections to Building Automation System. DOL/Star delta starters to be provided depending upon H.P rating of fans.
- Over-load relay, suitable for motor duty and able to withstand fault level of suitable kA rating.
- single phase preventer (Electronics type)
- Terminal block for power distribution.
- Power Contactor.
- Phase indicating lights and indicating light for ON/OFF/TRIP status phase sequence relay shall also be provided.

- Voltmeter and ammeter.
- Time delay relay for delayed automatic restart of motor
- Wiring for micro switch for starting / stopping the fan (in case of fire) / Power supply for damper control panel.
- For on/off/remote and local operation, 3 pole single throw switch shall be provided in each panel to facilitate override of the automatic operation.
- All starters shall be provided with suitable potential free contract for connections to the Building Automation System.
- Three phase star delta starter with overload relay and single phase preventer. Each of these compartments shall contain indicating lamp with ON/ OFF/ TRIP status for fan sections/axial fans.

Cables

Power and Control Cables should be preferably XLPE insulated and PVC sheathed Aluminium/Copper conductor armoured/un-armoured depending upon need and requirement, 1.1 KV grade conforming to IS: 7098:1988.

Glands and Lugs

Glands and Lugs suitable for Power and Control Cables XLPE insulated and PVC sheathed Aluminium/Copper conductor armoured/un-armoured (depending upon need and requirement), of 1.1 KV grade confirming to IS : 7098:1988.

Cable Tray

Preferably perforated G.I cable trays with perforation not more than 17.5%, in convenient sections, joined with connectors, suspended from the ceiling with G.I. suspenders including bolts & nuts, painting suspenders etc. complete with bends, reducers, Tees, cross members etc. as required.

Earthing

Earthing requirements to be in conformity with IS -3043 (latest).

Suitable capacity make up water tank is required. The tanks will be placed on terrace at least one meter above cooling tower base; the makeup tank will be filled twice in 24 Hours with treated water.

1.12.6. Design Parameters

Design parameter for selection of Air Handling Unit and its components shall be:

Maximum face velocity across pre/fine filters	2.54 m/sec (500 fpm)

Maximum face velocity across cooling coils	2.54 m/sec (500 fpm)
Maximum fan outlet velocity	9.14 m/sec (1800 fpm)
Maximum fan speed	
a. Fan above 450 mm dia.	As per OEM standards
b. Fan up to and including 450 mm dia.	As per OEM standards
Maximum fan motor speed	As per OEM standards

Design parameter for Duct design:

Maximum flow velocity in ducts for air conditioning	1500 fpm.
Maximum flow velocity in ducts for ventilation in pump room, boiler room, generator room, toilet exhaust & Kitchen exhaust.	7.5 m / sec – 12.5 m / Sec (1500 – 2500 FPM)
Maximum friction	1 cm WG/100 m run

Ventilation Fan:

Maximum fan outlet velocity for fan upto 450 mm dia.	9.14 m/sec (1800 fpm)
Maximum fan outlet velocity for fan above 450 mm dia.	12 m/sec (2400 fpm)
Maximum fan speed for fans.	As per OEM standards

Filtration:

Re circulated air (mixed fresh & return air) at air handling units.	Pre-filtration shall be through washable synthetic type air filters having 90% efficiency down to 10 microns (MERV 8) Further filtration shall be through MERV 13 filters having 99% efficiency down to 3 microns.

HEPA filters where ever required shall be as relevant standard Maximum velocity across filters:

Ordinary filters	155 m/min
Micro-vee filters	155 m/min
HEPA filters	155 m/min
Minimum spray density for humidification	10 lpm/sq.m

Piping shall be sized for the following design parameters:

Nominal Pipe Size, inches	**Flow in (GPM)**	
	Other (For Condenser Line) >4400 and ≤ 8760	**Variable Flow/ Variable Speed (For Chilled Water**

	Hours/Year	**Line) >4400 and ≤ 8760 Hours/Year**
2.5	68	110
3	110	170
4	210	320
5	250	370
6	440	680
8	510	770
10	1000	1600
12	1500	2300
Maximum Velocity for Pipes over 12 in. Size	5.0 fps	7.5 fps

MAIN Block - HVAC Area Details with equipment		
Floor	**Sl. No.**	**Room**
Ground Floor Radiology Area	1	CORRIDOR, REPORT COUNTER, CHANGE Rooms USG Waiting etc.
	2	USG-1
	3	USG-2
	4	USG-3
	5	X-RAY 1
	6	CR / CONSOLE
	7	X, Ray 2
	8	MAMMOGRAM
	9	RADIOLOGIST
	10	Report Counter
	11	CORRIDOR
	12	CONSOLE
	13	MRI
	14	EQUIPMENT ROOM
	15	CT
	16	EQUIPMENT ROOM
Ground Floor Casualty Area	1	LOBBY , Duty Rooms, Passage etc.
	2	STORE
	3	SAMPLE COLLECTION
	4	INJECTION ROOM,PLASTER, PROCEDURE, passage etc.
	5	ISOLATION ROOM [-ve] [100% Fresh air]
	6	ISOLATION ROOM [+ve] PE Room
	7	YELLOW AREA,
	8	RESUSCITATE/RED
	9	Green area
	10	Sterile Corridor etc.
	11	EMERGENCY OT
	12	SEPTIC OT
	13	PHARMACY

MAIN Block - HVAC Area Details with equipment		
Floor	**Sl. No.**	**Room**
	14	PHARMACY and Store
	15	BHOOMIKA CLINIC
		PROCEDURE ROOMS a. ENT – Endocopy room, Audiometry b. Surgery – Procedure room c. Respiratory Medicine – Bronchoscopy room d. Neurology – Procedure room e. Nephrology - Procedure room f. Urology - Procedure room g. Dermatology- Procedure room h. Gasto Entrology- Procedure room i. Pediatric OP j. Dental OP k. Ophthalmology OP
First Floor ICU & OPD Area	1	ICU
	2	PHYSIOTHERAPY
	3	PEDIATRIC OPD
	4	TREDMILL TEST
	5	ECHO
	6	DENTAL OPD
	7	DENTAL OPD Reception, Procedure rest room etc.
Second Floor Blood Bank Area	1	RECEPTION, Passage, DOCTOR ROOM, COUNSELLING, REFRESHMENT
	2	BLEEDING ROOM, APHAERESIS
	3	STERILE
	4	INFECTIOUS SEROLOGY
	5	ISSUE COUNTER, COMPONENT STORAGE
	6	COMPONENT SEPARATION
	7	WHOLE BLOOD STORAGE
	8	SERVER ROOM
Second Floor Lab Area	1	RECEPTION, RECEIVING, RECORDS, MALE, FEMALE STAFF
	2	HISTOPATHOGY, HEMATOLOGY, BIOCHEMISTRY, STAIN ROOM , GROSSING, MEDIA ROOM, MICROBIOLOGY, PATHOLOGIST ETC
	3	DUTY ROOMS
Second Floor Oncology Department	1	CHEMO THERAPY 1
	2	CHEMO THERAPY 2
Second Floor Dialysis	1	Dialysis area

1.13 FIRE FIGHTING SYSTEM

1.13.1 General

The Contractor shall carry out Design, Engineering, Supply, Installation, and Testing & Commissioning for conventional Fire Fighting Works for Construction at General Hospital, Thiruvananthapuram, Kerala and India. Every Building Safety point of view fire system recognized that fire safety plays an important role in influencing building design. The development of fire safety objectives at an early stage of the design process, and progressing throughout the project phases is to ensure the continuity of cohesion of fire safety design.

Fire Fighting system shall comprise of Wet Riser / Hydrant (Internal & External), Sprinkler system, Down comer System, Fire Extinguishers, Fire Signage's, Fire Brigade Inlet/Draw Out Connections etc. Suitable size shafts, cutouts, Niche, openings etc. shall be provided to facilitate installation of Pipelines etc. in all floor slabs for various service areas, as required. All shafts, cutouts, Niche, openings etc. provided on floor slabs shall be suitably closed after laying of services lines as per fire safety norms as per NBC 2016. Doors shall be provided for all shafts at all floors as per fire safety norms as per NBC 2016.

The ratings and capacities of various equipment are based on NBC 2016 Part - IV and subject to revision during detailed designing stage. The firefighting system is shall be provided on basis of type of occupancy as per NBC 2016 Part -IV and building Height. The system shall be are water based. Water based Fire suppression system is having piping network inside and outside the building with internal and external Hydrants, First Aid Hose reel at regular intervals according to various type of occupancy. The distribution system is finally connected to ring main system for firefighting.

Sprinkler system with water distribution pipes sprinkler heads above and below false ceiling is designed to actuate automatically to extinguish the fire by discharge of water when room temperature crosses 68˚ C in case of fire and Kitchen area 93˚ C.

Site Information

The tenderer should, in his own interest, visit the site and familiarize himself with the site conditions before tendering. For any clarification, tenderer may discuss with the Employer's Representative.

1.13.2 Conformity With Statutory Acts, Rules, Standards and Codes

(i) All components shall conform to relevant Indian Standard Specifications, wherever existing, amended to date. A list of such standards is appended in Technical Specification under same head.

(ii) All electrical works shall be carried out in accordance with the provisions of Indian Electricity Act, 2003 and Indian Electricity Rules, 1956 amended to date. They shall also conform to CPWD General Specifications for Electrical works, Part-I: Internal, 2005. Part-II: External, 1994 and Part IV (Sub-station) 1982, amended to date.

1.13.3 Safety Codes and Labour Regulations

(i) In respect of all labour employed directly or indirectly on the work for the performance of the firefighting Contractor's part of work, the Contractor at his own expense, will arrange for the safety provisions as per the statutory provisions. B.I.S recommendations, factory act, workman's compensation act, CPWD code and instructions issued from time to time. Failure to provide such safety requirements would make the tenderer liable for penalty for Rs. 200/- for each violation. In addition, the Employer's Representative, shall be at liberty to make arrangements and provide facilities as aforesaid and recover the cost incurred thereon from the Contractor.

(ii) The Contractor shall provide necessary barriers, warning signals and other safety measures while laying pipelines, cables etc. or wherever necessary so as to avoid accident. He shall also indemnify CPWD against claims for compensation arising out of negligence in this respect. Contractor shall be liable, in accordance with the Indian Law and Regulations for any accident occurring due to any cause. The department shall not be responsible for any accident occurred or damage incurred or claims arising there from during the execution of work. The Contractor shall also provide all insurance including third party insurance as may be necessary to cover the risk. No extra payment would be made to the Contractor due to the above provisions thereof.

1.13.4 Scope of Works

Unless otherwise mentioned in the tender documents, the following works shall be done by the Contractor and therefore, their cost shall be deemed to be included in their tendered cost- whether specifically indicated in the schedule of work or not: -

(i) Foundations for equipment including foundation bolts and vibration isolation spring/ pads.
(ii) Suspenders, brackets and floor/ wall supports for suspending/supporting pipes.
(iii) Suspenders and/or cable trays for laying the cables.
(iv) Excavation and refilling of trenches in soil wherever the pipes are to be laid directly in ground, including necessary base treatment and supports.
(v) Sealing of all floor slab/wall openings provided by the Department or made by the Contractor for pipes and cables, from fire safety point of view, after laying of the same.
(vi) Painting of all exposed metal surfaces of equipment and components with appropriate colour.
(vii) Making openings in the walls/ floors/ slabs or modification in the existing openings wherever provided for carrying pipe line, cables etc.
(viii) All electrical works including cable/wires, earthing etc. beyond power supply made available by the department.

(ix) Making good all damages caused to the structure during installation and restoring the same to their original finish.
(x) Approval from local fire authorities as may be required as per local bye-laws.

1.13.5 Power Supply, Water Supply and Drainage

Power Supply

(i) Unless otherwise specified, 3 phase, 415 volts, 50 Hz power supply (5 KW) shall be provided by the Hospital Authority free of charge to the Contractor at one point for installation at site. Termination switchgear however, shall be provided by the Contractor. Further extension if required shall be done by the Contractor.
(ii) For this purpose, the power supply shall be given at the main incomer unit of the electrical panel to be provided by the Contractor. The termination of this feeder in the main incomer unit shall be the responsibility of the Contractor and nothing extra shall be paid on these account.
(iii) Unless otherwise specified in the contract, further power distribution to the various equipment's shall be done by the Contractor.
(iv) Where the power supply has to be arranged by the Hospital Authority at more than one point as per the terms of the contract, the termination of all such power feeders in the incomer of respective control panels to be provided by the contactor shall be the responsibility of the Contractor and nothing extra shall be paid on this account.
(v) The Contractor shall use the power supply only for the bonafied use of the work. No major fabrication work shall be done at site. Power shall be used only for welding/ cutting works. The power supply shall be disconnected in case of such default and the Contractor shall then have to arrange the required power supply at his cost.

Water Supply

Water supply source shall be made available to the Contractor by the Hospital Authority free of charge at only one point for installation. Further extension if required shall be done by the Contractor at his cost.

Drainage

Piping Connections from the equipment to the drain trap shall be done by the Contractor. These items of work shall be measured and paid as per contract.

1.13.6 Machinery For Erection

All tools and tackles required for unloading / handling of equipment and materials at site, their assembly, erection, testing and commissioning shall be the responsibility of the Contractor.

1.13.7 Quality of Materials and Workmanship

(i) The components of the installation shall be of such design so as to satisfactorily function under all conditions of operation.

(ii) The entire work of manufacture/fabrication, assembly and installation shall conform to sound engineering practice.

(iii) All equipment and materials to be used in work shall be manufactured in factories of good repute having excellent track record of quality manufacturing, performance and proper after sales service.

1.13.8 Care of the Building

Care shall be taken by the Contractor during execution of the work to avoid damage to the building. He shall be responsible for repairing all such damages and restoring the same to the original finish at his cost. He shall also remove all unwanted and waste materials arising out of the installation from the site of work from time to time.

1.13.9 Inspection and Testing

Initial Inspection and testing

Initial inspection of materials and equipment at manufacturer works may be done by the Employer's Representative or his representative. For item/ equipment requiring initial inspection at manufacturer's works, the Contractor will intimate the date of testing of equipment at the manufacturer's works before dispatch. The Contractor shall give sufficient advance notice regarding the dates proposed for such tests to the department's representative(s) to facilitate his presence during testing. The Employer's Representative at his discretion may witness such testing. Equipment will be inspected at the manufacturer/ authorised dealer's premises, before dispatch to the site by the Contractor.

(i) The department also reserves the right to inspect the fabrication job at factory and the successful tenderer has to make arrangements for the same.

(ii) The materials duly inspected by Employer's Representative or his authorised representative shall be dispatched to site by the Contractor.

(iii) No additional payment shall be made to the Contractor for initial inspection/testing at the manufacturer's works by the representative of the Employer's Representative. However, the department will bear the expenses of its representative deputed for carrying out initial inspection/testing.

Final Inspection and Testing

Final Inspection and testing will be done by the Employer's Representative or his representative as per details indicated in Technical Specification. The installation will be offered for inspection by local bodies (Chief Fire Officer). The Contractor or his representative shall attend such inspection of the Chief Fire Officer, extend all test facilities as are considered necessary, rectify and comply with all observations of the Chief Fire Officer which are part of the agreement and arrange for obtaining necessary clearance certificate in

favour of the department. In case the Contractor fails to attend the inspection and make desired facilities available during inspection. The department reserves the right to provide the same at the risk and cost of the Contractor and impose penalty for the same. The installation will be accepted by the department only after receiving clearance from Chief Fire Officer for the work executed by the Contractor under the agreement.

Safety Measures

All equipment shall incorporate suitable safety provisions to ensure safety of the operating personnel at all times. The initial and final inspection reports shall bring out explicitly the safety provisions incorporated in each equipment.

Completion Drawings

Three sets of the following laminated drawings shall be submitted by the Contractor while handing over the installation to the Department. Out of this one of the sets shall be laminated on a hard base for display in the fire control room. In addition, one set will be given on compact disc.

(a) Installation drawings giving complete details of all the equipment, including their foundations.
(b) Plumbing layout drawings giving sizes and lengths of all the pipes and the sizes and locations of all types of valves, and including isometric drawings for the entire piping including the pipe connections to the various equipment.
(c) Line diagram and layout of all electrical control panels giving switchgear ratings and their disposition, cable feeder sizes and their layout.
(d) Control wiring drawings with all control components and sequence of operations to explain the operation of control circuits.

1.13.10 System and System Requirements

FIRE FIGHTING SYSTEM:

Following types of water based fixed firefighting installations are normally provided in buildings.

(i) Wet Riser.
(ii) Down Comer.
(iii) Wet Riser cum Down Comer.
(iv) Automatic Sprinkler.

In all the above systems, lines are laid in and/or around the building and permanently charged with water from a pressurized supply. In a building any one system or a combination may be provided depending upon application of guidelines laid down in National Building Code of India (Part-IV) as amended up to date.

Municipal Regulation of the city will also be taken in to consideration while selecting and designing firefighting system for a building.

SYSTEM COMPONENTS:

Besides architectural and building provisions such as underground tank, pump houses, terrace tank, shafts for installation of internal hydrants, etc. fire fighting systems shall generally comprise supply, installation, testing and commissioning of components as detailed in technical specification.

ARCHITECTURAL PROVISION

For any firefighting system, underground tank and pump house are required. These may be located anywhere in the campus subject to proper approach. The pump house should be near the sub-station or as per the approved layout. Reflected ceiling plan shall be prepared indicating all services above false ceiling.

SYSTEM ENGINEERING:

The capacities and sizes of various components described above will depend upon the type and height of the buildings. Specifications of various components have been described in Volume V: Technical Specification. Following factors shall be taken in to consideration while designing various components

A. Wet Riser cum Down Comer:

The operating pressure of individual hydrant shall be 3.5 kg/cm2.At terrace level hydrant minimum 3.5 kg/cm2 pressure shall be maintained.
The pipe line will be designed in such a way that it should be possible to get discharge at any location. Design parameters shall be as under:-

(i) Maximum flow velocity - 2.5 mps.
(ii) Maximum Friction - 5 m. per 100 m. run

Main Fire Pumps (Both electrical as well as diesel) shall be selected for.

(i) Discharge - 1620 lpm/2280 lpm/2850 lpm.
(ii) Head - 35 m + Height of terrace level hydrant above pump level + 6% of the maximum length of pipe from pump discharge to any hydrant at terrace level.

Terrace pump shall be selected for

(i) Discharge - 450 lpm/900 lpm. (To be selected from Appendix *A')
(ii) Head - 35 m+ 6% of the maximum length of pipe from terrace pump to any hydrant at terrace level.

Pressurisation pump (Jockey Pump) shall be selected for

(i) Discharge - 200 lpm to 300 lpm depending upon size of installation.
(ii) Head - 35 m. + height of terrace level hydrant above pump level.

No. of Risers: Number of risers will be decided to fulfill the following conditions:-

(i) No corner of the building is farther than 30 m. from nearest riser.
(ii) The horizontal distance between two risers shall not be more than 50 m.

Normally one riser is provided for every 1000 sq.m. of plinth area or part thereof. However the number of risers can be suitably increased to meet the given situation.

The components of fire fighting shall be design and provided as per the direction of the EMPLOYER.

B. Fire Service Inlet:

In order to facilitate feeding of water in the system by fire service, a 2/3 way 63 mm dia collecting head shall be provided and connected with each riser/down comer and the ring main with non-return valve and butterfly/sluice valve. This should be located at a place where fire brigade tender can reach.

C. Fire Service connection:

In case underground storage tank is not approachable by fire tenders, a 4 way 63 mm diameter instantaneous male inlet connection is provided at street level and connected to UG tank with 150 mm diameter underground pipe.

D. Air vessel:

To counteract the water hammer effect, air vessels shall be provided one at top of each riser.

E. Orifice Plate:

To reduce pressure on individual hydrant to operating pressure of 3.5kg/cm^2, orifice plate shall be provided before connection of hydrant.

F. Alarm:

To indicate the flow of water in the system, turbine type alarm shall be provided outside the pump house in the main line before any connection is taken. The alarm will indicate the healthiness of the system and shall not be silenced till the main fire pump is in operation.

G. Control system:

The system shall be designed for operation automatically so that as and when water is drawn from the system through any hydrant, the pumps will operate automatically and

feed water in to the system. However once a fire pump start working, it will be stopped only manually (except jockey pump) or on account of any fault or non-availability of power supply to electrical pumps or low water level in UG/Terrace tank.
Facility shall also be provided for manual operation. A selector switch for auto/manual selection shall be provided in each pump.

The control system shall be designed to provide the following sequence of operation.

(a) The Pressurisation Pump shall maintain pressure in the system and shall operate only on account of slow pressure loss. In case of sudden pressure loss the Pressurisation Pump shall not operate. The pump shall start when the water pressure in the system falls to a pre-set value (about 0.35 kg/cm2 below normal system pressure) and shut down when the system pressure reaches the set value. Both limits shall be adjustable.

(b) Main Electric Fire Pump shall operate on account of sudden pressure loss. So long as Main Electric Fire Pump is working, other Fire Pumps will not operate. The pump shall start when the water pressure falls to a pre-set value in the system (about 1 kg/cm2)

(c) The Diesel Fire Pump will start on sudden pressure loss, only in case supply to Main Electric Fire Pump is not available or within a pre-set time the Main Electric Fire Pump fails to start or fails during operation. No other pump will be working when Diesel Engine Fire Pump is in operation. Audio-Visual Alarm shall be available to indicate failure of Main Electric Fire Pump. A three attempts starting facility will be provided for diesel pump.

(d) If within a pre-set time, the standby pump also fails to start or fails to develop pressure, the standby pump shall also be shut down and locked out. An audio visual alarm indication shall be given at the control panel.

(e) The Terrace Pumps will start on sudden loss of pressure only when both the Fire Pumps have either failed to start or exhausted water.

(f) Only one pump will be working at a time. In manual mode more than one pump can be started.

(g) Water level in UG and terrace tanks shall be monitored and in case of low water level, pumps connected with the tank shall not operate (even on manual mode) or stop operation as the case may be. An audio-visual alarm shall be given at the control panel.

H. Wet Riser:

In wet riser system all components described in technical specification and shall be provided except terrace pump. Terrace tank shall also not be required.

I. Down Comer:

In down comer, underground tank, fire pumps at ground level, ring main and yard hydrant

will not be provided. Except these items, all other items as described below and technical specification shall be provided. Following points are also to be taken in to consideration.
A minimum of two terrace pumps (electrical) shall be provided. One pump shall act as standby.
All down comer pipes shall be inter connected at the terrace level. In case terraces are not interconnected, all building will be treated as individual buildings.
Fire service inlet shall be provided with each riser for facilitating pumping of water from fire service tenders.

J. Automatic Sprinkler:

In addition to all provisions of Wet riser and Down comer system as described below, in automatic sprinkler system, water lines of various size are laid throughout the area to be protected and sprinkler heads are provided at regular interval so that water from sprinkler head cover the entire area under fire.
Lines for sprinklers may be separate or common with wet riser system depending upon type of building.
The area to be protected by sprinkler is divided in to various zones. For detecting operation of sprinkler in a zone. Flow switches are provided which are wired to an annunciation panel installed in the Fire Control Room. In the event of operation of sprinkler(s) in an affected area. The annunciation panel will give audio-visual alarm and indicate the affected zone. This arrangement will be independent of fire alarm system.

K. Static Water Storage Tanks:

In order to ensure satisfactory supply of water for the pumps of firefighting, static water storage tanks exclusively for the purpose of firefighting shall be provided. The tank shall be provided both underground and/or at terrace. The capacities shall be determined as per the standards given below or as approved by the EMPLOYER.
While deciding the capacities of underground and terrace tanks following points shall also be taken into consideration.

- In case common pump house and underground tank are to be provided for more than one building in a campus, the capacity of UG tank shall be increased, if required in consultation with local Fire Brigade.
- Arrangement shall be made for replenishment of water from alternative source at the rate of 1000 Itrs. per minute for underground tank. When this is not feasible the capacities of storage tanks (both underground and terrace tanks) shall be increased suitably in consultation with local Fire Brigade.

Following factors are to be considered for deciding the location of underground water storage tank.

(i) The tank shall be by the side of road so that fire brigade personnel can draw water from the tank or discharge water into the tank. Suitable manhole shall be provided for this purpose.

(ii) When the slab of the tank forms a part of pathway/drive way, it shall be designed to withstand the vehicular load of 40 tonnes.
(iii) Arrangement shall be made to replenish water by mains or alternative source.
(iv) Suitable arrangement shall be made to prevent stagnation of water in the tank. For this purpose, the tank of domestic or other water supply may be fed from the over flow of static water storage tank to ensure water level there in. Figure 7 may be referred to.
(v) The static water storage is meant for firefighting only and is not to be used for any other purpose except when the tank is to be cleaned.
(vi) There shall be no leakage in the tank.

Following factors are to be considered for deciding the location of terrace tank.

(i) The terrace tank should be easily accessible.
(ii) Connection to terrace pump shall be conveniently made.
(iii) The terrace tank may be of masonary, cement concrete, M.S. or plastic depending upon relevant considerations.

L. Pump House:

For installation of firefighting pumps (Main Electrical Pump, Diesel Engine Driven and Pressurisation Pump along with Electrical Control Panel) pump house is required. Following factors are to be considered:

(i) In order to provide positive (flooded) suction to fire pumps, the pump house shall be at a level below or equal to that of static water storage tank.
(i) The pump house shall be easily accessible for firefighting operations and at least 6 meters away from the building.
(ii) The pump house shall not be located in the building to be protected.
(iii) Water supply pump can be installed in the same pump house.
(v) The size of the pump house shall be not less than 6.0 m.(W) x 8 m.(L) x 3.5 m. (H).
(vi) If two electrical pumps are to be provided, the length of the pump house shall be not less than 12 m. If the water supply pumps are to be installed in the same pump house, then either the width of pump house be increased by 1m. or length be increased by 2 m. or suitably as is necessary.
(vii) Suitable ramp shall be provided for lowering the equipment in to the pump house. Stair case with entry door at ground level and locking arrangement shall be provided.
(viii) Ventilators at least 500 mm. high shaft be provided on three sides for natural light. Adequate Ventilation for dissipation of heat due to operation of motors/ engine shall be provided.
(ix) Proper water proofing shall be provided. A sump of size 0.6 m x 0.6 m x 0.3 m shall be provided in the pump house in one corner adjacent with the tank wall. The floor slope will lead towards the sump so that water leakage can be

pumped out. In order to ensure that there is no leakage of water in the pump house, no pipe/ cable shall cross the pump house below ground level. Suitable opening in wall above ground level shall be provided for crossing of pipes/ cables.

(x) Where it is not possible to construct pump house underground, the same may be constructed over ground. However automatic priming arrangement shall be made to ensure operation of pump without priming.

(xi) There shall be no beam under the floor of pump house

(xii) The floor of the pump house shall be designed for loading of 1500 kg/ sq.m. Foundation of pumps shall be raised over finished floor and in no case flooring or RCC walls shall be damaged while installing equipment in the pump house.

(xiii) The pump house shall be clearly marked by luminous sign.

(xiv) Terrace Pump is required for terrace. However, suitable enclosure for protection of pump is to be provided. The pump may be located in stair case if suitable space is available. The pump may be located near beam so that its load is not transferred to slab.

M. Internal Hydrant:

Internal hydrants are provided to fight fire from within the building. Following factors are considered for deciding location of internal hydrant.

(i) Internal hydrants are provided at every floor at the same location and connected with risers.

(ii) Numbers and location of risers shall be decided as per the design. Every wing of the building shall preferably be provided with independent hydrants. Hydrant shall be located in the center of the building so that one hydrant can cover area on both sides.

(iii) A masonry enclosure on three sides of size minimum 1200 mm wide and 800 mm. deep and 2100 mm. height shall be provided. Cut of size 200 mm. x 200 mm be provided in one comer in the slab for down comer/wet riser pipe. If sprinkler installations are to be provided additional cut out of similar size for sprinkler pipe and drain pipe as the case may be, shall be provided. Steel shutter with 1250 mm. glazing on top with locking arrangement shall be provided in front of the hydrant. The shutter shall be painted red as per the color coding practice.

(iv) Internal hydrant shall be easily accessible and provided near stair case. A clear space of at least 1.5 m. should be available in front of the internal hydrant for operation. Internal hydrant shall not be provided in a lockable room.

(v) Internal hydrant shall be clearly marked with the inscription of “FIRE HYDRANT" by luminous sign. Suitable lighting arrangement shall be provided in front of the internal hydrant.

Note: The sprinkler pipes are installed throughout the area to be protected. The structure shall be designed to support sprinkler pipes and the contained water. Inbuilt drainage with slope shall be provided throughout the area so that in the event of operation of sprinkler, water is drained out without spreading to other parts of the building. Storage racks/ platforms shall be sufficiently raised above floor.

FIRE CONTROL ROOM

For all buildings 15 m. in height or above, and apartment buildings with height 30 m. and above, a fire control room (size 4 m x 4 m Approximately) shall be provided on the entrance floor of the building. One store for keeping spares for fire fighting system shall also be provided adjacent with the fire control room.

APPROVAL OF LOCAL BODIES

In the building plans which are submitted to local bodies for approval, details of tire fighting system in the building are also indicated. The system should incorporate the recommendation of competent authority.

FIRE PUMPS

The pumps shall be centrifugal type direct driven with a 3 phase, 415 V + 10%, 50 Hz., A.C. motor. The standby fire pump shall be driven by diesel engine. The pumps may be either of horizontal split casing (HSC) type with operating speed not exceeding 1500 rpm, or solid casing with operating speed not exceeding 3000 rpm. as approved in the layout. The main fire pump and terrace pump shall be suitable for continuous operation in the system. The jockey pump shall be suitable for intermittent operation to built-up pressure in the system on account of leakage. The head and discharge requirements shall be as specified in the tender documents. The head shall be suitable for the system and shall take into consideration the pressure drops across the various components in the water circuit as well as the frictional losses. Pump shall be capable of discharging not less than 150 percent of the rated discharge at a head of not less than 65 percent with the rated head. The shut off head shall not exceed 120 percent of the rated head. The material and construction shall be as follows:

(i) The centrifugal pumps shall conform to IS 1520.
(ii) The pump casing shall be of heavy section close grained cast iron and designed to withstand 1.5 times the working pressure. The casing shall be provided with shaft seal arrangement as well as flanges for suction and delivery pipe connections as required.
(iii) The impeller shall be of bronze or gunmetal. This shall be shrouded type with machined collars. Wear rings, where fitted to the impeller, shall be of the same material as the impeller. The impeller surface shall be smooth finished for minimum frictional loss. The impeller shall be secured to the shaft by a key.

(iv) The shaft shall be of stainless steel and shall be accurately machined. The shaft shall be balanced to avoid vibrations at any speed within the operating range of the pump.
(v) The shaft sleeve shall be of bronze or gunmetal.
(vi) The bearings shall be ball or roller type suitable for the duty involved. These shall be grease lubricated and shall be provided with grease nipples/cups. The bearings shall be effectively sealed against leakage of lubricant or entry of dust or water.
(vii) The shaft seal shall be mechanical type, so as to allow minimum leakage. A drip well shall be provided beneath the seal.
(viii) The pumps shall be directly coupled to the motor/diesel engine shaft through a flexible coupling protected by a coupling guard.
(ix) The pump and motor/diesel engine shall be mounted on a common base plate fabricated from mild steel section. The base plate shall have rigid, flat and true surfaces to receive the pump and motor/diesel engine mounting feet. The pump will be perfectly aligned with the motor/engine so as to avoid any vibration during operation.

DIESEL ENGINE FOR FIRE PUMP

The diesel engine shall be suitable for automatic operation complete with necessary automatic starting gear, battery system and shall be complete with all accessories. Both engine and pump shall be assembled on a common bed place, fabricated from mild steel channel. The pump shall be only direct driven by means of a flexible coupling. Coupling guard shall be provided. The speed shall be 1500 RPM.

The engine shall be suitable to operate under the conditions of environment at site. The engine shall be multi cylinder/ vertical 4 stroke cycle, water cooled, 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 specified environment conditions. The engine rating shall be suitable to drive the pump at 150 percent of its rated discharge with at least 65 percent of rated head. The engine shall have 10% overload capacity for one hour in any period of 12 hours continuous run. The engine shall be suitable for cold starting for which suitable heaters shall be provided in lubricating oil. The engine shall develop full load within 15 seconds from the receipt of signal to start. The diesel engine shall conform to BS 649/IS 1601/15 10002, amended upto date.

PIPE WORK

Pipe sizes shall be as per standards and approved layout. The Contractor shall be responsible for selection of sizes as per detailed engineering to be done by him. Plumbing design to be done by the Contractor shall incorporate the following:

Butterfly/ sluice valves shall be provided at suction and delivery sides of pumps. (If positive

suction is not provided valve at suction is not to be provided).

For testing the system healthiness and automatic operation on daily basis, one test pipe with butterfly/sluice valve shall be provided in common discharge header. For avoiding wastage of water, this pipe shall discharge water in the tank.

Non return valve shall be provided at the delivery of each pump and fire service inlet. This shall be of swing type.

Air release valves with ball valve shall be provided in the piping system for venting trapped air with a size of 25 mm for pipes upto 100 mm and 40 mm for larger pipes. Plumbing drawings showing the sizes of pipe, valves, layout and other details shall be prepared and shall be got approved from the Employer's Representative before the execution of the plumbing work.

Pipes shall be of the following materials.

- Mild steel heavy class (C-class) conforming to IS:1239 for sizes upto 150 mm.
- Welded black steel pipe, class 2, conforming to IS: 3589, for sizes greater than 150 mm. These pipes shall be factory rolled and fabricated from minimum 6mm thick M.S. Sheet for pipes upto 350 mm dia and from minimum 7mm thick M.S. sheet for pipes of 400 mm dia and above.
- Cast iron double flanged class-'A' conforming to IS 1536 or IS:1537(to be provided only in underground application).
- GI Pipe medium class (B-class) conforming to IS:1239 (For Drain)
- Cadmium plated steel nuts/bolts/washers shall be used.

PIPE JOINTS:

Electric welding joints shall be provided in the M.S. pipe work. Flanged joints shall be provided for connections to valves, pumps, air vessels etc. and also on straight lengths at suitable points to facilitate erection and subsequent maintenance.

For connection of C.I.Pipe, fittings shall also be of C.I.heavy grade conforming to IS:1538. The flanges shall be smooth faced and neoprene gasket shall be provided. Where un-avoidable and to connect underground pipe with risers, M.S.pipe may be used in the form of distant pieces. The joint between C.I. and M. S.pipe shall be flanged type. M.S.pipe laid at such locations shall be provided anti-corrosive treatment.

VALVES:

Sluice valve conforming to IS:780 or butterfly valve conforming to IS:13095 shall be provided. All valves shall be suitable to with-stand 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), the direction of opening and closing shall be marked and an open/shunt indicator fitted.

The material of valves shall be as under:

Body - Cast iron

Disc - Cast Bronze or Stainless Steel

Seat - Either integral or Nitrile rubber

O-ring - Nitrite/ Silicon

STRAINERS

Stainless steel strainers shall have minimum 1 mm thick screen with 3 mm perforations. Strainers shall be provided with flanges.

ORIFICE PLATE

Orifice plate shall be made of 6 mm. thick stainless steel and shall have an identification tag projecting beyond any flange between which it is clamped. The orifice shall be plain central hole without burs and diameter not less than one-half of the internal diameter of the pipe to which it is fitted.

INSTRUMENTS

- Pressure gauge of appropriate range and 150 mm. dia size shall be provided.
- The pressure gauge shall be duly calibrated before installation and shall be complete with shut off valve.

AIR VESSEL

Air vessel shall be provided on top of each riser and shall be fabricated out of 8 mm. thick M.S. Sheet. The ends shall be dished. This shall be of 250 mm. dia, 1.2 m. high and installed vertically on suitable legs. The legs shall be provided with M.S.Plate of size 75 mm x 75 mm x 5 mm at the bottom so that the legs do not puncture the roof. The legs shall be grouted in CC foundation. Flange connection shall be provided for connection with wet riser pipe. Air release valve and pressure gauge with shut off valve shall be provided. The air vessel shall be tested at 25 kg/cm2 pressure before installation.

PRESSURE TESTING

All piping shall be tested to hydrostatic test pressure of at least one and a half times the maximum operating pressure, but not less than 10 kg./sq.cm. for a period not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Employer's Representative.

Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.

System may be tested in sections and such sections shall be securely capped.

Pressure gauges may be capped off during pressure testing of the installation.

ANTI-CORROSIVE PROTECTION ON UNDER GROUND PIPE

Corrosion protection tape shall be wrapped on M.S. Pipes to be buried in ground. This corrosion protection tape shall comprise of coal tar/asphalt component supported on fabric of organic or inorganic fibre and minimum 4 mm. thick and conform to requirement of IS: 10221-Code of practice for coating and wrapping of underground mild steel pipe line. Before application of corrosion protection tape all foreign matter on pipe shall be removed with the help of wire brush and suitable primer shall be applied over the pipe thereafter. The primer shall be allowed to dry until the solvent evaporates and the surface becomes tacky. Both primer and tape shall be furnished by the same manufacturer. Corrosion protection tape shall then be wound around the pipe in spiral fashion and bounded completely to the pipe. There shall be no air pocket or bubble beneath the tape. The overlaps shall be 15 mm. and 250 mm. shall be left uncoated on either end of pipe to permit installation and welding. This area shall be coated in situ after the pipe line is installed. The tapes shall be wrapped in accordance with the manufacturer's recommendations. If application is done in cold weather, the surface of the pipe shall be pre- heated until it is warm to touch and traces of moisture are removed and then primer shall be applied and allowed to dry.

PIPE SUPPORTS

For installing pipes vertically or horizontally inside the building standard pipe supports of reputed make shall be used. Following supports shall be used.

(i) Split pipe support clamps with rubber lining for vertical, horizontal and roof hanging.
(ii) C/evis Hangers for horizontal supports to adjust varying heights.
(iii) Sprinkler Hangers for horizontal supports for pipes from 15 mm dia to 150 mm dia.

Fasteners and fully threaded rods shall be used for installing the pipe supports. The sizes of pipe supports and installation shall be In accordance with manufacturer's recommendations. Some of the typical supports are shown in the Figure-9.For pipes of size 100 mm and above, with the prior approval of Employer's Representative, 'U' clamp with dash fastener may be used for supporting horizontal pipe from ceiling.

LANDING VALVE

Landing valves are provided in the system for connection of hose pipes for discharging water for fighting fire by fire brigade or trained personnel.

The landing valves shall be as per I.S.: 5290

The landing valves are of single and double head outlet types.

Material of construction

(i) Body, outlet and cap etc - Bronze or Aluminium alloy or stainless steel
(ii) Spindle - Brass for Bronze body, stainless steel for Aluminium alloy and

stainless steel body

(iii) Hand wheel - Mild steel or cast iron

The water discharge shall be not less than 900 lpm for single head and 1800 Ipm for double head valves at 7 kg/cm* pressure.

FIRST AID HOSE REEL

First Aid Hose Reel is meant for delivering small quantity of water in early stage of fire and can be operated even by untrained personnel, and thus provides a most effective firefighting facility. It consists of a length of 20 mm (nominal internal) diameter hose tubing warped around a reel with water inlet pipe, stop valve and shut off nozzle. The entire assembly is mounted on a wall bracket and can swing 180 degree. The water inlet is connected to the riser pipe by means of 37 mm socket and valve. The hose tube can be pulled out easily for the purpose of discharge of water on fire.

First aid hose reel shall be as per IS- 884. The coupling, branch pipe and nozzle shall be as per IS:8090.

Material of Construction –

1.	Hub and sides	:	Aluminium Alloy / Mild steel / Aluminium sheets
2.	Wall Bracket	:	Cast iron / Mild steel
3.	Hose tube (20 mm) (nominal internal dia)	:	Thermoplastic (Textile Reinforced) Type-2. as per IS-12585
4.	Nozzle with branch Pipe	:	Brass.
5.	Stop Valve(Ball Valve)	:	Gun metal

Normally M S construction is used. Other material may be used in areas having corrosive atmosphere.

The water flow rate shall be not less than 24 lpm and the range of jet shall be not less than 6 m.

First aid hose reels are installed with internal hydrant. Where space is not provided, first aid hose reel shall be installed in suitable size MS cabinet made from 2 mm thick sheet with glass door. The cabinet shall be painted red and the size of the cabinet shall be such that there is no obstruction in swinging the hose reel. The location of cabinet shall be such that it does not form an obstruction in passage/escape route.

The length of hose tube shall be such that the nozzle of the hose can be taken into every room and within a range of 6 M from any part of the room.

There shall be no obstruction in swinging the hose reel and should be installed above landing valve where provided.

The inlet valve shall be at 900 mm above floor level.

Hose reel bracket should be firmly grouted on the wall with the help of rawl bolts.

FIRE SERVICE INLET AND FIRE SERVICE CONNECTION

These are provided for connection of fire service hose pipes for either directly pressurising the system with their pumps or filling water in the tank from a distance. In the first case non return valve with butterfly valve shall be provided for holding water pressure. Fire service inlet shall be provided with each wet riser/down comer and the ring main. The arrangement has been shown in Fig. S. These are fixed to 150 mm dia pipe and located in MS Box made of 2 mm thick mild steel sheet with operable glass cover. These shall be as per IS: 904.

HOSE PIPES

Hose pipes shall be rubber lined woven jacketed and 63 mm in diameter. They shall conform to Type A (Reinforced rubber lined) of IS: 636. They shall be flexible and capable of being rolled. Length of hose pipe will be 15 m. Besides keeping hose pipe with internal hydrant and yard hydrant, spare hose pipes along with branch pipes shall be kept in fire control room/pump room.

AUTOMATIC SPRINKLER SYSTEM

Following standards shall be followed:

- IS: 15105: Design and Installation of Fixed Automatic Sprinkler, Fire Extinguisher Systems- Code of Practice.
- IS: 9972: Specification for Automatic Sprinkler Heads for Fire Protection Service.

ELECTRICAL WORK

Electrical works associated with firefighting installations, namely, motors, switch boards, power cabling, control wiring, earthing and remote control-cum-indicating panels. Following conditions to be followed:

- Unless otherwise specified in the tender specifications, all equipment and materials for electrical works shall be suitable for operations on 415 V / 240 V + 10%(3 phase/single phase), 50 Hz. AC system.
- All electrical works shall be carried out complying with the Indian Electricity Rules, 1956 as amended to date.
- All parts of electrical works shall be carried out as per appropriate CPWD General Specifications for Electrical works, namely, Part I (Internal) 2005, Part II (External) 1994 work, and Part IV (Sub-station), 1982 all as amended to date.
- All materials and components used shall conform to the relevant IS specifications amended to date.
- Power cable of adequate size shall be laid from the sub-station directly to the switch board of above pumps. Independent supply shall be provided for water supply pumps if installed in the same pump house. The power supply for firefighting is net to be used for any other purpose.

- If the fire pump house. is away from the sub-station building, the route of the cable shall not pass under the building or permanent structure. Cable shall be laid along the route which is safe from fire.
- Sufficient spare power shall always be available to drive pumping sets at all times throughout the year. Suitable capacity ACB/MCCB/Fuse Switches/Switch Fuses shall be provided in the electrical panel for extending supplies to fire pumps. Such switches shall be suitably marked with "FIRE SWITCH" and shall not be switched off without permission/intimation to appropriate authority. In case any maintenance work is to be carried out on the electrical panel where from supplies to fire pumps have been extended, alternative arrangement shall be made to ensure that power supply to fire pumps continue to be available for operation any time.

MOTORS

The motors shall be squirrel cage AC induction type. The motors shall be suitable for continuous duty and rating necessary to drive the pump at 150 percent of its rated discharge w:'th at least 65 percent rated head. The motor shall be totally enclosed fan cooled type confirming to protection clause \P 21 of IS:4691. The class of insulation shall be 'F'. The synchronous speed shall be 1500/3000 rpm as per requirement of the pump. The motor shall conform to IS:325.

MOTOR STARTER

The motor starter shall conform to IS: 1822 "Motor starters of voltage not exceeding 1000 volts" and shall be air insulated and suitable for 415 V, + 10%, 50 Hz. 3 phase AC supply and shall be integrated in the panel.

Starter for the motor shall be direct on line (D.O.L) for motors up to and including 7.5 H.P (indicative) rating and automatic star-delta type for motors of higher ratings unless otherwise specified in the tender specifications.

Each starter shall be provided with the following protections: -

(a) Thermal overload on all the three phases with adjustable settings,
(b) Independent single phase preventer (current sensing type).

Adequate number of extra NO/NC contacts for interlocks, indicating lamps, remote operation etc shall be provided on the starter/ contactor.

Under voltage/No volt trip shall not be provided.

SWITCH BOARDS

- The main switch board shall be floor mounted, free standing or wall mounted cubical type and shall be factory built fabricated by one of the approved switch board manufacturer. The board shall be fabricated from 2.0 mm. thick CRCA sheet

and powder coated after 7 tank treatment process. The board shall be fabricated with IP 42 degree of protection. It shall be suitable for termination of the incoming cable(s) from bottom.

- The capacity of switch gear shall be suitable for the requirements of motor fed/ controlled. Starting currents shall be duly considered.
- Switch fuse units shall be used upto and including 32A and SDFU shall be used for 63A and above. ACB shall be used for 630A and above ratings. Alternatively MCCBs of appropriate fault level may be provided.
- All switch fuses/SDFU shall be of AC 23 duty as per IS: 4064-1978 as amended upto date. They shall be complete with suitable HRC cartridge type fuses.
- Switch boards shall house starters for motors with independent current sensing type single phase preventer for each starter.
- Volt meter with selector switch, a set of indicating lamps and fuses for voltmeter and lamps shall be provided. Ammeter with CTs, and selector switch shall be provided with each motor starter. Instruments shall be flush mounted with the panel and have a class index not higher than 1.0. The instruments and accessories shall be provided whether or not specifically indicated in the tender specifications.
- The fabrication of switchboard shall be taken up only after the drawings for the fabrication of the same are approved by the Employer's Representative.
- Switchboards shall be fabricated as per specifications indicated in sub-para above.
- The layout shall be designed for convenient connections and inter-connections with the various switchgear. 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.
- Care shall be taken to provide adequate clearances between phase bus bars as well as between phase bus bars, neutral and earth.
- Where terminations are done on the bus bars by drilling holes therein, extra cross section shall be provided for the bus bars. Alternatively, terminations may be made by clamping.
- Provision shall be made for proper termination of cables at the switchboards such that there is no strain either on the cables, or on the terminators. Cables connected to the upper tiers shall be duly clamped within the switchboard.
- Identification labels shall be provided against each switchgear and starter compartment, using plastic/aluminium engraved labels.
- Metallic danger board conforming to relevant IS shall be fixed on each electrical switchboard.

SYSTEM CONTROLLER

For controlling operation of pumps and indicating fault, system controller shall be provided. The system controller shall consist of relays timer, contactors etc and shall be designed to

operate the fire pumps with interlocking and fault indication as described in Para 2.4.1.14. Annunciation window shall be provided to indicate following faults.

- Low water level in UG tank
- Low water level in terrace tank.
- Main pump failed to start.
- Main pump failed during operation.
- Diesel pump failed to start.
- Diesel pump failed during operation

Suitable sensors, differential pressure switches, monitors shall be provided at respective location. The control system shall be operational on 12 Volt/24 Volt DC batteries of engine starting. Battery chargers shall be provided to ensure that the batteries remain, charged. Batteries shall be sealed maintenance free type.

REMOTE INDICATING PANEL

- The remote indicating panel shall be provided in the fire control room. This panel shall have necessary status indication of all electric motors.
- Back indication to show the status of operation of all the motors and also pressure in the system, water level in underground and overhead tank etc. shall be provided.
- Panel shall be fabricated from not less than 1.6 mm thick CRCA sheet and powder coated after 7 tank treatment process. The panel shall be dust, damp and vermin proof. This shall be of wall mounting type. This shall be complete with necessary termination arrangements, multicore cables, tag blocks, control transformer, designation plastic labels, double earth studs etc. as required.

POWER CABLING

- Unless otherwise specified, the power cables shall be XLPE insulated, PVC outer sheathed aluminium conductor, armoured cables 1100 V grade. The power cables shall be of 2 core for single phase, 4 core for sizes upto and including 25 sq.mm, 3-1/2 core for sizes higher than 25 sq.mm for 3 phase.
- Alternatively, XLPE/PVC insulated copper cable (single core/multicore un-armoured) of grade 1100 V shall be used.
- Power cables shall be of sizes to meet the starting and running current of motors fed and shall be as approved by the Employer's Representative, after taking into consideration the load, the length of cabling.
- Cables shall be laid in suitable metallic trays suspended from ceiling, or mounted on walls. Cable ducts shall not be provided in pump rooms. Cable trays shall be of perforated steel sheet with adequate structural strength and rigidity. Necessary supports and suspenders for cable trays shall be provided by the Contractor as required.

CONTROL WIRING

- Control wiring shall be done using ISI marked PVC insulated and PVC sheathed, 2.5 sq.mm, 250 V grade, armoured multi-core copper conductor cable. The control cable shall also be laid in the same manner as power cable.
- The number and size of the control cables shall be such as to suit the control system design adopted by the Contractor.
- Runs of control wires within the-switchboard shall be neatly bunched and suitably supported/clamped. Means shall be provided for easy identification of the control wires.
- Control wiring shall correspond to the circuitry/sequence of operations and interlocks approved by Employer's Representative.

EARTHING

- Provision of earth electrodes and the type of earthing shall be as specified in the tender specifications.
- The earth work shall be carried out in conformity with CPWD Specifications for Electrical works (Part-I), Internal 2005.
- Metallic body of all motors, medium voltage equipment and switch boards shall be connected by two separate and distinct earth conductors to the earth stations of the installations. Looping of such body earth conductors is acceptable from one equipment, or switch board to another.
- The size of earth conductors for body earthing of equipment shall be 2 Nos. 6 mm dia copper wire/2 Nos. 25 x 3 mm G.I. strip
- Armouring of cables shall be connected to the body of the equipment/switch board at both the ends. Compression type glands shall be used for all such terminations in the case of PVC cables.

PAINTING

All panels shall be supplied with the manufacturer's standard finish painting or as approved in the layout.

1.14 MEDICAL GAS PIPELINE SYSTEM

Medical Gas Pipeline System (MGPS) is installed to provide a safe, convenient and cost effective system for provision of medical gases to the clinical and nursing staff at the point of-use for patients. It reduces the problems associated with the use of gas cylinders such as safety, storage and noise.

1.14.1. Scope of Work

The Contractor shall carry out Design, Engineering, Supply, Installation, and Testing & Commissioning of Medical gas Pipeline System.

The system comprises of:

1. Secondary Oxygen Manifold and Emergency oxygen manifold with automatic control panels
2. Nitrous Oxide Manifold and Emergency NO2 Manifold with automatic control panel
3. Medical Air Supply System (4 Bar & 7 Bar) complete.
4. Medical Vacuum (suction) Supply System Complete.
5. Distribution Piping Complete with Accessories.
6. Area Valve Service System.
7. AGSS system Complete
8. Alarm Systems (Master & Area)
9. Gas Outlets with Probes
10. Bed Head Panels
11. Other associated & Optional works

1.14.2. Responsibility of Contractor

1. The Contractor shall be responsible for complete design, supply, installation, testing and commissioning including Civil Modification works, demolition and construction as applicable. The Contractor are required to survey the site before furnishing the quotations.
2. The Contractor shall execute all required civil, electrical, plumbing, fire safety, false ceiling trap door/ cutout and repair (if any) and other works as maybe required for complete installation and trouble-free functioning as a part of the ‘Civil Modification’.
3. Hospital will provide one-point electrical supply with isolator and an earth strip in the plant. The internal wiring and earthing, has to be done by the Contractor.
4. Control panel for Vacuum system and Air plant system has to be supplied by the Contractor.
5. The Contractor will be responsible for other associated work related to installation and commissioning of complete MGPS system.
6. The Contractor has to terminate/ interconnect all the medical gas lines up to/to the OT/MOT.
7. Installation and commissioning of area valve service unit and alarm unit for the operation theatre shall be done by the Contractor.

8. Medical gas pipe line inside the minor operation theatre has to be done by the Contractor.
9. The Contractor shall be responsible for the complete works including the submission of working drawings, and isometric views, detailed work schedule and materials. The Contractor shall be responsible for design, supply, installation, testing and commissioning of medical gas supply system in coordination with respective institute authorities & the EMPLOYER.
10. The Contractor shall be responsible for free maintenance of all component of Gas pipeline system during warranty period including all filters & consumables.
11. The Contractor shall provide factory test certificates for the materials used. The Contractor should supply complete set of part manuals, service manuals and user manuals for all the systems and subsystems supplied. Final electrical safety test, system test, leakage and calibration should be done by authorized persons using calibrated test equipment as per standards.
12. The Medical Gas Pipe Line System must follow Single Standard any one only from: NFPA 99c/HTM 02-01/ ISO 7396-1/DIN/EN except Copper Pipe, For AGSS Venturi type is not acceptable.
13. All Gas Outlets in MOT (i.e. O2, N2O, MA4, MA7, Vacuum, CO2 (if required), etc.) will come with OT Pendants (Under MOT Tender) The Contractor has to provide pipe lines up to all MOTs (if required)
14. The Contractor shall co-ordinate with respective Departments Head for their final Gas Outlets requirement per bed in their wards and should incorporate the same in drawing.
15. Control Panels & Manifold for O2, N2O &CO2, Medical Air Plant, Medical Vacuum Plant, AGSS Plant, Area & Master Alarm, All types Outlets, Oxygen flowmeter, AVSU, Line Isolation Valves, High Pressure Tubes shall comply with HTM 02-01/NFPA99C/DIN/EN/ISO-7396-1 standards and bidder should submit applicable certificates along with the bid.
16. The third-party compliance certification after installation to be done for the standard followed i.e. HTM 02-01/NFPA 99C/DIN/EN/ISO-7396-1 except copper pipe from the authorised agency. The cost for the same will be borne by the Contractor.
17. The Contractor must have a satisfactory installation of complete MGPS as per any international standard as asked in tender and demo may be taken for the same.
18. The Contractor will be provided after award either AutoCAD or PDF or hard Copy of building Layout drawing for preparation of MGPS drawings.

1.14.3. Standards

Medical gas pipeline system design installation, testing, commissioning activities should be compliance in line with the current HTM 02-01/NFPA 99C/ DIN / EN / ISO-7396-1 standards as specified in the specification

1.14.4. Material Description

All the copper pipes and necessary fittings should be from the reputed approved makes with necessary test certificates from third party or OEM Copper pipe must have reputed third party inspection certificate (E.g. Lloyd's or TUV or SGS).

Pipe fixing clamps shall be of nonferrous or non-deteriorating plastic suitable for the diameter of the pipe.

All the pipes from manifold/plant up to the outlets should be painted with two coats of synthetic enamel paint and colour codification should be as per standards followed and with consultation with competent authorities of the Institute.

1.14.5. Quality Standards and Records

a. All the components of MGPS should have the factory acceptance report during delivery at consignee end
b. Third party material test report to be submitted after delivery of the material when required as decided by the EIC
c. Necessary material arrival and utilization records should be maintained

1.14.6. Standard Execution Process

a. Execution drawing approval along with coordination drawing
b. Material sample approval, if necessary, the existing contract procedure should be adapted.
c. Pre-despatch/ Post-despatch inspection should be done as per the Design Basis Report.

1.14.7. Work Completion and Handing Over Process

As built drawings with coordination drawings should be submitted along with all necessary user manuals, do's and don'ts instructions, operation manuals and installation report

1.15 MODULAR OT

1.15.1 Scope of Work

a. The Contractor shall execute civil, electrical, plumbing, air-conditioning system and other works as required for complete installation by the dedicated agency and smooth functioning of the operation theatres. The power requirements considering the electrical load of the equipment for the OT shall be provided by the Contractor at one point to be identified in the OT at the time of execution.

1.16 ADDITIONAL REQUIREMENTS

In addition to the above requirements, the Contractor shall ensure compliance of the following requirements upto the satisfaction of Authority/EMPLOYER.

1.16.1 Additional Requirements 1

Building – 1– Main Block

1. The MRI room is located close to the lift lobby in the ground floor. As per rules, the lift should be installed at least 15m away from the magnetic iso-centre of the MRI unit. Relocation as necessary shall be done, care shall be taken to see that this condition is followed in execution.
2. The width of console room of MRI and CT scan may be increased to 5m since this room will be jointly used for CT and MRI. The door sizes may be increased as per standards.
3. The UG tanks for firefighting, drinking water, flush water and rain water harvesting should be included in the drawing.
4. The main entrance of the hospital building shall have entrance of minimum size of 2.4 meters by 2.4 meters with security arrangements.
5. The height and clearances of ELV and Electrical rooms may be changed as per standards.
6. All service shafts, including Electrical, HVAC, Plumbing, ELV, MGPS, and Fire, should be specified in the drawing. The MGPS and ELV shafts can be in a centralized location as far as possible.
7. The size and capacity of service lifts should be mentioned. All lifts should be machine room less.
8. The capacity of the Overhead water tanks should be as per NBC standards.

MEP Works

The MEP installation should be highly energy efficient, satisfy power quality requirements, and be cost-effective. The following shall be considered:

A. Electrical

1. The light fittings shall be highly energy-efficient and shall satisfy the power quality requirements. The lighting design shall comply with ECBC+ Building requirements maintaining hospital lighting Standards.
2. BLDC fans shall be proposed with good service value to enhance energy efficiency conforming to IS 374. The minimum power factor and the service value shall be 0.90 and 6.86 respectively.
3. All the pumps, motors, etc. shall comply with ECBC+ Building requirements. If VFDs are used, they shall comply with the latest version of IEEE 519 power quality requirements.
4. Panel boards shall comply with IS/IEC 61439 Standards maintaining the form of construction 3B or above. The panel boards shall be design-

verified and OEM certified. The Contractor shall submit the GAD and get it approved by competent officials before fabrication. Apart from the electrical parameters, the constructional requirements shall also be verified and confirmed.

5. The transformer shall comply with all the relevant Standards and match the ECBC/BEE requirements at the time of submission of the tender.
6. The DG sets shall comply with the latest ECBC requirements. Ensure that the products confirm the BEE requirements
7. Ensure that the transformer(s), DG set(s), APFC panel(s), LT panel(s), BBT, cable etc. are optimally rated. The transformer and DG sets shall be loaded at least to 70% of their rated capacity when commissioned for better energy efficiency.
8. Optimally rated UPS in N+1 configuration shall be installed and loaded to 70% of its rating for better energy efficiency when commissioned.

B. HVAC

1. The chiller shall satisfy the requirements of ECBC/ IBGC.
2. Sizing of the chiller shall be optimal
3. VFD for chillers, pump motors, cooling towers, AHUs, etc., shall comply with the requirements of IEE 519
4. It will be ideal if 5-star rated chillers are used for better energy efficiency.
5. Pumps, motors, etc. shall comply with the super ECBC Building requirements of the ECBC
6. Cooling tower, AHUs, etc., shall be with IE3 or better-rated motors
7. Insulation for chilled water lines shall satisfy the ECBC+Building requirements.
8. The ‘R’ value of insulation for ductwork and plenums shall satisfy the ECBC requirements.
9. The HVAC system as a whole shall be designed and installed to satisfy the highest level of energy efficiency as per ECBC/ ECSBC.
10. Chiller plant room shall be on first floor of service block.

C. LIFTS

1. Lifts installed should satisfy all the latest Standards.
2. Special emphasis on energy efficiency, drive quality, safety of electronic equipment, compliance to fire rating, etc., shall be complied with.
3. The selection of materials for car enclosure and landing doors shall be so selected for longevity and fire rating.
4. It shall be ensured that wiring inside the shaft shall be done through PVC/metal conduits or metal troughs. If this is not done, an arc fault detection device (AFDD) shall be installed for each lift.

D. FIRE PROTECTION SYSTEM

1. The proposal shall be based on requirements as per NBC

2. Conventional pumps and motors shall be proposed for electric-driven main fire pumps
3. Propose energy-efficient pumps and drive motors for jockey pumps

E. ELV

1. State-of-the-art solution shall be proposed for the ELV installation
2. Necessary inputs from the client department shall be obtained before finalizing the proposal.
3. If possible, a solution for paperless functioning shall be considered.

F. MGPS

1. This shall be based on the latest standards
2. Best-quality equipment and machinery proposed shall be proposed
3. Local service backup shall be ensured for the equipment and machinery with ease of availability of spares.

G. BMS

1. BMS shall be proposed only if it makes substantial savings in energy consumption
2. After-sales support of the BMS system shall be ensured for efficient functioning and utilization.
3. Obsolete components or components which are proposed to be withdrawn within a short period shall never be used.

H. Solar PV installation

1. The latest technology solar PV panels with high efficiency should be proposed.
   The solar inverters should conform to the requirements of KSEB.

1.16.2 Additional Requirements 2

Main block :

1. In casualty the change rooms entry (before change) and exit (after change) shall be rearranged to provide a unidirectional plan for the OT complex.
2. Public access for Casualty visitors to the main lobby without transversing the radiology department shall be provided. An access can be created by connecting Casualty Waiting with the corridor below the Building Ramp, provided the ramp starts from Left side upwards.
3. Entrance ramp should be provided for decontamination room.

4. The Plumbing duct down to Ground Floor (between CT Scan and Casualty Nurse Station) can be diverted on First floor terrace slab and combined with other ducts (to avoid space issues & maintenance problems).
5. A door also needs to be located between the Casualty and Radiology.
6. Distance between Lift core and MRI magnet should be at least 8 meters to avoid electromagnetic interference (EMI)
7. MRI Anteroom shall be provided with sufficient entry width and turning radius for the machine. Plumbing lines of wash basins above MRI should run along the wall and there should be no core-cut above MRI.
8. Sonography can be relocated inside the radiology department and the AHU, UPS Servers can be placed across the public access corridor to avoid splitting of the department.
9. Dialysis beds should be arranged to avoid RO water pipeline bends especially with reference to intruding columns.
10. Dialysis for Positive patients should be segregated with Positive wash area and catheter storage.
11. Dirty utility room is required for dialysis
12. For the 30 bed wards provide partitions like half height wall (with or without glass above) along the corridor for each 06 bed unit.
13. WCs and Bath shall be provided as per 1:5 & 1:10 norm for the wards.
14. Narrow corridor towards the Nurse Duty Room can be avoided.
15. Pantry to be added for the 36 bed wards.
16. In Chemotherapy ward 1, Medicine Preparation can be relocated to allow more natural light into the ward.
17. In Chemotherapy ward bath rooms are not required.
18. Duty Doctor and Nurses rooms should be mirrored with Treatment & Store Room to provide ventilation for the former rooms.
19. Dirty utility room is required for chemotherapy.
20. Room for AHUs warrant that the ducting be taken from outside the building as cut-outs over the OT Room are avoided and cannot be made in the corridor leading to fire staircase. For ICU review AHU room size as two nos. are required.
21. Both Isolation rooms for ICU should have separate ante-rooms.
22. Decentralized Sterilization units to be planned in Dental and ENT OPDs.
23. At least one Indian WC (Orrisa Pan) should be planned in all Toilet Blocks.
24. Staff Change Rooms with lockers and washrooms and staff dining shall be planned as per requirement.
25. The service lift ducts are to be provided in main block and service block.
26. Provision for windows/ cross ventilation shall be unsured for all rooms.
27. Every floor should have a Janitor’s room.
28. Stress relieving spaces like indoor landscapes, open courtyards, gathering spaces should be included.
29. Relocation of drinking water facility near the ramp area can be considered.
30. Rooms can be arranged to maximize direct ventilation.

31. Ducts can be provided for lifts to increase operational efficiency.

Electrical Engineering System Design :

1. The capacity of UPS and its backup time for OT should be in line with KEI / NBC norms.
2. Equipment such as hand held unit for EPABX, TV monitor etc. should be provided.
3. Minimum requirement of power amplifier, number of speakers, call back facility (feedback) etc. should be provided.
4. Minimum storage capacity should be provided for CCTV as per statutory requirement for CCTV system.
5. Control room with sufficient number of monitors for ELV system should be indicated.
6. No monitoring for Substation & DG sets is required under BMS system as the same is covered with SCADA under substation automation.
7. Proposal for External electrification arrangements such as yard lighting, parking area lighting, interior road lighting, Lighting in around periphery of hospital premises shall be provided.
8. Minimum capacity of solar panel should be mentioned.

PLUMBING AND FIRE PROTECTION SYSTEMS

1. Sewage Treatment and Waste Disposal Mechanism: Wastewater containing chemicals shall be collected separately and treated in an Effluent treatment plant and disposed of safely as per KPCB standards. The treated ETP effluent shall not be mixed with STP influent.
2. Details of the dead-end corridor shall be provided in the drawing.
3. Provide sink in Plaster room, Procedure room and nurses station.
4. Provide sink and sluice sink in dirty utility
5. Provide bath in Duty Doctor and Nurse's room
6. Identify Plumbing ducts.
7. Show plumbing fixtures in toilets.
8. Show water demand calculations and check the capacity of OHT and UG Sump.
9. Identify Fire ducts.
10. The Fire stair, Main stair and Fire lift shall be marked in the drawings.
11. Fire exits shall be planned with a door opening towards egress.
12. For small individual toilets, the floor slab shall be sunk by 10 cm and for group toilets by 15 cm. The sinking is to accommodate dip and surface slope. The slab shall have openings and drainage pipes are clamped to the ceiling below. If additional sinking is required the same shall be indicated in the drawings. Wet area shall not be proposed over, OT, ICU, CT, MRI etc.

13. Beams inside toilets shall be cast such that its top is flush with the top of the sunken floor slab.
14. Plumbing Duct size shall be 1,200 x 800 mm clear. There shall be no protrusion of beam or column into the ducts.
15. All ducts shall open to the terrace.
16. All ducts shall have duct doors. The window near the duct shall be openable. Arrangements shall be provided for a person to descend and enter the duct during maintenance. Epoxy coated steel rungs shall be planned inside ducts at appropriate places.
17. On the ground floor, the plinth beams in the toilet area shall be cast 35cm lower to lead the drainage pipes to the yard without disturbing the beams.
18. Pile caps shall be cast at a sufficiently lower level. This is to lay the drainage pipes below the ground and construct gully traps close to the building.
19. The present gap between the ramp and the wall of the building is only 1.5 m. This is insufficient for constructing gully traps and manholes. Hence increase it to 2 m or above. Also, cast the pile caps at a lower level to build manholes above it.
20. At present there is a wet area above the portico/entrance. They shall be relocated
21. The OHT shall be planned high to enable water flow under gravity with the required pressure.

Statutory Clearance

1. Clearances from Fire Safety, Pollution Control Board, KSEB, LSGD/Municipality, State Electrical Inspectorate, KWA, Environmental Clearance, EIA, IGBC, Ministry of Civil Aviation, etc shall be obtained prior to the commencement of work.
2. Kerala Municipality Building Rules are strictly to have adhered to for the construction and implementation of this project.

1.17 MAKES OF MATERIALS

All procurement shall be done is accordance with G.O. No. P-45021/2/2017-PP (BE-II) Government of India, Ministry of Commerce and Industry Department for Promotion of Industry and Internal Trade dated 16.09.2020. Acceptable makes of materials to be used in the work are enclosed. After the approval of EMPLOYER, the Contractor can use any material which are BIS approved and manufactured by ISO certified company conforming to the Technical Specifications as per Section-VII. Non BIS marked materials may be permitted by the EMPLOYER only when BIS marked materials are not manufactured.

CIVIL

Details of Materials	Makes
Reinforcement Steel (TMT – Fe500D/ Fe550D)	SAIL, Tata Steel, Rashtriya Ispat Nigam Ltd. (RINL), Jindal Steel & Power Ltd/Equivalent
White Cement	Birla White, J.K. White/ Ultratech/ Lafarge/ Travancore/Equivalent
Grade- 53 Ordinary Portland Cement / Portland Pozzolana Cement	ACC-Ambuja, J.K. Cement, Bharathi, RAMCO, Ultratech, Coromandel/Dalmia/Equivalent
Tubular truss /Structural Steel	SAIL, Tata Steel, Rashtriya Ispat Nigam Ltd. (RINL), Jindal Steel & Power Ltd. /Equivalent
Polycarbonate sheet	GE Platic, LEXAM/Equivalent
Decking steel sheet	Ezydec of TATA /Lloyed Superdeck / Multi Color/Equivalent
Vitrified tiles	Somany / Kajaria / OrientBell/ Nitco/ RAK/ Cera/ Simpolo/ AGL/Equivalent
Ceramic/Glazed tiles	Somany / Kajaria / OrientBell/ Nitco/ RAK/ Cera/ Simpolo/ AGL/Equivalent
Heat resistant tiles	Thermatek / Orient/ Starshield/Equivalent
Chemical emulsion for anti-termite treatment (Chloropyriphos emulsifiable concentrate)	Dursban 50 TC / Terrrashield 50 TC / Tafaban/ Bayer /Equivalent
Distemper/Paints Plastic Emulsion Synthetic Enamel Oil Bound Distemper Steel Primer Wood Primer Exterior waterproofing paint Wood finish (Melamine & PU Polish)	Asian/ICI/ Berger/ Nippon/ Nerolac/ Indigo/ Jotun Asian/Berger/Nerolac/ ICI/ Nippon/ Shalimar/ Jotun Asian/Berger/Nerolac/ ICI/ Nippon/ Shalimar/ Jotun ICI/ Nerolac/ Berger/ Asian Paints/ Jotun ICI/ Nerolac/ Berger/ Asian Paints/ Jotun Polydeck/ Dr. Fixit/ Asian/ Nippon/ Fosroc/ Berger/ Nerolac/ Jotun Asian/ Sheenlac/Waxpol/ Jotun
Curing compound	Fosroc/ Sika/ Cico/ Dr. Fixit/Equivalent

Details of Materials	Makes
Anti-Corrosive epoxy paint (For Concrete surface)	BASF/ Fosroc/ Sika/ Jotun/ Asian/ Pidilite/ Epoke/Equivalent
Anti-Corrosive epoxy paint (For steel surface)	BASF/ Fosroc/ Sika/ Asian// Jotun/ Pidilite/ Epoke/Equivalent
Textured paint	Unitile products / Heritage (Bakelite Hylam Ltd) / Spectrum / Jotun / Asian/Equivalent
Adhesive	Sika/ Fosroc/ Fevicol/ MAPEI/Equivalent
Wood Work Ply board/ Plywood Laminate Laminated Particle Board Veneer Ply Flush Door (Pine Filled) Locks Anodised Aluminium fittings for door & windows Door closer Floor springs	Merino / Green / Century / Kitply/ National Plywood Merino / Green Lam / Century Merino / Green Merino / Green / Century Merino / Green / Century / Kuttys Godrej/Golden/ Indo brass /Dorma /Dorset/Ozone/ Harrison Nu-lite /Argent / Classic (heavy duty) Everite/ Prabhat / Door King/ Hardwin/ Godrej/ Dorma/ Dorset/ Ozone Sandhu / Prabhat / Door King / Hardwin/ Godrej
Factory pressed Laminated doors	Merino / Green / Century / Kuttys/Equivalent
Inherent Fire-Retardant Fabric	Trevira CS fabric of RSWM Ltd. /Equivalent
Fire retardant paint	Nullifier / Signum / Godrej/Equivalent
Steel Fire rated doors	Navair / Godrej / Promat/Equivalent
Non hermetically sealed HPL finish swing/Sliding doors	Dorma/ Metaflex/Equivalent
Non hermetically sealed Stainless Steel swing/Sliding doors	Dorma/ Metaflex/Equivalent
Hermetically sealed HPL/stainless Steel automatic Sliding doors (BMT)	Dorma/ Metaflex/Equivalent
Wooden Fire rated Doors	Navair / Signum / Abacus/Equivalent
Fire rated vision Panels	Pilkington, Schott, Ferilite, Saint Gobain/Equivalent
Fire rated hardware	Dorma / Becker F S / Assaabloy/Equivalent
Skylight – Thermoform	Mccoy Architectural System, Vergola, Abucob/Equivalent
G.I. Steel door frame	Kutty Doors, Shakti Metdoor, Navair, Romat, Synergy Thrislington. /Equivalent
Friction Stay Hinges	Earl-Bihari, Ebco, Rotto, Cotswold, GU, Dorset. /Equivalent

Details of Materials	Makes
Steel Windows/ Pressed Steel frames	San Harvic, Steelman Industries, PD Industries, Metal Windows, Bhawani / Ganpati Udyog (Rajpura) / JMD Steel/ TATA Parvesh/Equivalent
Paver block & Kerb Stone	Nitco/ Unitile/ NTC/ Ultra/Equivalent
Glass Mosaic Tiles	Italia / Opio / Mridul/Equivalent
Wood Adhesive	Jivanjor / Fevicol / 3M /Equivalent
Tile Adhesive	ARDEX Endura / Fibrex / Pidilite / BASF /Equivalent
Grouting Compound	ARDEX Endura / Pidilite / Laticrete / BASF / Fibrex/Equivalent
Mosaic tiles	NITCO / Modern / NTC / GICO/Equivalent
Dash/Anchoring FASTENERS	HILTI / Fischer / Excel/Equivalent
High performance Epoxy based resin anchor system	BASF / Fosroc / Fibrex/Equivalent
Nuts/Bolts & Screws	GKW / Atul/Equivalent
Dholpur / red sand stone	Gang saw cut from Bansi Paharpur Quarry/Equivalent
Aluminium sections for doors & windows etc.	Jindal / Hindalco/Equivalent
Hardware fittings for Aluminium windows & doors	Powder coated fittings of Pulse make (LGF SYSMAC INDIA)/ ALUTEC/ Dorma/Dorset/Ozone/Equivalent
Polyster Powder Coating Shades	Nerolac/ Berger/ J & N/Equivalent
Metal ceiling	Hunter Douglas / Aura (ASIPL) / CKM / Amstrong/Equivalent
Mineral Fiber Ceiling	Armstrong / OWA / CKM/Equivalent
Extruded Polystyrene sheet (XPS)	Dow Corning / Supreme/Equivalent
Aluminium Composite Panel	ALUCOBOND / REYNOBOND / ALPOLIC/Equivalent
Specialised agencies for Aluminium glazing / Structural glazing / Aluminium door & windows / ACP work.	Bharat Archimetal / Green Façade Solution / AGV Alfab /Equivalent
Silicon sealant	GE / Dow corning /Equivalent
Solvent based silicone repellent coating	PIDILITE / Fibrex / BASF/Equivalent
PVC Continuous fillet for periphery packing of Glazing	Roop / Anand / Forex/Equivalent
Backer Rod	Supreme Industries Ltd. /Equivalent
Anti – static vinyl flooring	ARMSTRONG / TARKETT / FORBO/Equivalent
Anti – static homogeneous PU flooring	BASF / Fibrex/Equivalent

Details of Materials	Makes
PU flooring	BASF / Fibrex/Equivalent
Float Glass	Modi Glass / Saint Gobain Glass /Equivalent
Reflective Glass	Saint Gobain / Asahi (India) /Equivalent
Hermitically sealed performance glass & Toughened Glass	Saint Gobain, Asahi/Equivalent
Glass processor for making DGU/ Toughening (with Uniglass European Furnance)	AIS (Roorkee) / Sheesh Mahal Tuff Glasses Pvt. Ltd. (Rohtak) / Bala ji safety glass (Bangalore) / Fishwa Glass (Mumbai) /Equivalent
Looking glass / mirror	Saint Gobain / HNG / Modi Guard/Equivalent
Vertical / Venetian Blinds	Mac Décor / Vista Levealor / Neha's Touch / Cape Décor/Equivalent
Stainless Steel Railing, Accessories etc.	Jindal / Dorma / Geze/Equivalent
Gypsum Board	India Gypsum / Lafarge Boral/ Asian/Equivalent
Pre-coated Galvanised sheets	Multicolor / Interarch/ JSW/ Jindal/Equivalent
Wall Putty	JK / Birla / Berger/ Asian/Equivalent
Floor hardener	PIDILITE / Fosroc / Sika / BASF / Fibrex/Equivalent
Polysulphide Sealant	PIDILITE / Fosroc / Sika / BASF / Fibrex /Equivalent
Expansion joint treatment	Technocrats / M/s Tuff waterproofing Co. / BASF / Fibrex/Equivalent
Admixtures	Fosroc / Fibrex / BASF/Sika/Equivalent
For Structural Glazing	
Aluminium	Hindalco/ Jindal/Equivalent
S. S. Screws/ Bolts	Kundan /Puja / Atul/Equivalent
Dash Fasteners	Hilti /Fischer/Equivalent
S.S. Friction Stay	Alu Alpha/ Securistyle/Equivalent
E.P.D.M. Gaskets	Hanu Industries / Roop/Equivalent
Weather Silicon	GE / Dow Corning/Equivalent
Structural Sealant	GE / Dow Corning/Equivalent
Bitumen	Indian Oil/Hindustan Petroleum/Bharat Petroleum /Equivalent
Cement bonded particle board	Bison Panel/ Viroc/ Viva/ HIL/ NCL/Equivalent
Concrete Additive	Pidilite / Fosroc / MC Bauchemie /Sika/ Cico/ CHRYSO/ STP Ltd./ Asian Fairmate/ MYK Arment/ Berger/ MC Bauchemie/ Sunanda Chemicals/ Cera Chem/ Fibrex/Tremco/Equivalent
Cover	Fosroc / Astron/ KK/Equivalent
Spacer Block	Fosroc / Astron/ KK/Equivalent
Curtain Rod	Vista / Mac/Decor/ Deck / Hunter /PHIFER

Details of Materials	Makes
	/Equivalent
Drapery Rod	Vista / Mac/Decor/ Deck / Hunter /PHIFER /Equivalent
Venetian Blinds	Vista / Mac/Decor/ Deck / Hunter /PHIFER /Equivalent
Laminated Door Shutters	Duro / Greenply/ Archidply / Century / Merino/ Jayna / Kitply /JAIN Doors/ AK Plywood/ Kutty Flushdoor/Equivalent
Doors & Windows Fixtures / Fitting	Godrej/Ebco / Hafele/ Geze /Assaabloy / Hardwyn/ Hettich /Dorma/Hormann/ Everite/Equivalent
False Ceiling – Metal	Armstrong / Hunter-Douglas / Knauf/ Saint Gobain/ Unimet/ DEXUNE/ Everest/ Aura/Durlum /Equivalent
Lead Lined Door	REBBON/ Kutty's/ AHALDA/ Navair/ Shakti Hormann/ Metaflex/Equivalent
Modular Grab bars and Disabled Hardware	Dorma / D-line/ KICH/ Jaquar/ Hindware/ Kohler/Equivalent
Modular SS Railing System	Metallica India / D – Line International Denmark / Mobel Hardware /KICH/ Koncept/Equivalent
PVC Doors	Sintex/ Polyex/ Rajshri/Equivalent
PVC Flooring	Tarkett Floors / LG Floors / Gerflor /Premier Vinyl flooring / Regent/Armstrong / Responsive/ Wonderfloor/Equivalent
uPVC door & window system	Fenesta, NCL Veka, Rehaue, Aluplast / Deceunick / AMD Overseas/ Lingel/ CASSA/ Evolution/ Kommerling/ Duroplast/ Equivalent
AAC Block	Ultratech/ Ferrouscrete/Renacon/Birla Aerocon/ Equivalent
AAC Block adhesive	Ardex Endura/Ultratech/ Ferrouscrete/ Renacon/ Birla Aerocon/ Equivalent

ELECTRICAL

Details of Materials	Makes
ACB (SCADA Compatible with power metering and communication)	Legrand / ABB / Schneider / Seimens / L&T /Equivalent
ATS (Automatic transfer switch with controller)	ASCO, KOHLER, Caterpillar, Russel electric/Equivalent
Battery & Battery Charger	Legrand / Quanta / Exide / Amaron /Equivalent
Cable gland	Dowells / Comet / OBO Betterman / Polycab /

Details of Materials	Makes
	Cape/Equivalent
Cable Tray	Legrand / OBO Betterman / Indiana /Equivalent
Capacitors	Sprauge / Schneider / ABB / Siemens/ Shreem/Equivalent
Ceiling Fan / Exhaust Fan	Crompton / Usha / Bajaj / Armstrong/Equivalent
Ceiling Roses/Angle Batten	Precision/ Anchor / Legrand / Polycab/ MK /Equivalent
Contactors	ABB / Schneider / Legrand / Siemens/ L&T/Equivalent
Crimping Sockets	Dowells / Jaison/ Comet/Equivalent
Current transformer	PGR Power / Kapco / Kappa / Legrand / Schneider/Equivalent
DG Set Alternator	Stamford / Leroy Somer / Kirloskar / KEL/Equivalent
DG Set Engine	Cummins / MTU / Caterpillar / Kirloskar/ Sterling/Equivalent
EMS / SCADA system	L&T / Siemens / Schneider/Equivalent
External Lightning Protection / Structural earthing	OBO Betterman / Cape / Axis Electricals/Equivalent
Fire resistant mortar, bandage, fibre plate, pipe sleeves, ablation coating etc	OBO Betterman / Hilti/Equivalent
Horizontal & Vertical Distribution Boards (DBs)	Legrand / Schneider / ABB / L&T/Equivalent
HT BIDIRECTIONAL TOD Meter	KSEB approved make/Equivalent
HT Cable Termination Kit, [Heat shrinkable type]	Raychem / M-Seal / Tropodour /Equivalent
HT Panel	Siemens / ABB / L&T / Schneider /Equivalent
HT, LT & Control Cables	Polycab / Gloster/ UNISTAR / RR Kabel /Equivalent
Indicating Meters	AE / Schneider / ABB / Siemens / Legrand /Equivalent
Isolator / SFU / COS	L&T/ ABB / Siemens / Legrand / Schneider/Equivalent
Light Fixtures	Phillips / Lighting Technologies / Panasonic / Bajaj / Crompton / Jaguar/Equivalent
Lighting controls (All Sensors)	Crabtree (Havells) / Honeywell / Philips / GM/LT/Equivalent
LT Panel	Legrand / ABB / Schneider / L&T / Siemens /Equivalent
LED Street/ High Mast Light	Bajaj/ Lighting Technologies/ Philips/Equivalent
MCB, RCBO, RCCB & other	Legrand / ABB / Schneider / MK/ Panasonic /

Details of Materials	Makes
modular DB switchgears	BCH /Equivalent
MCCB (Microprocessor based)	ABB (T Max) / Schneider (NSX)/ Legrand (DPX3) / L&T (D Sine) /Equivalent
MCCB (TM Based)	ABB (T Max) / Schneider (Compact NSX) / Legrand (DPX3) / Seimens (3VA) /L&T (DU) /Equivalent
Metal Clad Sockets / IP67 socket / Car charger	HENSEL / CAPE / LEGRAND / Schneider/Equivalent
Multifunction Meters / DIN Rail meters	Schneider / ABB / Siemens /L&T /Equivalent
PLC / UNCO / Breaker interface	Siemens / L&T / Schneider / ABB /Equivalent
PVC Conduit	Balco / Finolex / Supreme / Polycab / Toms / Precise/Equivalent
PVC flexible Copper Wires (FRLS / HFFR)	Polycab / Havells / RR Kabel / Q-flex/Equivalent
Quick spot fire protection	Ceasefire / Minimax / Safex/Equivalent
Relay & Controls	Areva / Siemens / GE / ABB / Schneider / L&T
Rising Mains / BBT/ Tapp off / Plug In Box	Legrand / Schneider /L&T / C&S/Equivalent
Rubber Mat	Electromat / Safevolt/Equivalent
SMDB	L&T/ Seimens / Legrand/Equivalent
Surge Arrestor	OBO Betterman / Cape / Legrand / L&T/ Schneider/ Seimens/Equivalent
Switches / Sockets / Mounting box, cover plate, baseplate / Pop up box etc.	Legrand / Panasonic / Schneider / MK Honeywell /Crabtree/Equivalent
Synchronization relay	DEIF /Equivalent
Transformer	ABB / KEL / Voltamp / Kirloskar / Siemens/Equivalent
UPS	Legrand / Emerson (Liberty) / DELTA / ~~Socomec~~/ Numax /Equivalent

PLUMBING

Details of Materials	Makes
Sanitary wares	Hindware/ Parryware /Jaquar / Kohler / Cera/Equivalent
Sanitary Fixtures: Wash basin/ Sinks / kitchen sink	Hindware/ Parryware /Jaquar / Kohler / Cera/Equivalent
Bath Fittings/ CP Brass Fittings: Pillar cocks, Bib Cocks /Stop cock/ /bottle trap /Health faucet/	Hindware/ Parryware /Jaquar / Kohler / Cera/Equivalent

Details of Materials	Makes
concealed stop cock/ Angle valve	
Bath room accessories: Towel Rack, rail, ring/ soap holder, disk / paper holder	Hindware/ Parryware /Jaquar / Kohler / Cera/Equivalent
PVC Soil, Waste water & Rainwater Pipes & fittings	Supreme / Finolex/ Astral /Equivalent
UPVC Soil, Waste water & Rainwater Pipes & fittings	Supreme / Finolex/ Astral / Ajay / Prince/Equivalent
UPVC / CPVC / PVC pressure pipes/ Low Noise drainage pipes	Supreme / Finolex/ Astral / Prince/Equivalent
Butterfly valves/Ball Valves/Non return valves/Automatic Air release valves/Strainers/Pressure reducing valves/	Leader / Zoloto / RB / SKS/ Advance / Castle / Sant/Equivalent
CI / DI Manholes Covers	KK / NECO/ ARECO / BIC/Equivalent
G.I Clamps and Fixing accessories	Hi-tech/ Hilti / Fixotech/Equivalent
Mirror	Modi/Saint Gobain/Equivalent
Pumps	Kirloskar/Lubi/Xylem/Grundfos/KSB/Wilo/Equivalent
Variable Frequency Drive	Danfoss / Emerson/ ABB / Yaskawa / Siemens / Honeywell/Equivalent
Concealed Flush Tank	Geberitt /Kohler/ Grohe/ Cera/ Viega/Equivalent
PVC Floor Traps, Gully Traps	Supreme / Vectus/Equivalent
Electric Water Heaters	A.O Smith/ Ariston/ Racold/ Havells/Equivalent
SS Gratings for Floor Traps	ACO / Chilly/Equivalent
Gratings for Rain Water Channel	ACO / NECO/Equivalent
Rain water outlet	NECO / WADE/ACO/Equivalent
Water meter (Mechanical Type)	Capstan/Anand/Kranti/Equivalent
Level Controller (Water)	Minilec / KVB/Equivalent
Level indicator (Water)	Minilec / KVB/Equivalent
Flow Switch	Honeywell/ Johnson/Legrands/ Siemens/Equivalent
Thermal Insulation	Armaflex/ K Flex/Aeroflex/Equivalent
Automatic Hand drier	Kopal / Blue circle / Novatech/Equivalent
Pressure gauges	H Guru/ Waaree/ Baumer / Fiebig/Equivalent
Water purifiers	Aquaguard/ Blue star/ Kent / LG/Equivalent

HVAC

Details of Materials	Makes
Water Cooled Chiller Unit	Kirloksar/ Bluestar/ Carrier/ Daikin/ Voltas/ LG/Equivalent
Air Cooled Chiller Unit	Kirloksar/ Bluestar/ Carrier/ Daikin/ Voltas/ LG/Equivalent
Cooling Tower	Advance/ Bell / Paharpur / Mihir/Equivalent
Pumps	Kirloskar/ Lubi/ Xylem/ Grundfos/ KSB/ Wilo/ Armstrong/Equivalent
VRV / VRF / Split AC System	Carrier / Daikin / Hitachi / Samsung / Bluestar / Voltas /LG/Equivalent
DX Condensing units	Daikin / Bluestar / Voltas/LG/Equivalent
Air handling units	VTS/ Zeco/ Edgetech/ System Air / Finpower/Equivalent
Fan coil Units	VTS/ Zeco/ Edgetech/ System Air / Finpower/Equivalent
GI Sheets	TATA / JINDAL / SAIL/Equivalent
Factory Fabricated Duct	Rolastar/ Seven star/ Zeco/Equivalent
Grills/Dampers/Louvers/Diffusers	Airmaster/ Ravistar/ Systemair / Cosmos / Dynacraft/Equivalent
Actuator for Fire Damper	Belimo / Honeywell / Siemens/Equivalent
Nitrile Rubber Insulation	Armaflex/ K Flex/ Superlon / Aeroflex/Equivalent
Acoustic Insulation	Armaflex/ K Flex/ Superlon / Aeroflex/Equivalent
Fans	System Air/ Kruger/ Greenheck/ Astberg / Ostberg / Humidin/Equivalent
Variable Frequency Drive	Danfoss / Emerson/ ABB / Yaskawa / Siemens / Honeywell/Equivalent
Control Cabling	Polycab/ Bonton cables/Equivalent
DOL Starter	Schneider/ Seimens/L & T/ ABB/Equivalent
BTU Meter (Modbus compatible)	Spire MT/ Siemens/ Kamstrup / Shenitech/Equivalent
Hepa Filter	Porvair/ Freudenberg/Equivalent
GI / MS Pipes	Tata/ Jindal / SAIL/Equivalent
Jet Fan	Nicotra / Green Heck/ System air / Humidin / Kruger/Equivalent
Air Curtain	Euronics/ Dolphy/Equivalent
Plant Manager	Danfoss/ Seimens/ Honeywell/Equivalent
Anchor Fastener	Fischer / Hilti/Equivalent
UVC Duct Mounted Ozone Generating Lamp	UVI Aire / SPC/Equivalent
Refrigerant Pipes	Mandev / Parasmani / Jugal / Kwality Tubes & Capillaries (KTC) /Equivalent

Details of Materials	Makes
Vibration pads	Resistroflex / Dunlop/Equivalent
Vibration isolator	Cori,Diamond / Kanwal Industries Corporation / Resistoflex/ Aeroduct/Equivalent
Power Cables	Polycab / Torrant / Finolex / Universal/Equivalent
Valves & Strainers	L&T /Advance/Zoloto / Sant / Kartar / Emerald / Castle/Equivalent
Pressure Independent Balancing Cum Control Valve (PIBCV)	Danfoss / Balimo / Siemens / Honeywell/Equivalent
Fire Sealant	Birla 3M / Hilti / Promat/Equivalent
Pressure Gauge	H Guru/ Waaree/ Baumer / Fiebig/Equivalent
Automatic Air Vents	Anergy/Equivalent
Thermometers	Waaree / Mars/Equivalent
Rubber bellow	Cori Rubber / Resistoflex/Equivalent
Flow Switch	Honeywell /Johnson / Siemens/Equivalent
Thermostat	Seimens/ Honeywell/ Johnson controls/Equivalent
Flexible Duct Connector (Canvass Connection)	Mapro / Kanwal Industries Corporation/ Resistoflex /Aeroduct/Equivalent
Variable Air Volume Units (VAV)	Systemair / Trane / Honeywell / Siemens / Johnson Controls/Equivalent
PVC pipes	Ajay / Supreme /Astral /Prince/Equivalent
Air separator	Emerald/Equivalent
Sound Attenuators	Air master / Airtech Control/Equivalent
Co2 Sensor	Seimens/ Honeywell/ Johnson controls/Equivalent
Cable Tray	Obo Bettermann/ Profab/ Indiana/ Legrand/Equivalent
Motors	ABB / Bharat Bijlee / Kirloskar/ Siemens/Equivalent

WTP

Details of Materials	Makes
Filter Feed Pumps	Kirloskar/ Lubi / Grundfos/Equivalent
Sludge Handling pump	Kirloskar/ Lubi / Grundfos/Equivalent
Iron Remover filter - MS	Tata/ Jindal/ Sail/Equivalent
Activated Carbon Filter - MS	Tata/ Jindal/ Sail/Equivalent
Softener Filter – MS	Tata/ Jindal/ Sail/Equivalent
Resin make	Dupont/ Thermax /DOW/Equivalent
Regeneration Tank	Sintex/Equivalent

Details of Materials	Makes
Dosing Pump	Lubi/ Xeed / Kirloskar/Equivalent
Pipe & fittings - UPVC	Astral / Finolex/ Ashirwad/Equivalent
Electrical Control Panel	CPRI approved/Equivalent
Components of the Control panel	ABB/ Schneider/ Siemens / Legrand/Equivalent
Electrical Cable	Polycab/ RR kabel / Bonton cables/Equivalent
Float Switch	Aster/ Sinicon / JKN/Equivalent
Pressure Gauge	Baumar/ WIKA/Equivalent

SOLAR

Details of Materials	Makes
PV Solar Panels	Polycab /Trina Solar/ Renewsys / Goldi / Canadian Solar/Equivalent
Power Conditioning Unit	Solis/ Growwatt / ABB / Polycab/Equivalent
Surge Protection Device	OBO Betterman/CAPE /Equivalent
Outdoor enclosure	CAPE/Hensel/Equivalent
MCB / MCCB	L&T / Legrand / Schnieder / ABB / Seimens/Equivalent
Cables	Polycab / Bonton cables / Finolex / RR Kabel / Lapp/Equivalent
Conduits	Precision/ Balco/TOMS/Equivalent
Raceways	Obo Betterman/ Profab/MK/ Legrand/Equivalent
Lightning protection & Earthing	OBO Betterman / Cape / Axis Electricals /Equivalent

ETP

Details of Materials	Makes
Filter Feed Pumps	Kirlosker/ Lubi / Grundfos/Equivalent
Sludge Handling pump	Kirlosker/ Lubi / Grundfos/Equivalent
Iron Remover filter - MS	Tata/ Jindal/ Sail/Equivalent
Activated Carbon Filter - MS	Tata/ Jindal/ Sail/Equivalent
Dosing Pump	E- Dos/ Xeed/ Lubi/ Xylem/Equivalent
Pipe & fittings - UPVC	Astral / Finolex/ Ashirwad/Equivalent

Details of Materials	Makes
Electrical Control Panel	CPRI approved /Equivalent
Components of the Control panel	ABB/ L&T/ Schneider/Equivalent
Electrical Cable	Polycab/ RR kabel /Bonton cables/ Havells/Equivalent
Float Switch	Aster/ Sinicon/ JKN/Equivalent
Pressure Gauge	Baumar/zoloto/Equivalent

Fire Fighting System

Details of Materials	Makes
PUMPS	Kirloskar / LUBI / KSB / Armstrong / WILO/ Crompton Greaves/Equivalent
MOTORS	ABB / Siemens / Bharat Bijlee / Crompton Greaves / Kirloskar/Equivalent
Diesel Engine	Cummins / Greaves / Caterpillar / Kirloskar /Equivalent
MS / GI PIPES	TATA / JINDAL / SAIL / ZENITH/Equivalent
G.I. & M.S Fittings	Tube weld / Tube Products / Punjab Steel / Bharath Forge/Equivalent
Valves & strainers	L&T / Intervalve / Zoloto / Advance / Leader / Sant / Kartar / Monsher/Equivalent
Internal / External Hydrant Valve	Minimax / Newage / Monsher / Kartar / Eversafe / Safex / Shah Bhogilal /Equivalent
HOSE REEL	Minimax / Newage / Eversafe / Safex / Shah Bhogilal / Kartar/Equivalent
FIRE HOSE	Minimax / Newage / Monsher / Kartar / Eversafe / Safex / Shah Bhogilal/Equivalent
BRANCH PIPE	Minimax / Newage / Monsher / Kartar / Eversafe / Safex / Shah Bhogilal/Equivalent
FIRE BRIGADE INLET	Minimax / Newage / Eversafe / Safex / Shah Bhogilal / Kartar /Equivalent
HOSE BOX	NEWAGE /MINIMAX/AAG/Equivalent
AIR RELEASE VALVE	ATOM/ LEADER/Equivalent
BUTTERFLY VALVE	L&T / Intervalve / Zoloto / Advance / Leader / Sant / Kartar / Monsher / Castle/Equivalent
NON RETURN VALVE	L&T / Intervalve / Zoloto / Advance / Leader / Sant / Kartar / Monsher / Castle/Equivalent
PIPE SUPPORTS	Hi tech / Chilly / Euroclamp / Gripple / HILTI / OBO BETTERMAN/Equivalent

Details of Materials	Makes
PRESSURE GAUGE	H Guru/ Waaree/ Baumer / Fiebig / NATIONAL/Equivalent
FIRE EXTINGUISHER	CEASE FIRE/ MINIMAX/ SAFEX/Equivalent
AUTOMATIC SPRINKLERS	NEWAGE/ HD/TYCO/Viking/Equivalent
PRESSURE SWITCH	Danfoss / Infoss / Viking / Switzer / Schneider / Siemens/Equivalent
FLOW SWITCH	Danfoss / Infoss / Tyco / Siemens / Honeywell/Equivalent
PAINT /PRIMER	BERGER / ASIAN PAINTS /Equivalent
WRAPPING COATING	Pypkote/Equivalent
FIRE RATED DUCT DOORS /DOORS	ARISHTHA/ Shakthi /Equivalent
Water level Controller	Pumptrol /RMG Automation / Minilec / KVB/Equivalent
Batteries	Exide / Global /Equivalent
First Aid Hose Reel Drum	Newage / Eversafe / Safex / Shah Bhogilal /Equivalent
Power & Control Cables	Polycab / Gloster / Terexel/Equivalent
SDFU/SFU with HRC Fuses	L & T / Siemens / Schneider/Equivalent
Sprinkler Flexible drop pipe (SS)	Tyco / Newage / HD Fire / Monsher / Kartar/Equivalent

FIRE DETECTION AND ALARM SYSTEM

Details of Materials	Makes
Fire alarm components	Siemens, Honey well, Secutron, Ravel/Equivalent
Detectors	Siemens, Honey well, Secutron, Ravel/Equivalent
Response indicators	Siemens, Honey well, Secutron, Ravel/Equivalent
Manual call points	Siemens, Honey well, Secutron, Ravel/Equivalent
Hooter	Siemens, Honey well, Secutron, Ravel/Equivalent
Isolator Module	Siemens, Honey well, Secutron, /Equivalent
Control/ Monitor module	Siemens, Honey well, Secutron, Ravel/Equivalent
FRLS Cables	Polycab, RR cables, Havells, Bonton cables/Equivalent

Tack back system	Siemens, Honey well, Morlay, Secutron, Ravel/Equivalent
Copper Wire / cable	Havells, Bonton cables, Polycab, RR Cables/Equivalent
SIGNAGES/ Exit lights	Seculite, Prolite, Legrand, Lighting Technology/Equivalent
BATTERY	Exide, Amara Raja, Amaron/Equivalent
AMPLIFIER	Ahuja, Bosch/Equivalent
GAS SUPPRESSION SYSTEM	Cease fire,Minimax, Topaz, Safex/Equivalent
Fire alarm panel / Repeater panel	Ravel, Siemens, Honeywell, Secutron/Equivalent

RO PLANT

Details of Materials	Makes
Filter Feed Pumps	Kirlosker / Lubi / Grundfos/Equivalent
Sludge Handling pump	Kirlosker/ Lubi / Grundfos/Equivalent
Iron Remover filter - MS	Tata/ Jindal/ Sail/Equivalent
Activated Carbon Filter - MS	Tata/ Jindal/ Sail/Equivalent
Dosing Pump	E- Dos/ Xeed/ Xylem/ Lubi/Equivalent
Pipe & fittings - UPVC	Astral / Finolex/ Ashirwad / Supreme /Equivalent
Electrical Control Panel	CPRI approved/Equivalent
Components of the Control panel	ABB/ L&T/ Schneider/Equivalent
Electrical Cable	Polycab/ RR kabel / Bonton cables / Havells/Equivalent
Float Switch	Aster/ Sinicon/ JKN/Equivalent
Pressure Gauge	Baumar/zoloto/Equivalent

ELV (EXTRA LOW VOLTAGE)

Details of Materials	Makes
Structured Cabling System - Data Passive	
Information Outlets - CAT6/ CAT6A	Legrand/ Panduit/ Nexans, Schneider/ Honeywell/Equivalent
Faceplates	Legrand/ Panduit/ Nexans, Schneider/ Honeywell/Equivalent
Cables - CAT6/ CAT6A/ OFC	Legrand/ Panduit/ Nexans, Schneider/ Honeywell/Equivalent
Patch Cords - CAT6/ CAT6A/	Siemens/ Legrand/ Legrand Panduit/ Nexans/

Details of Materials	Makes
OFC	Belden/Equivalent
Patch Panels - CAT6/ CAT6A/ OFC	Siemens/ Legrand/ Legrand Panduit/ Nexans/ Belden/Equivalent
Racks	Rittal/ Netrack/ President/Equivalent
Structured Cabling System - Voice Passive	
Information Outlets - CAT6/ RJ11/ CAT5E	Legrand/ Panduit/ Nexans, Schneider/ Honeywell/Equivalent
Faceplates	Legrand/ Panduit/ Nexans, Schneider/ Honeywell/Equivalent
Cables - CAT6/ CAT5E	Legrand/ Panduit/ Nexans/ Comscope/ Belden/Equivalent
Multipair Cables - 2/10/20/50/100 Pair	Legrand/ Panduit/ Nexans/ Comscope/ Belden/Equivalent
Patch Cords - CAT6/ CAT5E	Legrand/ Panduit/ Nexans/ Comscope/ Belden/Equivalent
Patch Panels - CAT6/ CAT5E	Legrand/ Panduit/ Nexans/ Comscope/ Belden/Equivalent
IDF/ MDF Termination Module	Legrand/ Panduit/ Nexans/ Krone/ Besenet/Equivalent
IT - Active	
Network Switches	HP/ Cisco/ Juniper/Equivalent
SFP Modules	HP/ Cisco/ Juniper/Equivalent
Wireless Access Points	HP/ Cisco/ Juniper/ Ruckus/Equivalent
Wireless Controller	HP/ Cisco/ Juniper/ Ruckus/Equivalent
Surveillance System	
IP Cameras	Honeywell/ Pelco/ Bosch/Equivalent
NVR/ Video Management System	Honeywell/ Pelco/ Bosch/Equivalent
Workstations	IBM/ Dell/ HP/Equivalent
Display	Sony/ Samsung/ LG /Equivalent
Storage	Seagate/ HP/ Samsung/Equivalent
Access Control System	
Door Controllers	HID/ Honeywell/ Schneider/ Siemens/Equivalent
Card Readers	HID/ Honeywell/ Schneider/ Siemens/Equivalent
Software	HID/ Honeywell/ Schneider/ Siemens/Equivalent
EM Locks/ Exit Switches/ Glass Break/Locks/Brackets, Door Loop etc	Faradays/ BEL/ Algatec/Equivalent
Cables	Bonton Cables/ Polycab/ Finolex/ RR Cable/Equivalent
Public Addressing System	

Details of Materials	Makes
Speakers	Honeywell/ Bosch/ Ahuja/ Tyco/Equivalent
Controllers	Honeywell/ Bosch/ Ahuja/ Tyco/Equivalent
Amplifiers	Honeywell/ Bosch/ Ahuja/ Tyco/Equivalent
Call Stations	Honeywell/ Bosch/ Ahuja/ Tyco/Equivalent
Cables	Bonton/ Polycab/ Finolex/ RR /Equivalent
Telephone - Active	
Phones	Beetel/ Panasonic/ Avaya/Equivalent
Conduit	Precision/ Balco/ Supreme/ Polycab/Equivalent
Raceways / Cable Tray	Legrand/ OBO Betterman/ Profab/Equivalent
PBX	NEC/ Siemens/ Avaya/ Alcatel/Equivalent
Nurse Call System	
Bedside Unit	Siemens/ Norris/ Schrack/ Chiron/ Honeywell/ Calix/ Austco/ Ascom /Equivalent
Toilet Pull Cords	Siemens/ Norris/ Schrack/ Chiron/ Honeywell/ Calix/ Austco/ Ascom/Equivalent
Dome Light	Siemens/ Norris/ Schrack/ Chiron/ Honeywell/ Calix/ Austco/ Ascom/Equivalent
Nurse Station	Siemens/ Norris/ Schrack/ Chiron/ Honeywell/ Calix/ Austco/ Ascom/Equivalent
Software	Siemens/ Norris/ Schrack/ Chiron/ Honeywell/ Calix/ Austco/ Ascom/Equivalent
Workstations	IBM/ Apple/ Del/ HP/Equivalent
IBMS	
Software	Schneider/ Johnson Controls/ Honeywell/ Siemens/Equivalent
Controllers	Schneider/ Johnson Controls/ Honeywell/ Siemens/Equivalent
Temperature Sensors	Schneider/ Johnson Controls/ Honeywell/ Siemens/Equivalent
Pressure Sensors/ Switches	Schneider/ Johnson Controls/ Honeywell/ Siemens/Equivalent
Air Flow Switches	Schneider/ Johnson Controls/ Honeywell/ Siemens/Equivalent
Level Sensors	Filpro/ Techtrol/ Omicron/ Coleman/Equivalent
CO2/ CO Sensors	Schneider/ Johnson Controls/ Honeywell/ Siemens/Equivalent
Humidity Sensors	Schneider/ Johnson Controls/ Honeywell/ Siemens/Equivalent
Cables	Polycab/ Finolex/ Finecore/ Bonton cables/Equivalent
Conduits	Precision, Balco, Supreme, Polycab/Equivalent
Raceways / Cable Tray	Legrand , OBO Betterman, MK/Equivalent

Details of Materials	Makes
Workstations	IBM, Dell, HP/Equivalent
AV System	
Projector	Epson/ Panasonic/ Christie/Equivalent
Projector Screen	Dalite/ Chief/ Draper/Equivalent
HDMI Embedders/ DE embedders	Kramer/ Extron/ Crestron/Equivalent
HDMI Transmitter/ Receiver	Kramer/ Extron/ Crestron/Equivalent
Speakers	JBL/ Bose/ Ahuja/ Sony/Equivalent
Amplifiers	JBL/ Bose/ Ahuja/ Sony/Equivalent
Microphones	Shure, Beyerdynamic, AKG/Equivalent
Displays	LG/ Samsung/ Sony/Equivalent
Controllers	Kramer/ Crestron/ Extron/ AMX/Equivalent
Touch Screens	Kramer/ Crestron/ Extron/ AMX/Equivalent
DSP	Biamp/ Bose/ BSS/ Sennheiser/Equivalent
Matrix Switchers	Kramer/ Crestron/ Extron/ AMX/Equivalent
Queue management system	Qmatics/ Qnetics/Equivalent

MODULAR OPERATION THEATRE

Description	Make
WALL PANELS	LG/HT Labor/ Trumpf /AURA (GridSquare)/Kenswick /ALTRO/Equivalent
CEILING PANELS	LG/HT Labor/ Trumpf /AURA (GridSquare)/Kenswick / ALTRO/Equivalent
Doors	ALTRO/HT Labor/ ALTOS/ Metaflex/Equivalent
Scrub sinks	ALTRO /HT Labor/ BALAJI/ MEDFLOW/Equivalent
Cabinets	ALTRO /HT Labor/ JDV/ BALAJI/ MEDFLOW/Equivalent
Lamps	ALTRO /AGAT Clean/HT Labor/Philips/Equivalent
X–ray film viewers LED	ALTRO /HT Labor /JDV/DG LINE/Equivalent
Electric clock with stopper	ALTRO /HT Labor/ JDV/DG LINE/Equivalent
Writing board	ALTRO /HT Labor /JDV/DG LINE/Equivalent
Laminar air flow ALF 3/4	ALTRO /HT Labor/Kenswick /JDV/BALAJI/Equivalent
Extractions corners	ALTRO / Kenswick /HT Labor /JDV/ALTOS/Equivalent
Vinyl Floor cladding	Trakeet/Amstrong/HT Labor/Gerflor/Equivalent

Description	Make
Surgeon Control Panel	ALTRO /Breandon/Brandon Medical UK/DG LINE/Equivalent
Pass Box	ALTRO /Traket/JDV/AKTIV/BALAJI/Equivalent
Anaesthesia Pendants	DRAEGER/Precision UK Ltd / MARTIN/ Maquet/ ALTOS/Equivalent
Surgeon Pendants	DRAEGER /Precision UK Ltd/ MARTIN/ Kenswick/ Martin/ Maquet/ ALTOS/Equivalent
Endoscopy Pendants	DRAEGER/ Trumpf/ Precision UK Ltd/ MARTIN/ Maquet/ ALTOS/Equivalent
OT Light	DRAEGER /Trumpf/ MARTIN/ Kenswick /Maquet/ DR.MACH/Equivalent

MEDICAL GAS PIPELINE SYSTEM

Description	Make
Oxygen Supply System	PRECISION UK/LINDE/MEP/AKTIV/G SAMRA/Equivalent
N2O Supply System	PRECISION UK/LINDE/MEP/AKTIV/G SAMRA/Equivalent
CO2 Supply System	PRECISION UK/LINDE/MEP/AKTIV/G SAMRA/Equivalent
Air Compressors	HITACHI/ BOGE/PRECISION UK/AIRTEC/Equivalent
Air Dreyer And Filter	TRIDENT/ BOGE/PRECISION UK/Equivalent
Medical Vacuum Pumps	PRECISION UK /BUSCH/ANEST IWATA/AIRTEC/Equivalent
Area Alarm + Area Valves +Gauges	PRECISION UK/LINDE/MEP/AKTIV/Equivalent
Master Plant Alarm	PRECISION UK/LINDE/MEP/AKTIV/Equivalent
Terminal Units Wall/Bhu/Pendant Mounted	PRECISION UK/LINDE/MEP/AKTIV/G SAMRA/Equivalent
Agss - Agss-Terminal Unit With Probe	PRECISION UK/LINDE/MEP/AKTIV/G SAMRA/Equivalent
Isolation Valves	RB ITALLY/ PRECISION UK/Equivalent
Copper Piping As Per En13348 Standards.	MANDE / MEHTA TUBE/ JANYA /Equivalent
Probes Matching	PRECISION UK/LINDE/MEP/ AKTIV/ G SAMRA/Equivalent
Bed Head Panels	S KUMAR/ AKTIV/ PRECISION UK/ ALTOS/ G SAMRA/Equivalent
Pendants-Ot	AKTIV/ S-KUMAR/ALTOS/Equivalent

Description	Make
Pendants-Icu	AKTIV/ S-KUMAR/ALTOS/Equivalent
Vacuum Switch	INDFOSS / DANFOSS/Equivalent
Bacterial Filter	DOMINIC HUNTER/TRIDENT/Equivalent
Flow Meter/Suction Jar	PRECISION UK/LINDE/MEP/AKTIV/G SAMRA/Equivalent
Vacuum Unit	PRECISION UK/ G SAMRA /MEP/ AKTIV/Equivalent
Theatre Suction Unit	PRECISION UK/ G SAMRA /MEP/ AKTIV/Equivalent
High Pressure Tube	PRECISION UK/ G SAMRA /MEP/ AKTIV/Equivalent

OTHER ITEMS

Details Of Materials	Makes
Bio Gas Plant	Bioenergy Solution, Neo Energy/Equivalent
Incinerator	Green Method, 7C, Manikandaincitech System/Equivalent
Elevator/ Lift/ Dumb Waiter	Schindler / OTIS / TKE/Equivalent

Notes:

- EMPLOYER is at liberty to select any of the brands indicated above or equivalent. The Contractor obtains prior approval from Employer's Representative before placing the order listed above.
- Change of any make of material in case of its non-availability or any other such reason shall be at the discretion of EMPLOYER. The Contractor shall not be allowed to change the makes without their prior permission.
- Equivalent make of any item may be added with the approval of EMPLOYER, wherever makes have not been specified for certain items, the same shall be as per BIS and as per approval of EMPLOYER.
- In case of items for which approved make is not given above, the Contractor shall place the order with the prior approval of EMPLOYER.
- In case of Contradiction between the approved makes/brands specified above and mentioned in the Specifications /Bill of quantities. The decision of EMPLOYER shall be final and binding on the Contractor.
- "Equivalent" shall mean any make that is BIS approved and is manufactured by an ISO Certified company. Proof of documentation shall be provided to Employer's Representative as and when required.
- All materials should conform to relevant standard and codes of BIS and shall have ISI mark.

SECTION II: TECHNICAL SPECIFICATIONS

2.1 CIVIL WORKS

Latest CPWD specification shall be followed for the Civil works

2.2 PLUMBING, SANITARY WORKS

Without restricting to the generality of the foregoing, the plumbing installations shall include the following: -

i. Plumbing Works
ii. Sanitary Fixtures & C.P Brass Fittings
iii. Soil, Waste, Vent, Pipes & Fittings
iv. Water Supply System
v. Water metering system
vi. Garden Irrigation System
vii. Sewerage System
viii. Storm Water Drainage System
ix. Water Supply & Drainage Pumps.
x. Effluent Treatment Plant.
xi. Water treatment Plant.
xii. Solar water heater/ heat pump
xiii. RO Plant

Inspection and Testing of Materials

Contractor shall be required, to produce manufacturers test certificate for the particular batch of materials supplied to him. Contractor may be required to get the material tested from outside approved laboratory for confirmation of material as per Employer's Representative instruction as and when required. The tests carried out shall be as per the relevant Bureau of Indian Standards.

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 following:

- Steel tapes
- Weighing machine
- Plumb bobs, sprit levels, hammer
- Micrometres
- Hydraulic

All such equipment shall be tested for calibration at approved laboratory, if required bythe Employer's Representative. All testing equipment shall be preferably located in special room meant for the purpose.

Samples of all materials shall be got approved by Employer's Representative and the approved samples shall be deposited with the Employer's Representative.

Reference Points

The Contractor shall provide permanent bench marks, flag tops and other reference points and check that with other agencies to confirm the same reference point for all the proper execution of work and these shall be preserved till the end of the work.

All such reference points shall be in relation to the levels and locations, given in the architectural and plumbing drawings.

Completion Drawings

- On completion of work, Contractor shall submit one complete set of original tracings and three prints of "as built" drawings to the Employer's Representative . These drawings shall have the following information.
- Run of all piping, diameters on all floors, vertical stacks and location of external services.
- Ground and invert levels of all drainage pipes together with location of all manholes and connections upto outfall.
- Run of all water supply lines with diameters, locations of control valves, access panels.
- Location of all mechanical equipment with layout and piping connections and mechanical equipment.
- All shop drawings shall be updated from time to time for the purpose of making Completiondrawings.
- No completion certificate shall be issued unless the above drawings are submitted.
- Contractor shall provide four sets of catalogues, service manuals manufacturer's drawings, 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.
- All "warranty cards" given by the manufacturers shall be handed over to the Employer's Representative.

Testing

- Piping and drainage works shall be tested as specified under the relevant clauses of thespecifications.
- Tests shall be performed in presence of the Employer's Representative and test records for the tests shall be duly signed by Plumbing Consultant, Contractor and the Employer's Representative.
- All materials and equipment found defective shall be replaced at Contractor cost and whole work shall be tested to meet the requirements of the specifications.
- Contractor shall perform all such tests as may be necessary and required by the localauthorities to meet municipal or other bye-laws in force.
- Contractor shall provide all labour, equipment and materials for the performance of thetests at no extra cost.

Site Clearance and Clean-up

- The Contractor shall, from time to time, clear away all debris and excess materials accumulated at the site. Failing of which attract penalties:
- 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 or discolouration leaving the same in a ready to use condition. The equipment installed shall be protected by Contractor till formal handing over takes place by The Employer.
- 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 by the Employer's Representative at the Contractor's risk and cost. Cost of the clean-up shall be deducted from the Contractor's bills on pro-rata basis in proportion to his contract value.

Licence Permits and Authorities

- Contractor must hold a valid plumbing or any other licence as required by the municipal authority or other competent authority under whose jurisdiction the work falls.
- Contractor must keep constant liaison with the local development, municipal/ statutory authority and obtain approval of all drainage, water supply and other works carried out by him.
- Contractor shall obtain, from the municipal and other authorities 'C' & 'D' forms approval of drainage and water supply works during execution and the completion certificatewith respect to his work as required for occupation of the building. Contractor shall obtain permanent water supply and drainage connections from authorities concerned.Fees paid to the authorities towards the connection charges shall be re-imbursed on production of original receipts for the amount paid.
- Contractor shall get any materials tested from the appropriate authority if so required atno extra cost.

Cutting of Water Proofing Membrane:

No walls terraces shall be cut for making and opening after water proofing has been done without written approval. Cutting of water proofing membrane shall be done very carefully so as other portion of water proofing is not damaged. On completion of work at such place the water proofing membrane shall be made good and ensured that the opening/cutting is made fully water proof as per specifications and details of water proofing approved by Employer's Representative. Actual cost of any damage to finished work by Contractor shall be recovered from Plumbing Contractor.

Cutting of Structural Members

No structural member shall be chased or cut without the written permission of the Employer's Representative. Any damage to the structure shall be on Contractor's account.

Materials

Contractor to procure material as per first make from approved make list only unless otherwise specified and expressly approved in writing by the Employer's Representative/The Employer.

If required, the Contractor shall submit samples of materials proposed to be used in the works. Approved samples shall be kept in the office of the Employer's Representative.

Specifications for Sanitary Fixtures & C.P Brass Fittings

i. WCs - Low volume dual flushing system comprising concealed/exposed cistern with low flow fixture unit of 5lpm @3bar pressure are proposed as per IS: 2556.
ii. URINALS shall be provided with Infra-red sensor battery operated as per IS: 2556 part confirming to low flow fixture unit of 2lpm@3bar pressure.(.75L /flush)
iii. SHOWER: - Mixer type shower shall be used with low fixture unit of 6lpm flow @ 3.1bar pressure
iv. PILLAR TAP/BIBTAP/SINK COCK: - Mixer type shower shall be used with low fixture unit of 6lpm flow @ 3.1 bar pressure
v. HEALTH FAUCET:- low fixture unit of 6lpm flow @ 3.1 bar pressure

Work under this section shall consist of furnishing all materials & labour necessary and required to completely install all sanitary fixtures, chromium plated fittings and accessories as required by the drawings specified hereinafter and given in the DBR & Technical Specifications.

Without restricting to the generality of the foregoing the sanitary fixtures shall include the following:

a) Sanitary fixtures
b) Chromium plated fittings
c) Porcelain or stainless steel sinks
d) Accessories e.g. towel rods, toilet paper holders, soap dish, towel rack, coat hooks, grabbar and hinges, mirror etc.

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

- All exposed pipes within toilets and near fixtures shall be chromium plated brass or copper unless otherwise specified.
- Fixture unit of sanitary fixtures to be considered as per IGBC norms.

A. General Requirements

- All Sanitary Ware & C.P Brass Fittings shall be low flow rate fixtures to confirm the IGBC Standards.
- The Contractor shall be identifying the quantity of sanitary fixtures and fittings as per the drawing.
- Sanitary fixtures shall be of the best quality approved by the Employer's Representative. Wherever particular makes are mentioned, the choice of selection shall remain with the Employer's Representative.
- 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 DBR, specifications, drawings. Accessories shall include proper fixing arrangement, brackets, nuts, bolts, screws and required connection pieces.
- Fixing screws shall be half round head chromium plated brass screws with C.P. washerswhere necessary.
- Contractor shall furnish without cost all such accessories and fixing devices that are necessary and required but not supplied along with the Plumbing Fixtures & CP Fittings by the manufacturers as a part of the original and standard supply.
- All fittings and fixtures shall be fixed in a neat workmanlike manner true to level 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 Contractor's cost.
- Contractor seal all fixtures fixed near wall, marble and edges. With an approved type of poly-sulphide sealant appropriate for its application.

B. Plumbing Fixtures:

Wash Down Type (European Type W.C.):

Water closets shall be of white vitreous china 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). The closets shall be of two 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 at least 50 mm 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 50 mm dia vent horn on the outlet side of the trap with dimension and 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.Each W.C. set shall be provided with a plastic seat shall be with rubber buffers and chromium plated hinges.Plastic seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the

W.C. Each W.C. shall be suitable for flushing in low volume of water 2/4 litres.

Indian W.C

Indian water closet squatting pan (Indian type W.C. pan) wherever required shall be with 100 mm sand cast Iron P or S trap, 10 litre low level white P.V.C. flushing cistern, including flush pipe, with manually controlled device (handle lever) conforming to IS: 7231, with all fittings and fixtures complete, including cutting and making good the walls and floors wherever required. The cistern shall be of low flow fixture to meet IGBC standard.

Wash basin

Wash basins shall be of white vitreous china conforming to IS 2556 (Part-I) and 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 on 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 diameter, 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 Employer's Representative.

The wash basins shall be one of the following patterns and sizes as specified.

- Counter wash basin: 520 x 450 mm

- Angle back: 400 × 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 pipesand 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. Each basin shall be provided with brackets and clips of approved and securely fixed. Placing of basins over the brackets without secure fixing shall not be accepted

Each basin shall be provided with single lever pillar tap as specified in the specification. Washbasin for nurse station shall be single lever basin mixer type.

Waste Fittings for 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 moveson the body.

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

Each basin shall be provided with brackets and clips of approved and securely fixed. Placing of basins over the brackets without secure fixing shall not be accepted.

Sinks

Sinks shall be white glazed fireclay or vitreous china or stainless steel or any other material asspecified in the Drawings.

The sink shall be supported on C.I. cantilever brackets, embedded in cement concrete (1:2:4) block of size 100 x 75 x 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 bent 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. Fixing shall be done as directed by Employer's Representative.Sinks shall be provided with sink mixer as specified in the specifications / DBR/Drawings. Hot water tap points shall be provided in lab areas whatever area mentions later as per the the Employer requirements. The installation shall consist of assembly of sink C.I. brackets, union and P.V.C. waste pipe.

Toilets for Disabled

Where specified in washroom facilities designed to accommodate physically handicapped, accessories shall be provided as directed by the Employer's Representative.

Stainless steel grab bars of required size (350 mm for wash basin, 600mm grab bar for water closet, 600mm hinged arm) suitable shall be provided in all washrooms to be used by physically handicapped as directed by the Employer's Representative.

Shower set

Shower set shall comprise of single lever mixer type, C.P. shower arm with wall flange, shower head and hand shower of approved quality or as specified in the Bill of Quantities.Shower mixer and shower arm shall be so fixed as to keep the wall flange clear off the finished wall. Wall flanges embedded in the finishing shall not be accepted. 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.

Urinals

Flat Back Lipped Front Urinal:

Urinals shall be white glazed vitreous china of size, shape and type specified in the drawings / specifications. It shall be sensor type with low flow fixture rate of 2lpm @3.1bar pressure.Urinal basins shall be of flat back type lipped in front. 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 groovesat 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. Bowl urinals shall be provided with 15 mm dia C.P. spreader, 40 mm dia stainless steel domical waste and C.P. cast brass bottle trap with pipe and wall flange, and shall be fixed to wall by C.I. brackets and C.I. wall clips as recommended by manufacturers complete as directed by Employer's Representative. Urinals shall be fixed with C.P. brass screws and shall be provided with 32 mm dia domical waste leading to urinal's trap. Urinals shall be provided with integrated sensors flushed by means of fully automatic. Waste pipe for urinal shall be 50mm dia PVC -6Kg/cm2 pipe.

Urinal Partitions

Urinal partitions shall be white/ black glazed vitreous china, marble, granite or any other material selected by the Employer's Representative. The same shall be fixed by Contractor executing the finishing work. The exact location shall however be co oriented by the Plumbing Contractor. Urinal 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 Employer's Representative.

Pillar Taps

Pillar taps shall be chromium plated brass and shall conform to IS 1795. The nominal sizes ofthe pillar tap shall be 15 mm or 20 mm as specified. The nominal size shall be designated by the nominal bore of the pipe outlet to which the tap is to be fitted.

Casting shall be sound and free from laps, blow hole and pitting. External and internal surfacesshall be clean, smooth and free from sand and be neatly dressed. The body, bonnet and other parts shall be machined true so that when assembled, the parts shall be axial, parallel and cylindrical with surfaces smoothly finished.

The area of waterway through the body shall not be less than the area of the circle of diameterequal to the bore of the seating of the tap. The seating of pillar tap shall be integral with the body and edges rounded to avoid cutting of washer. Pillar taps shall be nickel chromium plated and thickness of coating shall not be less than service grade No. 2 of IS 4827 and plating shallbe capable of taking high polish which shall not easily tarnish or scale.

Every pillar tap, complete with its component parts shall withstand an internally applied hydraulic pressure of 20 Kg/sq. cm maintained for a period of 2 minutes during which period it shall neither leak nor sweat.

Accessories Towel rail

It shall be fixed in position by means of C.P. brass screws on wall surface by PVC dashfasteners, firmly embedded in wall.

Mirror

The mirror shall be of superior glass with edges rounded off or beveled, as specified. It shall be free from flaws, specks or bubbles. The size of the mirror shall be 60 x 45 cm unless specified otherwise and its thickness shall not be less than 5.5 mm. It shall be uniformly silver plated at the back and shall be free from silvering defects. Silvering shall have a protective uniform covering of red lead paint. Where beveled edge mirrors of 5.5 mm thickness are not available, fancy looking mirrors with PVC beading/border or aluminium beading or stainless steel beading/border based on manufacture's specifications be provided nothing extra shall be paid on this account. Backing of mirrors shall be provided with environmentally friendly material other than asbestos cement sheet.

General Instructions

- Contractor shall install all chromium plated and porcelain accessories as shown on the drawingsor directed by the Employer's Representative.
- All C.P. accessories shall be fixed with C.P. brass half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required ordirected by Employer's Representative.

- Recessed porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work as per Architect / Interior Designer's drawings.

Final Installation

The Contractor shall install all sanitary fixtures and fittings in their position in accordance with approved trial assemblies and as shown on drawings. The installation shall be completed 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 to alignment. The outlets of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting on the receiving pipes before making the joints. 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 the necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other materials.

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. At the time of handling over, the Contractor shall clean, disinfect and polish all the fixtures and fittings. Any fixtures and fittings found damaged, cracked chipped stained or scratched shall be removed and new fixtures and fittingsfree from defects shall be installed at his own cost to complete the work.

Specifications for Soil, Waste, Vent & Rainwater Pipes & Fittings

The soil, waste, vent pipes system shall include the following:

- Horizontal soil, waste and vent pipes, and fittings, joints, clamps, connections tofixtures.
- Floor and urinal traps, cleanout plugs, inlet fittings.
- uPVC Rain Water Pipes.
- Testing of all pipe lines.

General requirements

- All materials shall be new of the best quality conforming to specifications and subject to the approval of Employer's Representative.
- Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- 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.

- Pipes shall be securely fixed to walls and ceilings by suitable clamps intervals specified.
- Access doors for fittings and clean outs shall be so located that they are easily accessible for repair and maintenance. Any access panel required in the civil structure, false ceiling or marble cladding etc. shall be clearly reported to the Owner in the form of shop drawing so thatother agencies are instructed to provide the same well in advance.

Piping System

Schedule of Pipes Use

- uPVC Pipes-SWR Type B (6 kg/cm2) Conforming to IS: 4985, For Waste Connection from WB,FD, Soil & Sewage pipes.
- uPVC Pipes –SWR Type B (6 kg/cm2) Conforming to IS: 4985, For external rain water System.
- uPVC Pipes –SWR Type A-(4 kg/cm2) Conforming to IS: 4985, For shaft rain water System.

Soil, Waste & Vent Pipes

The Soil & Waste Pipe System above ground has been planned as a "two pipe system" as defined in IS: 5329 having separate pipes for waste for kitchen sinks, bath tubs, showers, washbasins, condensate drains and floor drains and is approved by Employer's Representative.

All pipes shall be straight and smooth from inside free from irregular bore, blow holes, cracks and other manufacturing defects.

Fittings

- Fittings shall conform to the same Indian Standard as for pipes. Pipes and fittings must be of matching I.S. Specification. Interchange of pipes of one standard with fittings on the other standard will not be permitted.
- Fittings shall be of the required degree of curvature with or without access door.
- Access door shall be made up with 3 mm thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal later. The fixing shallbe air and water tight.

Jointing (CI Pipes & Fittings)

- All Hub less centrifugally cast (Span) iron pipes shall be jointed with SS 304 grade coupling with EPDM rubber gasket joints as per requirement and specifications. These pipes shall be used for CSSD drainage system.
- All uPVC pipes & Fittings shall be jointed with solvent cement as per manufacturer's specifications and relevant I.S codes.
- All pipes shall be tested after installation for a pressure equal to twice the maximum

working pressure in the line as per manufacturer's specifications.

uPVC Rain Water Pipes

- All Rain Water Pipes used in building shall be uPVC pipes type A (4kg/cm2) for shaft pipes and 6kg/cm2 for external pipes. Rain water pipes above 200mm dia shall be NP2 pipes of light duty class.
- All pipes shall be straight and smooth from inside free from cracks and other manufacturing defects.
- uPVC Pipes & Matching Fitting shall be conforming to IS 4985 or BS: 4514.

Fixing

- All vertical pipes shall be fixed by Galvanised clamps and galvanised angle brackets truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).
- Horizontal pipes running along ceiling shall be fixed on galvanised structural adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.
- Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building Contractor for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces.

Clamps

- All pipe clamps, supports and hangers shall be galvanised. Factory made Pre-fabricated clamps shall be preferred. Contactor may fabricate the clamps of special nature and galvanise them after fabrication but before installation. All nuts, bolts, washers and other fasteners shall be factory galvanised.
- Clamps shall be of approved designs and fabricated from GI flats (which shall be galvanised after fabrication) of thickness and sizes as per drawings or Contractor's shop drawings. Clamps shall be fixed in accordance to manufacturer's details/ shop drawings to be submitted by the Contractors.
- When required to be fixed on RCC columns, walls or beam they shall be fixed with approved type of galvanised expansion anchor fasteners (Dash fasteners) of approved design and size according to load.
- Structural clamps e.g. trapeze or cluster hangers shall be fabricated by electro-welding from M.S. Structural members e.g. rods, angles, channels flats as per Contractors shop drawing shall be galvanised after fabrication. All nuts, bolts and washers shall be galvanised.
- Galvanised slotted angle/channel supports on walls shall be provided wherever shown on drawings. Angles/ channels shall be of sizes shown on drawings or specified in Bill of Quantities. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with anchor fasteners

mentioned above. The spacing of support bolts on support members fixed horizontally shall not exceed 1 m.

Traps

Floor Traps

Floor traps where specified shall be siphon type full bore P or S type Hubless centrifugally cast(Span) iron having a minimum 50 mm deep seal. The trap and waste pipes when buried belowground shall be set and encased in cement concrete blocks firmly supported on firm ground or when installed on a sunken RCC structural slab. The blocks shall be in 1:2:4 mix (1 cement: 2 coarse sand : 4 stone aggregate 20 mm nominal size).

Contractor shall provide all necessary shuttering and centring for the blocks. Size of the block shall be 30x30 cms of the required depth.

Floor Trap Inlet

Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type of floor or manhole inlet fitting fabricated from G.I. uPVC pipe without, with one, two or three inlet sockets welded on side to connect the waste pipe or joint between waste and inlet socket shall be Drip Seal. Inlet shall be connected to a C.I. P or S trap. Floor trap inlet and the traps shall be set in cement concrete blocks where varied in floors as specified without extra charge. Floor trap for the shower cubicle shall suit site and as per the approval of Employer's Representative.

Floor Trap Grating

Floor and urinal traps shall be provided with 100 -150mm square or round Stainless Steel gratings as approved with frame and rim of approved design and shape or as shown in the Drawings or approved by the Employer's Representative.

Cleanout plugs

Clean out plug for Soil, Waste or Rainwater pipes laid under floors shall be provided near pipejunctions bends, tees, "Ys" and on straight runs at such intervals as required as per site conditions. Cleanout plugs shall terminate flush with the floor levels. They shall be threaded and provided with key holes for opening. Cleanout plugs shall be Cast Brass suitable for the Pipe dia. With screwed to a G.I. socket. The socket shall be lead caulked to the drain pipes.

Waste Pipe from Appliances

- Waste pipe from appliances e.g. washbasins, sinks and urinals shall be of uPVC Pipes (6 kg/cm2) conforming to IS: 4985 in typical Toilets kitchens, pantries, and equipment's and service areas where so required, and as shown on the drawings.
- All pipes shall be fixed in gradient towards the connection to stack or drains. Pipes inside all toilets shall be in chase unless otherwise shown on drawings. Where so

required and shown on drawings or directed by the Employer's Representative.

Encasing in Cement Concrete

- Encasing of pipes is required to provide stability to the line and prevent its damage during construction.
- Pipes lay 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 12 mm size) 75 mm in bed and all round. When pipes are running well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars of required height at intervals of 1.8m.

Cutting and making good

Contractor shall provide all holes cut outs and chases in structural members necessary and required for the pipe work as building work proceeds. Wherever cut outs , holes are left in the original construction, 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.

Sleeves/ Cut-Outs.

Contractor shall utilised all cut out and sleeves provided during construction to prevent breaking. The annular space between the pipe and the sleeve shall be filled up with approved type of fire retardant sealant. When sleeves are misplaced or inaccurately located Contractor shall make the holes in the wall or structural members at his own cost but only with the prior permission of the Employer's Representative.

Testing

- Testing procedure specified below apply to all soil, waste and vent pipes above ground.
- Entire drainage system shall be tested for water tightness and smoke tightness during and after completion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber bellow plugs, manometers, smoke testing machines, pipe and fitting work test benches and any other equipment necessary and required to conduct the tests.
- 3.14.3. All materials obtained and used on site must have manufacturer's hydraulic test certificate for each batch of materials used on the site.

Specification for Water Supply System

The water supply system shall include the following:-

- Distribution system from main supply to all fixtures and appliances for cold & hot water Cold water supply lines from city water connections to Under Ground Water Tanks.
- Excavation and refilling of pipes trenches. Insulation to hot water pipes
- Control valves, masonry chambers and other appurtenances.
- Pipe protection and painting

General Requirements

- All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Employer's Representative.
- Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- 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.
- 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.
- Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.
- Clamps, hangers and supports on RCC walls, columns & slabs shall be fixed only by means of approved made of expandable metal fasteners inserted by use of power drills.
- 2.7. All pipe clamps, supports, nuts, bolts, washers shall be galvanised MS steel throughout the building. Painted MS clamps & MS nuts, bolts & washers shall not be accepted.
- 2.8 Valves and other appurtenances shall be so located as to provide easy accessibility foroperations, maintenance and repairs.

Water Supply System

EPC Contractor shall study the Design Basis Report, site plan and water supply system diagram for anoverview of the system.

Source of Water supply

a. Contractor shall study the site plan and water supply system diagram for overviews of the system.

b. Source

i. Local water supply for which a water main from the main road to theunderground water tank will be laid by Contractor.

ii. The rising mains will be connected to the main fire static tank and thenoverflow into the main domestic water tank.

c. Water supply piping for garden hydrant and sprinkler and irrigation system will be separate and independent connected to a different pumping system.

CPVC Pipes, Fittings

All cold & hot water pipes inside the toilet (Concealed in wall or in false ceiling) shall be CPVC pipes SDR 11 conforming to IS 15778.

Materials

- All pipes and fitting comply with IS 15778 standard.
- CPVC fusion compound (solvent cement) as per ASTM F493.
- All fitting are fusion bonding type (assembly using CPVC fusion compound) unless otherwise specified.
- All metal transition are brass type with threads as per IS 554 CPVC threaded fittingare not recommended.

Installation

- Install product according to manufacturer installation instruction and manual andfollow recommended safe works practices.
- Keep pipe and fitting in original packaging until needed and store pipes in coveredareas.
- Use tools designed for use with plastic pipe and fitting.
- Cut of minimum 25mm beyond the edge of the crack in case any crack is discovered inthe pipe.
- Cut the pipe as square (perpendicular) as possible before making joint. Always usesharp edge cutting tools. Sharpen holder tools periodically.
- Always apply a heavy & even cost of CPVC solvent cement on pipe and a light costinside fittings.
- Use CPVC fusion compound confirming with ASTMF 493.
- Always hold the fresh fusion compounded joint in place for 20-30 second.
- Use brass threaded MTA's and FTA's for hot water & for transition to or from Metal.
- Always conduct hydraulic pressure testing after installation to detect any leaks and faults. Wait for appropriate cure time before pressure testing. Fill lines slowly and bleed air from the system prior to pressure testing.
- Deburr, bevel and clean mating surface of pipe and fittings before joining.
- Rotate the pipe 80 degree to 190 degree to spread the CPVC solvent cement evenly in the while pushing the pipe into fitting.
- Use Teflon tapes with threaded fitting.
- Ensure that there no share edge in contact with the pipe while embedding the pipes onthe wall or in the floors.
- Provide vertical and horizontal supports as recommended using the plastic straps only.
- Apply only water- based paint on exposed pipes and fitting.
- Provide sleeves (pipe cover) at entry & exit it under slab installations & while crossing walls. Visually inspect all joints for proper cemented at the

end of shift or day. A visual inspection of the complete system is also recommended during pressure testing.

G.I. Pipes & Fittings

- Pipes shall be galvanised steel tubes conforming to I.S. 1239 of Medium / Heavy Class.
- Fittings shall be malleable galvanised iron and shall have manufacturer's trade mark stamped on it. Fittings for G.I. pipes shall include couplings, tees, reducers, nipples, unions, bushes. Fittings shall conform to I.S.1879-(Part I to X).
- Pipes and fittings shall be jointed with screwed joints. Care shall be taken to remove burr from the end of the pipe after reaming with a proper time.
- Pipe threaded joints will be made by applying suitable grade of TEFLON tape used for drinking water supply.
- All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. No pipes be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other areas as shown on drawings.

Stainless Steel – 316 Grade Pipe and Fittings

The pipes shall be Stainless Steel 316 pipes confirming to requirements of DIN-EN 10088 and the press fittings shall confirm to DVGW and Material No. 1.4404 for Press Connection system with leak before pressed function (LBP) showing penetration of water at the unpressed connection while filling the installation. The system shall withstand working pressure of 16 bars at 30 degree centigrade and shall withstand temperature of 110 degree centigrade shallbe doubly secured locking system.

The fittings shall be as follows:

Doubley secure Press fittings with leak before pressed function (LBP) for pipes from 15mm to 108 mm dia.

Technical Data

Stainless steel pipes - thin-walled and corrosion resistant stainless steel pipes. Material no. 1.4401 (X5 CrNiMo 17-12-2)

Black; EPDM (ethylene propylene diene rubber); up to 110 °C;

Not resistant to hydrocarbon solvents, chlorinated hydrocarbons, turpentine, petrol. Bars 3/6 m in length, with bright-finished external and internal surfaces

Plastic plugs on pipe ends.

All pipes are leak-tested and marked as such Pipe material no. 1.4401:DVGW approval

Fixing intervals

Pipe clamps suitable for SS pipes with protective inserts can be used.

Pipe Sizes	Interval [m]
15	1.25
22	2.00
28	2.25
35	2.75
42	3.00
54	3.50
76	4.00
88.9	4.00
108	4.00

Storage and transportation

Stainless steel pipes are thin-walled welded pipes made from material 1.4401 compliant with EN 10088.

To prevent damage impairing hygienic characteristics, the following information must be taken into account when transporting and storing pipes. Do not remove protective foils and protective caps until immediately before use. Do not store the pipes on hard floors without protection. Donot stick protective foils or similar to pipes. Do not pull pipes over loading sills. Only use a stainless steel cleaning agent to clean the surfaces of pipes.

Making the press connection

Metal pipes 12 – 54 mm

The press connection provides an easy and reliable means of connecting stainless steel and copper pipes. To make this connection, you will need Pipe cutters or a fine-toothed steel saw De-burrer and coloured pen to mark the insertion depth Certified press tool with press jaw suitable for pipe diameter 64.0 – 108.0 mm.

The press connection provides an easy and reliable means of connecting stainless steel pipes. Pipe cutters or fine-toothed steel saw De-burrer and coloured pen for marking Viega press toolwith press jaw suitable for pipe diameter Place the hinged tension jaw on the press tool and push in the retaining pin until it snaps into place.

Valves

All Valves shall be ball valve or butterfly valve as specified below or as per bill of quantities.

a. Ball Valves

Valves upto 40 mm dia. shall be screwed type Ball Valves with stainless steel balls, spindle, Teflon seating and gland packing tested to a hydraulic pressure of 20 kg/cm2, and accompanying couplings and steel handles.(to BS 5351)

b. Butterfly Valves

Valves 50 mm dia and above shall be cast iron butterfly valve to be used for isolation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction with accompanying flanges and steel handle. Butterfly valve shall be of best quality conforming to IS: 13095.

c. Non Return Valve (Slim Type)

Where specified non return valve (dual type check valve) shall be provided through which flow can occur in one direction only. It shall be single door swing check type of best quality.

Each Butterfly and dual plate Check (NRV) Valve shall be provided with a pair of flanges screwed or welded to the main line and having the required number of galvanised nuts, bolts and washers of correct length.

Pipe Supports

- All pipes clamps, supports, hangers, rods, pipe supports, nuts bolts & washers shall be factory made galvanised or alternatively galvanised after fabrication to suit site requirements.
- Stainless Steel Pipes in shafts and other locations shall be supported by galvanised clamps of design approved by Pipes in wall chases shall be anchored by G.I. hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from M.S. Structural. Pipes in typical shafts shall be supported on Galvanised slotted angles/channels as specified elsewhere.
- All pipes supports, hangers and clamps to be fixed on RCC walls, beams, columns, slabs and masonry walls 230mm thick and above by means of galvanised expandable anchor fasteners in drilled holes of correct size and model to carry the weight of pipes. Drilling shall be made only by approved type of power drill as recommend and approved by manufacturer of the anchor fasteners. Failure of any fastening devices shall be the entire responsibility and Contractor shall redo or provide additional supports at his own cost. He shall also compensate the owner for any damage that may be caused by such failures.

- 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 Employer’s Representative.

- Flanges
  Flanged connections shall be provided on pipes as required or where shown on the drawings, all equipment connections as necessary and required or as directed by Connections shall be made by the correct number and size of GI nuts, bolts & washers with 3 mm thick gasket. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by Bolt hole dia for flanges shall conform to match the specification for C.I. sluice valve to I.S. 780. And C.I. butterfly valve to IS: 13095.

Trenches

All water supply pipes below ground shall be laid in trenches. The width and depth of the trenches shall be as follows:-

Dia of pipe	Width of trench	Depth of trench
15 mm to 50 mm	30 cms	75 cms
65 mm to 100 mm	45 cms	100 cms

Sand filling

CPVC / G.I Pipes in trenches shall be protected with fine sand 15 cms all round before filling in the trenches.

Painting

All GI pipes above ground shall be painted with one coat of red lead and two coats of synthetic enamel paint of approved shade and quality. Pipes shall be painted to standard colour code given in these documents or specified by Employer's Representative.

Pipe protection

All GI in wall chase and below floor in toilets (where so fixed) shall be protected against corrosion by the application of two coats of bitumen paint covered with polythene tape and a final coat of bitumen paint.

G.I. waste pipes buried in ground or sunken slab shall be protected with multi-layer bitumenmembrane tape 3mm thick with a final coat of hot or cold applied bitumen.

Insulation

All hot water pipes shall be insulated with elastomeric closed shells circular pipes.

All insulation material shall be elastomeric closed shells foam has a high diffusion resistance factor that prevent excessive water diffusion that gives longer lifetime of material.

The insulation material having the property of resistance of fire i.e. in case of fire these materials do not drop and do not spread flames.

All insulation material as per din 1988/7 (standard for drinking water pipe installation and for avoiding corrosion damage and scale formation).

The thermal conductivity of material at 0 deg. C = 0.035 w/(m.K).

The temperature resistance of material between –45 deg. C to +116 deg. C.

The Thickness of insulation pipes as follows:

Size of pipes	Application of pipes	Location	Thickness of Material (mm)	Type of Section
15 mm to 40mm	Hot water supply	Concealed	6 mm	Tube Section
15 mm to 100 mm	Hot water supply	Exposed	13 mm	Tube Section

Water Meters

Flow has been designed to allow wireless remote reading in different types of applications. Flow shall be compatible with all the predisposed multiple jet meters and bulk meters and is compliant with the Modbus or equivalent protocol.

The system shall have the following features

Fraud control (Following can be identified with the system - Removal of the radio module, Application of external magnetic field, Reverse flow, Identification of system loss)

Magnetic tampering at the counter and removal are recorded and reported to the receivingsystem via radio transmission.

Automatic update of battery life for easier maintenance of the AMR system. Easy configuration through mobile application.

Certifications: IS 779:94 and conforming to ISO 4064(1) Class ‘B” Standard

IP68 protection allows the use of the module also for meters installed in difficult environments Specification sheets shall be submitted with material

Power Option: Battery with Direct AC Adaptor.

If the consumption is above a Specific threshold in a given time, Leakage alert is generated. Water meter has to be proposed in the following areas,

1. domestic water collection tanks,
2. corporation water inlet line,
3. rain water using lines,
4. STP treated water for flushing,
5. STP treaded water for gardening,
6. STP treated water for cooling tower,

Water meters of approved make and design shall be supplied for installation at locations as shown. The water meters shall meet with the approval of local supply authorities. Suitable valves and chambers or wall meter box to house the meters shall also be provided along with the meters.

The meters shall conform to Indian Standard IS:779 and IS:2373. Calibration certificate shall be obtained and submitted for each water meter.

Provision shall also be made to lock the water meter. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use in conjunction with padlocks, the hole provided for padlocks shall be a diameter not less than 4mm.

Disinfection of Piping System and Storage Tanks

Before commissioning the water supply system, the Contractor shall arrange to disinfect the entire system as described in the succeeding paragraph.

The water storage tanks and pipes shall first be filled with water and thoroughly flushed out. The storage tanks shall then be filled with water again and disinfecting chemical containing chlorine added gradually while tanks are being filled to ensure thorough mixing. Sufficient chemical shall be used to give water a dose of 50 parts of chlorine to one million parts of water.

If ordinary bleaching powder is used, the proportions will be 150 gm of power to 1000 liters of water. The power shall be mixed with water in the storage tank. If a proprietary brand of chemical is used, the proportions shall be specified by the manufacturer. When the storage tanks is full, the supply shall be stopped and all the taps on the distributing pipes are opened successively working progressively away from the storage tank. Each tap shall be closed when the water discharged begins to smell of chlorine. The storage tank shall then be filled up with water from supply pipe and added with more disinfecting chemical in the recommended proportions. The storage tank and pipe shall then remain charged at least for three hours. Finally the tank and pipes shall be thoroughly flushed out before any water is used for domestic purpose.

The pipe work shall be thoroughly flushed before supply is restored.

Sterilization of Main

After the pipe work has been tested and approved, but before it is coupled, it shall be sterilizedwith a solution of chloride of lime.

Lawn Hydrants

Lawn hydrants shall be of 25mm size unless otherwise indicated. All hydrants shall be provided with gate valves and threaded nipple to receive hose pipes. Lawn hydrant valves shall be of approved make and design. Where called for lawn hydrants shall be located in masonry chambers of appropriate size.

Irrigation System (Drip & Sprinkler Irrigation System)

¾” GEAR DRIVEN POP UP SPRINKLER

The sprinkler shall be of the gear-driven, rotary type, capable of covering an area of 6.7 to 15.2 meters radius at nozzle pressures of 2.0 to 5 bar with a discharge rate of 1.9 to 37.9litres/min.

The sprinkler shall come supplied with nine (9) standard and four (4) low angle numerically coded interchangeable nozzles.

Sprinkler Nozzle Trajectory shall be 26 degrees (standard) and 12 degrees (low angle).

The sprinkler shall be fitted with a radius adjustment/nozzle retainer screw.

The Sprinkler shall incorporate an “Arc Recall” feature to allow original arc pattern to be automatically resumed following by disturbance of nozzle setting.

Sprinkler shall have a Friction Clutch Mechanism to allow for 360 degree + forward or reverse movement of the nozzle turret without damage to the internal gear component.

Sprinkler shall provide both Part and Continuous Forward Full Circle adjustment from 40 degree to 360 degree.

Sprinkler coverage pattern shall be indicated by degree graduations and an arrow located onthe top cover. The arrow shall rotate to correspond with arc selected.

The sprinkler shall have a minimum of 5-inch (12.5 cm) pop-up stroke. The sprinkler shall have a 3/4” female thread inlet.

The body and riser of the sprinkler shall be constructed of Non corrodible, heavy duty ABS material.

The Sprinkler shall come equipped with anti-drain-check valve.

SOLENOID ELECTRONIC CONTROL VALVE

The valve shall have an operating pressure range of 1.0 -13.6 bars (15-200 psi).

The valve body shall be manufactured of 33% glass reinforced nylon and be unaffected by Climatic temperature variations within its full operating pressure range.

The valve shall incorporate a straight through flow path design and be full ported to provide very high flow capacities at minimal friction loss.

The valve shall meet / exceed the following flow characteristics at pressure losses not exceeding 0.5 bar (7.5psi).

Size 2” Valve – 756 LPM [200 (US) GPM] with a minimum flow capability of 7.6 LPM (2.0 (US) GPM).

The Valve shall be slow closing to avoid the potential for pressure surge/water hammer. The valve shall be normally closed and be either electrically or manually activated to open.

The valve diaphragm shall be spherical, reversible and manufactured of durable reinforced Rubber.

The valve diaphragm shall have a double seating surface for leak free closure.

The valve manual operator shall be of an internal bleed design so as to provide no discharge ofwater to atmosphere.

The valve manual operator shall be captive to the valve body assembly.

The valve flow control stem shall be constructed of stainless steel.

All internal components, including the diaphragm shall be captive within the valve bonnet ssembly.

The valve shall utilize stainless steel screws and integrally molded brass inserts as body toBonnet fasteners.

All valve control water shall be filtered through a conical stainless steel mesh screen.

The valve shall incorporate not more than three internal components to minimize servicing.

The valve shall have no hidden cavities so as to avoid potential for clogging.

The valve shall have pressure regulator to provide constant outlet pressure from 5to125psi.

DISC FILTER

SPECIFICATION DATA SUMMARY

2” T TYPE DISC FILTER:

Available Connection:		2" (BSPT)
Closing system	:	Stainless Steel Clamp
Max. Pressure :		8 kg/cm2

Range of Flow Rate:		22-35 m3 /hr
Nominal Flow Rate:		30 m3 /hr
Clean Pressure Drop:		Max 0.32 kg/cm2 atNominal flow
Filtration Surface Area	:	1193 cm2
Filtering Cartridge	:	PP Disc (130 micron)
Cartridge Diameter:		117 mm
Cartridge length:		394 mm
Weight	:	6.100 kg

PRO-Ex CONTROLLER

PRO-Ex (6 Station) Controller having multiple wire technology having 6 program with 6 starts time program. It has 6 available stations and run time per stations will be 0-10 hrs. 59 minutes max., and irrigation water budget by program 0-250% it has programmable rain of days 0-31 days max. and pause time between station will be 0-59 sec. It can run two valves plus master valve simultaneously. The controller shall be capable to rain sensor and operate 100-230 VAC 50/60 Hz input power.

AIR RELEASE CUM VACCUM RELIEF VALVE

Inlet size 2”

Material of construction – cast aluminum for dual advantage of being light weight as well as provides coregent resistance.

Synthetic rubber seal assure positive rubber seal with low head applications. Working pressure 10 bar

Testing pressure 16 bar

PRESSURE RELIEF VALVE

Inlet size 2” BSP female threaded connection Material of construction - cast aluminum Operating pressure 10 bar

Testing Pressure 16 bar

Specific pressure setting 8 bar which can be change in field as per requirement.

Masonry Chamber

i. All masonry chambers for stop cocks, sluice valves and meter etc. shall be built as persupplied drawings.
ii. The excavation for chambers shall be done true to dimension and level indicated on plans or as directed by the Owner’s site representative.
iii. Concrete shall be of cement concrete 1:5:10 (1 cement: 5 coarse sand: 10 graded stone aggregate 40 mm nominal size.
iv. Brick shall be of class designation 75 in cement mortar 1:4 (1 cement : 4 fine sand)
v. Inside Plastering not less than 12 mm thick shall be done in cement mortar 1:3 (1 cement: 3 fine sand) finished with a floating coat of neat cement.

Rectify all leakages, make adjustments and retest as required and directed.

All tests shall be made in the presence of the EMPLOYER’S REPRESENTATIVE or his representative or any inspecting authority. Any tests proved unsatisfactory shall be repeated to the satisfaction of the inspectingparties.

To provide skilled technicians/EPC engineer to commission the plant and associated controls to the satisfaction of the Consultant. The technicians/ EPC engineers will be required to demonstrate the correct procedures in starting and stopping the plant, running the various itemsof equipment under automatic and manual control and the correct maintenance of the plant.

When installed and subjected to the test loadings, the hanger shall not rupture, pull out, distortor otherwise be damaged and hangars shall not show permanent distortion resulting in a changein level or material position of the pipe to be supported in excess of 8 mm. If in-situ tests are conducted, appropriate safety precautions must be taken.

Prior to the system start-up, the following inspection, tests and pre-commissioning treatment shall be carried out:

Tanks and Level Switches:

The tanks shall be thoroughly cleaned with water and drained before city mains supply will feed in. Also before city mains supply will feed in, the level switch shall be simulated for the various cut-in and cut-out settings.

Pressure Switches

The testing equipment arrangement for pressure switches and pressure gauges shall be as shown on the drawings or of an approved equivalent.

Hydrostatic Tests:

All parts of the water circuit shall be filled with water before hydrostatic pressure testing, and pump running tests for verification of pressure and flow rate are conducted.

All parts of the water circuit shall be filled with water before hydrostatic pressure testing, and pump running tests for verification of pressure and flow rate are conducted.

The hand jacking pump shall be applied to increase the system pressure to 2 times the workingpressure or 1.5 times the working pressure plus 3.5 kg/cm2 whichever is more but in any casenot less than 7 bar. The pressure shall be maintained for a period not less than 24 hours.

Where any sections of pipe work or equipments unable to withstand the maximum pipe work test pressure, it shall be isolated during the pipe work test then that section of pipe work or equipment shall be re-tested at the appropriate test pressure.

The working pressure for various systems shall be as NFPA Rules or NBC/BIS guidelines. Before performing the hydrostatic test, the following system component shall be fulfilled:

Electrical Tests:

Electrical tests shall comply with the current edition of IEE regulations and requirements enforced by local authorities.

Electrical insulation tests earth electrode resistance test and cost amenity test shall apply to busbars, isolators and other equipment and wiring where applicable.

A 500V DC instrument shall be used to check the insulation resistance. The reading shall not be less than 1 mega-ohm in all instances.

Function simulation tests shall be performed to ensure that the systems have been installed to the control requirements as described in the specification therein.

Pump Tests:

The direct coupling of the pump drives shall be dismantled before the pump motor control panel is energised.

Demonstrate to the Consultant of acceptable clearances of the coupling alignment for ensuringsatisfactory power transmission.

The coupling shall not be re-mated again till the correct motor rotation has been demonstratedwith power drawn from the energised pump motor control panel.

Satutory Authorities Tests and Inspections.

Submission of all necessary forms and shop drawings/as-built drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted kept by these Authorities.

The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings shall be forwarded to the EMPLOYER for checking before submission.

Ensure that his submission shall not delay the subsequent inspection and test, otherwise he shallbe fully responsible for any consequence due to his delay.

Preliminary Commission Checks

Ensure that all equipment is thoroughly cleaned, lubricated and checked for serviceability before setting to work. Particular attention is drawn to the removal of building debris from the pipe work systems.

Special attention is drawn to the need for thoroughly flushing out all pipe work systems to ensure that all foreign matter is removed.

All automatic controls and safety devices shall be inspected and checked for service ability before the working fluid or electricity is applied to the system.

Commission Checks

When the various installations have been completed and the preliminary commissioning checkscarried out, EPC Contractor shall set to work, regulate and calibrate all system in the entire installation. Special attention shall be paid to the following items:

That all valves, switches, controls, etc. are regulated and capable of proper operation and in thecase of isolation valves that they are capable of tight shut off.

That all apparatus is silent in accordance with the requirements of this Specification. That all instruments are correctly calibrated and read accurately.

That all services are tested in accordance with the details in the relevant clauses of thisSpecification.

Operate pumps, pressure reducing sets, etc. to ensure that all control systems are functioningcorrectly and are properly set, sequenced or interlocked.

Final Acceptance Tests

Following commissioning of the entire installation, and prior to issue of the Completion Certificate, EPC Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the EMPLOYER

Shall the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, EPC Contractor shall adjust, modify and if necessary replace the equipment without further paymentin order that the required performance be obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these testsshall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

Specification for Sewerage and Drainage system

The drainage system shall include:

a) Sewer lines including excavations, pipe lines, manholes, drop connections
b) Storm water drainage, excavation, pipe lines.
c) Drainage lines and open drains shall be laid to the required gradients and profiles.
d) All drainage work shall be done in accordance with the local municipal bye-laws.
e) Location of all manholes, etc. shall be got approved from the Employer's Representative.

No drains or sewers shall be laid in the middle of road unless otherwise specifically shown onthe drawings or directed by the Employer's Representative.

Alignment and grade

The sewer pipes shall be laid to alignment and gradient as per the final drawings, depths of cutting or gradients of sewers shown on the drawings and sections shall be permitted except by the express direction in writing of the Employer's Representative.

Opening out trenches

In excavating the trenches, etc. The solid road metalling, pavement, kerbing, etc. and turf is to be placed on one side and preserved for reinstatement when the trenches or other excavation shall be filled up. Before any road metal is replaced, it shall be carefully sifted. The surface ofall trenches and holes shall be restored and maintained to the satisfaction of the Employer's Representative.

The Contractor shall grub up and clear the surface over the trenches and other excavations of all trees, stumps roots and all other encumbrances affecting execution of the work and shall remove them from the site to the approval of the Employer's Representative.

Obstruction of roads

The Contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit, he shall remove the materials excavated and bring them back again when the trench is required to be refilled. The Contractor shall obtain the consent of the Employer's Representative.

Removal of filth

All night soil, filth or any other offensive matter met with during the execution of the works, immediately after it is taken out of any trench, sewer, shall not be deposited on to the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be at once put into the carts and removed to a suitable place to be provided by the Employer.

Excavation

The trenches shall be excavated to such a depth that the sewer shall rest on concrete as described in the several clauses relating thereto and so that the inverts may be at the levels given in the sections.

Refilling

After the sewer or other work has been laid and proved to be water tight, the trench or other excavations shall be refilled. Utmost care shall be taken in doing this, so that no damage shall be caused to the sewer and other permanent work. The back filling up to 75 cms above the crown of the sewer pipe shall consist of the finest selected materials placed carefully in 15 cms layers and flooded and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 15 cms layers with materials taken from the excavation, each layer being watered to assist in the consolidation unless the Employer's Representative.

Restoration of settlement and damages

The Contractor shall, at his own costs and Charges, make good promptly during the whole period the works are in hand, any settlement that may occur in the surfaces of roads, berms, footpaths, gardens, open spaces etc. Whether public or private caused by his trenches or by hisother excavations and he shall be liable for any accidents caused thereby. He shall also, at his own expense and Charges, repair and make good any damage done to buildings and other property. If in the opinion of the Employer's Representative.

Disposal of surplus soil

The Contractor shall at his own costs and charges dispose all surplus materials not required to be used on the works. As each trench is refilled the surplus soil shall be immediately removed, the surface properly restored and roadways and sides left clear.

Width of trench

Recommended width of trenches at the bottom shall be as follows:-

100 mm dia pipe	55 cms
150 mm dia pipe	55 cms
225-250 mm dia pipe	60 cms
300 mm dia pipe	75 cms
400 mm dia pipe	80 cms
600 mm dia pipe	100 cms

Laying and jointing of HDPE pipes

a) Pipes are liable to be damaged in transit and not withstanding tests that may have been made before dispatch each pipe shall be examined carefully on arrival at site. Each pipe shall be rung with a wooden hammer or mallet and those that do not ring true and clear shall be rejected. Sound pipes shall be carefully stacked to prevent damage. All defective pipes shall be segregated, marked in a conspicuous manner and their use in the works prevented.
b) The pipes shall be laid with sockets leading uphill and rest on solid and even foundations for the full length of the barrel. Socket holes shall be formed in the foundation sufficiently deep to allow the pipe jointer room to work right round the pipe and as short as practicable to admit the socket and allow the joint to be made.
c) Where pipes are not bedded on concrete the trench bottom shall be left slightly high and carefully bottomed up as pipe laying proceeds so that the pipe barrels rest on firm ground. If excavation has been carried too low it shall be made up with cement concrete at the Contractor's cost and Charges.
d) If the bottom of the trench consists of rock or very hard ground that cannot be easily excavated to a smooth surface, the pipes shall be laid on cement concrete bed to ensure even bearing.

Gully traps

a) Gully traps shall be of the same quality as described for stoneware pipes in the final drawings.
b) Gully traps shall be fixed in cement concrete 1:4:8 mix and a brick masonry chamber 30x30 cms inside in cement mortar 1:5 with 15x15 cms grating inside and 30x30 cms C.I sealed cover and frame weighing not less than 7.0

kg (approx.) to be constructed as per standard drawing.

Reinforced cement concrete pipes

All underground storm water drainage pipes and sewer lines where specified shall be centrifugally spun S & S RCC pipes of NP2 class. Pipes shall be true and straight with uniform bore, throughout. Cracked, warped pipes shall not be used on the work. Laying R.C.C. spun pipes shall be laid on cement concrete bed as per the final drawings.

Jointing

After setting out the pipes the socket shall be centred over the spigot and filled with cement mortar 1:1 (1 cement: 1 fine sand) and caulked by means of proper tools. All joints shall be finished at an angle of 45 degrees to the longitudinal axis of the pipe.

Manholes and chambers

All manholes, chambers and other such works as specified shall be constructed in brick masonry in cement mortar 1:4 (1 cement: 4 coarse sand) or as specified in the Bill of Quantities.

All manholes and chambers, etc. shall be supported on base of cement concrete of such thickness and mix as given in the Bill of Quantities or shown on the drawings.

All manholes shall be provided with cement concrete benching in 1:2:4 mix. The benching shall have a slope of 10 cms towards the channel. The depth of the channel shall be full diameter of the pipe. Benching shall be finished with a floating coat of neat cement. (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal Size) as per standard details.

All manholes shall be plastered with 12/15 mm thick cement mortar 1:3 (1 cement: 3 coarse sand) and finished with a floating coat of neat cement inside. Manhole shall be plastered outside as above but with rough plaster mixed with water proofing compound.

All manholes with depths greater than 1 m. shall be provided with plastic coated catch rings set in cement concrete vertically and staggered.

All manholes shall be provided with steel Fibre reinforced plastic (SFRC) covers and frames and embedded in reinforced cement concrete slab. Weight of cover, frame and thickness of slab shall be as specified in the Bill of Quantities or given above.

Cement Concrete and Masonry Works (for manholes etc.)

Materials

a. Water

Water used for all the constructional purposes shall be clear and free from oil, acid, alkali, organic and other harmful matters, which shall deteriorate the strength and/or durability of the structure. In general, the water suitable for drinking purposes shall be considered good enoughfor constructional purpose.

b. Aggregate for concrete

The aggregate for concrete shall be in accordance with I.S.383 and I.S. 515.in general; these shall be free from all impurities that may cause corrosion of the reinforcement. Before actual use these shall be washed in water, if required as per the direction of Employer's Representative. The size of the coarse aggregate shall be done as per I.S.383.

c. Sand

Sand for various constructional purposes shall comply in all respects with I.S. 650 and I.S. 2116. It shall be clean, coarse hard and stone, sharp, durable, uncoated, free from any mixture of clay, dust, vegetable matters, mica, iron impurities soft or flaky and elongated particles, alkali, organic matters, salt, loam and other impurities which may be considered by the Employer's Representative'

d. Cement

The cement used for all the constructional purposes shall be grade 43 or 53 conforming to I.S.269.

e. Mild steel reinforcement

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

f. Bricks

Brick shall have uniform Colour, thoroughly burnt but not over burnt, shall have plain rectangular faces with parallel sides and sharp right angled edges. They shall give ringing sound when struck. Brick shall not absorb more than 20% to 22% of water, when immersed inwater for 24 hours. Bricks to be used shall be approved by the Employer's Representative

g. 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 Employer's Representative

Cement concrete (plain or reinforced)

a) Cement concrete pipes bedding, cradles, foundations and R.C.C. 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 Employer's Representative Rate for cement concrete shall be inclusive of all shuttering and centering at all depth and heights.

b) Concrete work shall be of such thickness and mix as CPWD Specifications.

c) 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 pipes trenches and foundations shall be kept dryduring the curing period.

Masonry work

Masonry work for manholes, chambers, septic tanks, and such other works as required shall be constructed from1st class bricks or 2nd class as specified in the bill of quantities in cement mortar 1:5 mix (1cement: 5 coarse sand). All joints shall be properly raked to receive plaster.

Cement concrete for pipe support

d) Wherever specified or shown on the drawings, all pipes shall be supported in bed all round or haunches. The thickness and mix of the concrete shall be given in the Bill of Quantities.

e) Unless otherwise directed by the Employer's Representative cement concrete for bed, all around or in haunches shall be laid as follows :-

	Depth Upto 1.5 m	Depth Upto 3 m	Depth Beyond 3 m
Stoneware pipes In open ground (No sub soilWater)	all round (1:4:8)	in haunches (1:4:8)	all round (1:4:8)
R.C.C or SW In sub soilWater	All round (1:3:6)	in haunches (1:3:6)	in haunches (1:3:6)

C.I. Pipes (In all Conditions)	All round (1:3:6)	in haunches (1:3:6)	in haunches (1:3:6)
R.C.C. Pipes	All around (1:4:8)	all around (1:3:6)	all around (1:3:6)

(Ratio refer to cement: coarse sand: stone aggregate 40 mm nominal size)

Connection to existing sewer

The connection to an existing sewer shall, as far as possible, be done at the manholes. Where it is unavoidable to make connection in between two manholes, the work of breaking into the existing sewer and forming the connection shall be carried out under the supervision Administrative Authority.

Breaking of sewer shall be effected by the cautions enlargement of sewer hole and every precaution shall be taken to prevent any material from entering the sewer. No connection shallbe former in such a way so as to constitute a projection into the sewer or to cause any diminutions in its effective size.

Specifications for Water Supply & Drainage Pumps

General requirements

- All water supply pumps shall be energy efficient to confirm IGBC rating.
- All water supply pumps shall be with IE-3 efficiency motors.
- All materials shall be new of the best quality conforming tospecifications and subject to the approval of Employer's Representative.
- All equipment shall be of the best available as per approved make list manufactured by reputed firms.
- All equipment shall be installed on suitable foundations true to level and in a neat workmanlike manner.
- Equipment shall be so installed as to provide sufficient clearance between the end walls and between equipment to equipment.
- Piping within the pump house shall be so done as to prevent any obstruction in the movement within the pump house.
- Each pumping set shall be provided with a butterfly valve on deliveryside and a flap type non return valve on the delivery side along with pressure gauges as required.

Specifications for Pumps

All systems offered will be complete packaged systems comprising of the pumps, stainless steel vessels, variable speed control systems, sensors, pressure gauges and switches.

Pumping Sets for Water Transfer Pumps

Water supply pumps shall be suitable for clean filtered water. Pumps shall be single/multi stage vertical, centrifugal pumps with stainless steel 304 body and stainless steel (DIN W-Nr .1.4301) 304 impeller, stainless steel 316 shaft and mechanical seal and coupled to a TEFC electric motor. Each pump shall be operating to a curve required by the operating conditions.

All parts in contact with water shall be corrosion resistant stainless steel DIN- Nr.1.4401.

Each pump shall be provided with a totally enclosed fan cooled induction motor of suitable H.P. The motors shall be suitable for 410 volts, 3 phases, 50 cycles A.C. power supply and shall conform to IS 325 operating at 2900 RPM nominal speed.

Each pumping set shall be provided with 100-mm dia gunmetal “Borden” type pressure gauge with gunmetal valve and connecting piping.

Pump or the whole set shall be stable on rubber vibration eliminating pads appropriate for each pump as recommended by the manufacturer and accepted by the Employer’s Representative/Owner rep.

Submersible Pumps

Submersible pumps for sewage/drainage shall be single stage, single entry pump. Pump shall be with C.I. casing and C.I. two vane enclosed type dynamically balanced impeller connected to a common SS-304 shaft to the motor. The vane for sewage pump will be open type, while for drainage pump etc. It will be of semi open type.

Stuffing box shall be provided with mechanical seals

Each pump shall be provided with water cooled squirrel cage induction motor suitable for 415 volts, 3 phase, 50 cycles AC power supply.

Each pump shall be provided with liquid level controller for operating the pump between predetermined levels.

The pumping set shall be for stationary application and shall be provided with pump connector in it. The delivery pipe shall be joined to the pump through a rubber diaphragm, and bend and guide pipe for easy installation, without disturbing delivery pipe the pump unit shall have a back pull out design. A rust proof chain shall be provided for each pump.

Pump shall be provided with all accessories and devices necessary and required for the pump to make a complete working system.

Level Controllers

Level controllers shall be electronic low voltage type using required number of stainless steel type probes, shrouded in PVC sheath or encapsulated in a stainless steel pipe. The level controller will be used for following applications: -

Filter feed pump and domestic water transfer pump. To start/cut off all operating pumps when:-

a) Water level is low in storage water tanks with low water level audible alarm.

b) To cut off filter feed pump and domestic water transfer pump when water in tank is full.

Sump Pump level controller & high water alarm

To cut off the drainage sump pump when the sump is empty and to start when:-

a) Duty pump No. 1 at pre-determined level No.1

b) Duty pump No. 2 at a higher pre-determined level.No.2

Pipe & Fittings (for Headers and Connections)

Pump suction and delivery headers shall be Galvanized iron pipes with matching fittings. The pipe joints shall be threaded as per manufacturer's instructions.

Valves

Butterfly Valves

Butterfly Valves shall be cast iron body with following details:-

a) Disc shall be CI heavy duty electrolysis nickel plated abrasion resistant.

b) The shaft is EN-8 Carbon Steel with low friction nylon bearings.

c) The seat shall be drop tight constructed by bonding resilient elastomer inside a rigidbacking.

d) Built in flanged rubber seals.

e) Actuator to level operated for valves above ground and T Key operated for valves belowground.

f) Built in flanges for screwed on flanged connections.

Manufacturer's details on fixing and installation will be followed.

Non Return Valves (NRV)

a) Non return valves will be used at location to allow flow only in one direction andprevent flow in the opposite direction.

b) NRV shall be cast iron slim type with cast iron body and gunmetal internal parts andaccompanying flanges. Valves shall conform BS.

c)

Painting and cleanup

a) On completion of the installation Contractor shall scrub clean all pumps, piping, filtersand equipment and apply one coat of primer.

b) Apply two or more coats of synthetic enamel paint of approved make and shade on steelpipes.

c) Provide painted identification legend and direction arrows on all equipment and piping asdirected by Employer's Representative.

d) On final completion of the work, Contractor shall cleanup the site, filter room of allsurplus materials rubbish and leave the place in a broom-clean condition.

Pipe & Fittings (for Headers and Connections)

Pump suction and delivery headers shall be of approved corrosion resistant material with matching fittings. The pipe joints shall be threaded or as per manufacturer's instructions.

Vibration Eliminators

Provide on all suction and delivery lines as shown on the drawings double flanged reinforced neoprene flexible pipe connectors. Connectors shall be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connectorsshall be as per site requirements in accordance with manufacturer details.

Valves

Valves 50 mm dia and above shall be rubber lined butterfly valves.

Non return valves shall be rubber lines cast iron slim type of approved make.

Flow measurement

Provide Rota meter reading "LPH" or "LPM" on delivery line of the plant.

Painting and cleanup

a) On completion of the installation Contractor shall scrub clean all pumps, piping, filters and equipment and apply one coat of primer.
b) Apply two or more coats of synthetic enamel paint of approved make and shade on steel pipes.
c) Provide painted identification legend and direction arrows on all equipment and piping as directed by Employer's Representative.

On final completion of the work, Contractor shall cleanup the site, filter room of all surplus materials rubbish and leave the place in a broom-clean condition.

Piping Materials

SS304 - Submerged air piping

MS epoxy	-	Air piping and pumped effluent riser (Non submerged) PVC
piping	-	Pumped effluent (submerged) & tank overflow pipe line.
GI (Heavy) filter.	-	Interconnecting pipe line after delivery header of pump /

Valves

The Contractor shall supply and install all isolating valves and control valves as required for the proper and efficient operation and maintenance of the entire systems.

All valves supplied shall be suitable for the working pressure and test pressure of the system as specified elsewhere in this specification.

Regulating valves shall be of similar materials as that specified for cast iron gate valves.

All regulating valves shall be lock shield type.

All valves shall be full line size.

Each valve shall have a purpose made reference number plate for label engraved or stamped indicating the manufacturer's catalogue number, pressure and temperature ratings. Valves shall be arranged so that clockwise rotation of the spindle will close the valve. Dymo labels are not acceptable.

Furnish all valves and accessory materials necessary in the piping whether or not shown on drawings as flows.

All valves shall be packed with an approved packing and threads shall be coated with oil and graphite. Packings shall be replaced when found deteriorated on site.

Where possible locate all valves at convenient positions of operation from the floor with valve stems upright.

Valves that are flanged shall have flanges to the table specified for the pipe work.

Plastic or metal plates (rustless) shall be provided to indicate the open / close status as well asthe use of each valve in the pump and tank rooms.

Intrudence clause of pipe support here.

General Support

The Contractor, on the award of the work, shall prepare detailed working drawings, showing the cross-sections, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in buildings and other structure through which pipes are designed to pass.

Piping shall be properly supported on or suspended from, on stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchor, clamps and hangers, and be responsible for their structural stability.

Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. Risers shall be supported at each floor with Galvanised steel clamps. To permit free movement of common piping support shall be from a common hanger bar fabricatedfrom Galvanised steel sections.

Piping shall be supported from the building structure, which shall support the sum of the load of a water-filled pipe and a minimum of 120 kg applied at the point of hanging.

All piping brackets shall be constructed as shown on the standard detail drawings. Vertical

pipe work shall be supported at intervals of at least one per floor level.

Horizontal pipe work shall also be supported by adjustable flat iron or clevis type hangers hung by hot rolled steel rods of the following diameters and spacing subject to the EMPLOYER'S REPRESENTATIVE's approval:

Nominal Pipe Size	Distance between Supports	Diameter of Rod
25 mm	1.8 m	10
32 mm	2.4 m	10
40 mm	2.7 m	10
50 mm	2.7 mm	10
65-80 mm	3.0 m	12
100 mm	3.0 m	16
150-200 mm	3.6 m	18

The end of the steel rods shall be threaded and not welded to threaded bolt.

Hangers shall be supported by means of approved fasteners. Wood plugs shall not be used. Unless allowed by the structural Employer's Representative, power fixings may be used for pipe work of diameter less than 50 mm. Expansion fasteners may be used for vertical pipe work under 100 mm diameter.

All pipe work shall be carried out in a proper workman like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shallbe organized in consultation with other agencies work, so that area can be carried out in one stretch.

Pipe sleeves, larger diameter than pipes, shall be provided wherever pipes pass through walls and slab and annular space filled with fiberglass and finished with retainer rings.

The Contractor shall make sure that the clamps, brackets, saddles and hangers provided for pipe supports are adequate or as specified / approved by Consultants. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installedto avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reduces shall be used for the piping to drain freely. In other locations, concentric reduces maybe used.

Automatic air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15mm pipe size and shall be associated with an equal size gate valves.

Discharge from the air valves shall be piped through a pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.

Pressure gauges shall be provided and Care shall be taken to protect pressure gauges during pressure testing.

Installation

The Contractor shall check the associated civil work prior to the installation of any item of machinery and advise the Employer's Representative, in writing, of any deviation of such work fromthe specified details.

The machinery shall be accurately installed to correct dimensions, alignments, levels, etc., all as indicated on the final drawings. The machinery shall be mounted on flat steel packing piecesof thickness suitable to take up variations in level of the concrete foundations. Suitable packing pieces shall be located adjacent to each holding down bolt and shall be properly bedded by grinding the concrete surface to a smooth, level finish. The machinery shall be aligned and levelled and the nuts of the holding down bolts tightened with a spanner of normal length. The base plates shall be packed with grout after the machinery has been run and checked by the Employer's Representative for stability and vibration.

Installation shall include the provision and fixing of all necessary holding down bolts, washers, nuts etc.

The length of all bolts shall be such that when fitted with a nut and tightened the threaded portion of the bolts shall protrude from the top face of the nut by a distance not exceeding half the bolt diameter. Exposed bolt heads and nuts shall be hexagonal. All equipment and materials of the same type shall be products of the same manufacturer. Locally made equipment will notbe accepted unless otherwise specified. All similar items of plant and their component part shall be completely interchangeable. Spare parts shall be manufactured from materials similarto the originals and shall fit all similar items of plant. Where machining may be needed beforefitting renewable parts, the machining fits with their tolerance shall be shown on the drawingsaccompanying the instruction manuals.

All motors and/or revolving parts shall be truly balanced both statically and dynamically so that when running at normal speeds and any load up to the maximum there shall be no significant vibration due to lack of balance. All parts which can be worn or damaged by dust shall be totally enclosed in dust-proof housings.

Maintenance Facilities

Permanent work platform and catwalk shall be designed by the Contractor and provided by theContractor for access to elevated equipment. The catwalk and platform for access shall allowa minimum width of 750mm.

Catwalk to maintenance platform shall be provided with railings and guards designed for safemovement of personnel in a restricted space including provision for gaining access and to accommodate maintenance personnel.

Hand railing and guards shall be designed by the Contractor and provided by the Contractor for all concrete tanks to allow safe movement of personnel.

Permanent I-beams, lifting eyes, etc. shall be provided by the Contractor over major equipmentwhich requires lifting for overhaul and maintenance.

Waterproof power sockets required for servicing shall be provided by the Contractor. The number and locations shall be proposed by the Contractor and approved by the Employer's Representative/ Employer's Representative. Power supply to these sockets shall be taken from control panel of the sewage treatment system.

The design of all permanent work platform, hand rails, etc. shall be submitted to the Employer's Representative for approval. The loading and fixing method of lifting facilitate shall also be submitted to the Employer's Representative/ Employer's Representative for approval and checking within 4 weeks on award of Contract or receipt of letter of intent.

Testing

The performance of the system shall be demonstrated by taking hourly samples of the raw sewage and final effluent over a twelve hour period. The sample shall be taken at periods approximately the flow rates specified by the plant. The sample shall be combined and a 5-day BOD shall be run, the results of which must verify the capacity of the treatment plant prior to acceptance.

Training

Required Training to be provided by the Contractor to ensure that the employer's staff associated with the project may acquire full knowledge and appreciation of all aspects of the design, day-to-day operation, breakdown and routine maintenance, and fault diagnosis of all plant, equipment and systems.

Training to the employer's staff shall be held as appropriate at the Contractor's or manufacturer's premises and on site. A detailed syllabus for each of the training courses specified or proposed and the timing of the courses shall be submitted for approval. The Contractor shall recommend the desirable qualifications and experience of the trainees to optimally benefit from the courses.

The Contractor shall be deemed to have include in his tender price the cost of providing training facilities as specified. In addition to the above, the Contractor shall submit to the Employer's Representative a list describing such other spares and special tools, their

number, price and where appropriate the anticipated frequency of replacement as soon as is practicable.

Reference Drawings

- The Contractor shall maintain one set of all drawings as reference drawings. These shall not be used on site. All important drawings shall be mounted on boards and placed in racks indexed. No drawings shall be rolled.
- All corrections, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings to be submitted by the Contractor in fulfilment of the conditions of this contract.
- Before execution of work, the Contractor shall submit detailed working/shop drawing to the Employer's for clearance.
- Shop drawings are detailed working drawings which incorporate the Contractor's details for execution of the work and incorporate equipment manufacturer's details and dimensions to ensure that the same can be installed in the space provided.
- All shop drawings shall be with detailed pipe routing and levels, showing location ofother services at crossings etc., cable runs, route cable trays and all allied works and must be fully co-ordinated with other services and approved by the Employer's Representative before execution of the works. Employer's Representative shall arrange to issue two copies/prints of services drawings from the respective contracting agencies. All drawings will be valid only when stamped and issued by the Employer's Representative.
- Shop drawings shall also be furnished for detailed layout of all equipment, foundation, bolting and vibration elimination details along with information on dead and dynamic load, vibration etc.
- Six sets of manufacturer's equipment drawings, roughing in and wiring diagrams shallbe submitted.
- Contractor shall submit shop drawings furnishing all details of MCC panels, cable routes, wiring diagrams and connection details as required.
- Three copies of each set of shop drawings shall be submitted for initial scrutiny, discussion and approval.
- Each submission shall be accompanied by Contractor's certificate stating that the shop drawings meet all the contract requirements and that the piping and equipment can besatisfactorily installed without any obstructions in the space available.
- On approval of the above the Contractor shall furnish three sets of the approved shop drawings for execution of the work.

2.3 SEWAGE TREATMENT PLANT

2.3.1 Basis of Design

The capacity/ rating of pumps and equipment etc. shall hold good for the capacity of 400 cu m/ day and shall be good for meeting the treated parameters requirement as follows:

a. Permissible limit as prescribed in IS: 2490 (Part-I) – 1974 and environment (Protection) Rules 1986.
b. Water (Prevention and Control of Pollution) Act, 1977 & 1978.
c. Environment (Protection) Act, 1986.
d. Environment (Protection) Rules, 1986.
e. Hazardous Wastes (Management & Handling) Rules, 1989.
f. Manufacturer, Storage and Import of Hazardous Chemicals Rules, 1989.
g. Manufacturer, use import and storage and hazardous Micro-Organizers, Genetically Engineered organizations or Cell Rules, 1989.
h. Manual on sewage & sewage treatment - CPHEEO
i. The Public Liability Insurance Act, 1991.
j. All standards as laid down by Central Pollution Control Board and any other relevant statutory authority.
k. 100% recycle of waste water and removed of sludge with no water to be discharged outside the premises.

2.4 WATER TREATMENT PLANT (WTP)

Filters-Dual Media/ Activated Carbon/ Pressurized Sand Type & Softener

i. Pressure filters for Water Supply System

- Pressure filters shall be manufactured with factory made bobbin wound polyester fibre glass multilayer filters fitted with internal GI distribution pipe with polypropylene diffusers on top, collector pipes and arms, inlet and outlet header vertical water pressure dished ends complete with initial charge of filter media, G.I. face piping, accessories testing and commissioning complete, Working Pressure 3.5 kg/cm2 (Test pressure 5 kg/cm2). Along with Butterfly Valve/NRV or Dual Plate Check Valve & Gauge etc.
- Each vessel will be provided with suitable pressure tight manhole cover appropriately located for inspection and repairs.
- The diameter and height of each vessel shall be as per the design requirement and as per site conditions.

ii. Multi-Port Valves

- Each vessel will be provided with multi-port valves to operate and regulate the normal flow, backwash and rinsing, rapid washing, on the face piping.
- Provide suitable sampling cocks to draw water samples for raw water and treated water.

iii. Face Piping

- Each vessel shall be provided with non-corrosive face piping from the inlet to the outlet. Face piping shall be CPVC (IS 4985)/UPVC/GI 10 kg/cm2 all CPVC/UPVC/GI fittings are heavy grade to pipe and solvent weld and flanged joints
- All valves shall be butterfly valves as specified in the piping section over 50 mm dia. And above and for pipe dia. below 50 mm dia. shall be provided with ball valves.

iv. Water Filtration Plant (For Domestic Water)

Design parameters for the proposed filter shall be as follows:

i. Filter media:- Graded aggregate of required size selected coarse and fine silica sand as per latest water treatment practice. Aggregate and sand to be acid washed and having purity of 99.9%.
ii. Depth of filter media:- Approx. 750-900 mm deep (as per manufacturer‘s design)
iii. Back washing :- By air scouring through air blower (approx. 5.1 lpm/m2 of filter surface area and water supply from raw water pumps by reverse flow
iv. Output Water Quality for Domestic Filters: To conform to IS 10500 for the

relevant designcriteria.

v. Chemical Dosing Pumps

Dosing system comprising of an electronic metering pump with, 100 lit capacity uPVC/ HDPE solution tank with level gauge and lid on top.

Electronic driven metering pumps with mechanically actuated diaphragm with oil lubricated gear mechanism. The output of the pump shall be adjustable for operation from 10-100%. Pump construction shall be corrosion resistant polypropylene or similar material. Pump electrical circuit shall be interlocked with the main raw water /pool recirculation pumpsso that they operate only when the pumps are operating.

vi. Air Blower for Back Washing

Low pressure air blower with TEFC electrical motor, belt driven or direct drive, allmounted on a common structural based plate with oil and water separator.

Air blowers will be used for back washing operations. The air blower shall be designed foroperation of one filter at a time. Blowers will be designed for air flow of required capacity at 0.5 kg/cm2 pressure. (This may be modified to suit manufacturer's requirement for filtersoffered.)

The electrical switchgear shall be included in the respective MCC panel of the system

vii. Softener

Specifications shall be as per requirements. As per discharge & head, HOS shall be decided,dimension of shell shall be accordingly selected, optimum Resin quantity shall be selected with required OBR provisions to be considered. Softener shall be of MS with inner shell FRP lined. It shall be provided with back wash, regeneration facility.

Max. Working pressure : 3.5 Kg/cm

Min. Working pressure : 2.0 Kg/cm2

Output water parameters shall be as per IGBC norms & relevant IS standards.

The quality of Treated Water shall be as follows: -

pH	- 6.5 to 8.5
Total Dissolved Solids	- < 200 mg/l
Total Hardness as $CaCO_3$	- < 50 mg/l
Total Alkalinity	- < 100 mg/l
Total Bacterial Count	- < 10 MPN
Turbidity	- nil
Suspended solids	- < 1mg/ltr

2.5 R.O. PLANT

The Contractor shall provide water treatment plant suitable for supplying water to haemodialysis machines with necessary supportive arrangement like pre-treatment, RO Unit, Post treatment unit, electrical panel, RO panel, Inline conductivity monitoring for the proper functioning of the plant in the haemodialysis unit with the quality of treated water as per latest AAMI standard or ISO 23500 standard. The RO plant shall be able to generate ultrapure water and shall have integrated heat (80 deg C) and chemical disinfection facility.

General

- Water testing (Chemical and bacterial) shall be included in maintenance.
- Chemical testing shall be done in every 3 months and bacterial testing shall be done every month
- All piping (of PEX material) and plumbing work related to unit as per design of unit shall be provided.
- It shall have 1500 liters capacity or more.
- The unit shall have BIS or US FDA or European CE with four digit notified body number certificate or ISO 13485 (from notified body) and certificate to be submitted to the Employer.

Pre-treatment

- Pre-treatment shall have a Mesh Filter of 50 microns.
- There shall be an automatically controlled Solenoid Valve to fill the Raw Water Tank.
- Raw Water Tank having food grade quality for at least 750 liters capacity to store Raw Water
- Sand filter with sand particles for different grade shall have fully automatic backwash & rinse cycles every day.
- Particle filter, cartridge filter type of 10 -50 microns.
- Shall have build in softener with fully automated digital display, brine fill and clean cycles. It shall also have a brine tank incorporated in the system.
- Carbon filters (2 nos) with fine carbon granules shall have fully automatic backwash cycle & rinse every day.
- Shall have fine filter, cartridge type of 1 -5 micron.
- Raw water feed pump (centrifugal) as per institution requirements has to be provided by the vendor during installation RO Unit
- Shall be microprocessor based double stage RO System which shall produce water as per latest AAMI Standard or ISO 23500 standard
- Shall have dynamic Water-Saving Technology and rinsing system available.
- In built capabilities to show on display (Supply in litre/hr, Temperature) & for Raw Water (Consumption in litre/hr& Pressure).
- Shall have programmable fully automated rinse cycle for membranes wash.

Post Treatment System

- Shall have food grade material and conical shape Permeate Storage
- Tank of at least 750 Liters capacity with level control system.
- Shall have sub-micron bacterial filter of 0.2 microns manually back washable.
- Shall have Flow indicator of Wall Mounting type showing Liters/Min Supply and to build back pressure.
- One addition booster pump made up of Stainless steel 316 shall be supplied with the system.
- Shall have Stainless Steel, 316 grade Push-Pull type Stainless Steel Connections for up to 30 nos (as per requirement- Price for 30 nos will be considered for ranking purpose and price shall be quoted separately) Water outlet at Dialysis machine connecting points for dialysis machines.

Other requirements

OEM has to provide Suitable Air conditioning (AC) System if it is required for the smooth functioning of the RO system during DNP.

The Contractor shall install feed water pipe for hemodialysis machine from RO room to hemodialysis room.

Specifications

Work under this Contract shall be carried out strictly in accordance with specifications attached with the tender.

Items not covered under these specifications or 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 up to date amendments as applicable in the Contract.

Works not covered under Paragraphs above shall be carried out as per relevant Codes & Bureau of Indian Standards and in case of its absence as per CPWD Specification

Design Basis

The Contractor shall work out central RO Capacity for Hospital Building as per Indian standard / Norms. The system is installed in a set of two (1 Working+1 Standby). In all other areas potable RO Water System shall be installed as per DBR

Components & specification of Centralized RO Plant are mentioned hereunder:

RO High Pressure Feed Pumps (HPP) of Vertical multistage centrifugal type and suitable head togenerate permeate flow. The pump casing construction shall be of SS-316 & impeller shall be also SS 316. The motor shall be TEFC with IE-3 efficiency suitable for a supply of 415V / 3 Phase at 50 Hz. Supply. The pump shall be supplied complete with base channel, coupling foundation bolts, pressure gauge, valves at inlet and outlet of each pump. (1 working + 1 Standby). RO high pressurepump is water feeding from treated water tank to RO module at high pressure flow.

RO Raw Water Pumps (RWP) of Vertical multistage centrifugal type and suitable head to generate permeate flow as required. The pump casing construction shall be of SS-316 & impeller shall be also SS 316. The motor shall be TEFC with IE -3 efficiency suitable for a supply of 415 V / 3 Phase / 50 Hz. Supply. The pump shall be supplied complete with base channel, coupling foundation bolts, pressure gauge, valves at inlet and outlet of each pump. (Contractor to confirm duty for suitability). (1 working + 1 Standby).

Package type RO module capable of giving a net treated water output as required. The Reverse osmosis module shall be made out of Sprial Wound Thin Film Composite suitable BSPT/NPT connections shall be used for connecting feed and reject ends. The modules shall be supplied complete with all necessary instrumentation, valves for sampling, drain, reject and permeate.

Special Antiscalant dosing system consisting of one HDPE tank of capacity as required with a positive displacement diaphragm dosing pump having variable flow rate. The motor shall be suitable for operation at 240 V / single phase / 50 Hz supply. The pump shall be supplied completewith necessary polypropylene piping, valves, strainers and injection fittings.

Micron cartridge filter (shall be made of FDA compliant high quality poly propylene material) suitable for a flow rate as required to achieve particle filtration of less than 5 microns. The unit shall be supplied complete with inlet and outlet branches, removal caps for replacement of elements, inlet and outlet pressure indicator, valves etc. complete in all respect.

CIP system (Cleaning in Place) consisting of HDPE tank with agitator complete with inlet/outlet,drain overflow etc. along with SS pump of capacity as required and cartridge filter of 10 micron. The cartridge filter shall be made of FDA compliant high quality poly propylene material to achieve particle filtration of less than 10 microns.

PH correction dosing system consisting of one HDPE tank with a positive displacement diaphragmdosing pump having variable flow rate as required. The motor shall be suitable for operation at 240 V / single phase / 50 Hz supply. The pump shall be supplied complete with necessary polypropylene piping, valves, strainers and injection fittings.

Centralized control panel made out of CRCA sheet min. 2mm thick having main contactors for allpumps (listed above) including SPP, 3 phase thermal overload relay. The control panel for monitoring and control of RO system shall include all required signal lamps, HRC fuses, and Annunciation box with hooter. All control and power cabling along with double earthing betweenthe panel shall be included in the scope of the Contractor. An emergency stop push button shall beprovided in the panel.

High pressure side piping from the RO high pressure pumps to the rejects stream control valves shall be of SS 316 using all SS fittings ball valves of suitable pressure rating shall be

used till 50 MM size, above 50 MM, flanged globe / water butterfly valves in SS construction shall be used. Rejects pressure control valves shall be globe valve and feed flow control valve shall be of SS 316.

SS 316 RO Water storage tank (Capacity as Required) of minimum 3mm thickness. Tank shall be provided with water flow meter at inlet & outlet, inlet / outlet valves, overflow / drain connection with MH cover (550 mm I.D.) Tank shall be mounted on 450 mm high steel structural supports with access ladder painted with 2 coats of red oxide paint.

Electrical and Instrumentations

Control Panel : Fixed cubical type with weather proof DOL/Star Delta Starters (as per requirements) consisting of incoming feeder with outgoing feeder feeders, Voltmeters, Ammeter, push button with indicator lamp, overload relays, Contactors, Bus bar of required size, control cablings etc.

Potable Water Purifer

Design, Supply, installation, testing & commissioning of Potable Water Purifier (RO+UV) of water flow rate & Storage as required incl. RO membrane, pumps, motors, cartridge filters, interconnecting pipes, valves, cable etc. complete in all respects as per manufacturer's standards & as directed by Employer's Representative.

Required Treated Water Parameters

S. No.	Parameter	Unit	Value
1	PH Value	-	7.2 – 7.5
2	Colour	hazen	Clear
3	Total Hardness	mg/l	< 50
4	Iron	mg/l	< 0.05
5	Chlorides	mg/l	< 50
6	Total Dissolved Solids	mg/l	< 100
7	Magnesium	mg/l	Nil
8	Sulphate	mg/l	< 100

Pipe & Fittings (for Headers and Connections)

Pump suction and delivery headers shall be of approved corrosion resistant material with matching fittings. The pipe joints shall be threaded or as per manufacturer's instructions.

Vibration Eliminators

Provide on all suction and delivery lines as shown on the drawings double flanged reinforced neoprene flexible pipe connectors. Connectors shall be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connectors shall beas per site requirements in accordance with manufacturer details.

Valves

Valves 50 mm dia and above shall be rubber lined butterfly valves. Non return valves shall be rubber lines cast iron slim type of approved make.

Flow measurement

- Provide Rota meter reading "LPH" or "LPM" on delivery line of the plant.
- Provide one direct reading flanged type water meter with strainer on outlet of water softeneror water filter.

Painting and cleanup

a) On completion of the installation Contractor shall scrub clean all pumps, piping, filters andequipment and apply one coat of primer.
b) Apply two or more coats of synthetic enamel paint of approved make and shade on steelpipes.
c) Provide painted identification legend and direction arrows on all equipment and piping asdirected by Employer's Representative.
d) On final completion of the work, Contractor shall cleanup the site, filter room of all surplus materials rubbish and leave the place in a broom-clean condition.

2.6 SOLAR WATER HEATING SYSTEM & ELECTRIC WATER HEATERS

Materials

- All materials used in this work shall be new, conforming to the specifications.
- All materials used in the project shall be approved by the Employer's Representative before use.
- Solar water heating system shall meet the minimum efficiency levels as mentioned in IS 13129 (Part 1 & 2).
- Piping insulation shall comply with 5.2.4 of ECBC latest edition. The entire hot water system including storage tanks, pipelines shall comply relevant IS standards.

Design Criteria

Solar Panels

Minimum Ambient temperature shall be approximate 2 deg C.

Water temperature in storage tank shall be 600 C and supply temperature at taps shall be 550 C.

Storage tanks

Hot Water Storage Tanks shall be made up of stainless steel (SS 304) horizontal / vertical hot water storage tank with SS lining from inside having a suitable working pressure of 5 kg/sq.cm and tested to 7 kg./sq.cm. The tank shall be provided with 100 mm thick glass wool / rock wool insulation covered with chicken mesh, polythene lining including 24 gauge aluminium cladding.

The entire solar hot water system shall be packaged type mounted on a factory made GI/aluminium support system with adequate anchorage to prevent the panels from high wind velocities and rain.

Each system of the panels, collector box and storage tank shall be of capacity given in theBOQ.

Technical Specifications of Solar Hot Water Heating System

Solar Panels

Solar panels shall be flat plate type manufactured from copper sheets approx. 23 mm thick(± 2%) with the header made of copper 25.4 mm dia and 0.7 to 0.8 mm thick, risers made of copper 12.5 mm dia and .56 mm thick. The riser and header brazed and the riser and sheet bondedby laser or ultrasonic welding.

The surface shall be coated with black chrome coating with approx. solar absorptive of the order of 0.95 and emissivity – 0.12 ± 2%. The panel shall be factory tested to a pressure of 290 kpa without any pressure drop in 30 min. The flanges for connections shall be copper.

Collector Box

The panels shall be placed in collector box fabricated from 16swg, 1.4 mm thick extruded aluminium section with size to accommodate the solar panels and insulation (Approx. size 1860 x1240 x 100 mm deep). The collector box shall be provided with one piece toughened glass 4 mmthick with 92% transmittance co-efficient. The glass shall be fixed with a gasket suitable for high temperature. The glass shall not break and /or crack on impact. The solar panels installed in the collector box shall be insulated with rock wool / mineral wool having a density of 48 kg. /cum and K value of 0.52 W/m k or less. Thickness of the insulation at the back of the panels shall be 50 mm and on sides 25 mm. The insulation shall be protected from moisture with sealed 0.05 mm thick aluminium foil.

Storage Tank

Hot Water Storage Tanks shall be made up of stainless steel (SS 316) horizontal / vertical hot water storage tank having a suitable working pressure of 5 kg/sq.cm and tested to 7 kg./sq.cm. The tank shall be provided with 100 mm thick glass wool / rock wool insulation covered with chicken mesh, polythene lining including 24 gauge aluminium cladding.

The tank end shall also be provided with a coupling for installation of an electrical heating element.

Each storage tank shall be provided with required KW of electric heater element with a thermostatand require size of power cable.

Each hot water storage water tank shall be provided with a sacrificial magnesium anode with steelcore. The anode shall be screwed to the tank from outside for easy replacement.

Collector support frame

The solar collector and the water tank shall be supported on a factory galvanized steel frame fabricated from 40 x 40 x 4 mm thick angle, flat and other sections. Alternatively the support framemade from pressed steel galvanized sections for lower weight will be accepted.

Piping

All pipes shall be galvanized iron pipes conforming to IS 1239 Medium Class. Hot water pipes shall be insulated and comply with 5.2.4 of ECBC. The insulation shall be protected with a protective coating comprising of fiber glass fabric and an active resin system and shall be applied in situ in accordance with insulation manufacturer's recommendation.

Pipes and insulation between the solar panels and the hot water tanks shall be an integral and inherent part of the system and the rate for the same will be included in the solar panel item.

Piping from the HW storage tank upto the connection to the building's cold water and hotwater supply and return lines shall be a part of the item.

Valves:

Valves upto 40 mm dia shall be ball valves with brass body and chrome plated balls and operating handle.

Valves 50 mm dia and above shall be CI butterfly valves with CI handle as per IS : 13095.

Air Valve

An automatic air release valve on top of each hot water line to expel entrapped air shall be provided.

Water meter

A water meter on the main cold water inlet on the terrace shall be provided .The water meter shall be provided with a brass strainer recommended by the meter manufacturer.

Main hot water outlet shall have a thermostatic mixing valve for controlling temperature.

Electric Water Heaters

Electrical water heaters shall be of storage type and capacity as mentioned in Drawings. The heating element in water heaters shall be titanium enameled which gives better performance and longer life. The power supply shall be 230 volts Ac, 50 HZ single phase.

Electrical water heater shall meet minimum efficiency level as mentioned in IS 2082.

Heat Pumps

The Packaged type Air to Water Heat Pump. shall be completely factory assembled including 2 Nos. Scroll Hermetically Sealed Scroll / Reciprocating Compressor(s), evaporator, Condenser and Microprocessor Control Panel etc with R134a / 410 a Referigerant and COP between 3-4. The Heat Pump shall have inbuilt hot water heat exchanger, vibratipon isoltors, pumps, valves, expansion valve, Copper / Aluminium fins, and other accessories.The Heat Pump shall be capable of producing hot water at minimum 55°C temperature at outlet (condenser circuit) temperatures at approx. 40°C ΔT. The Machine shall have an operating ambient temperature range of 0°C to 40°C.

Heat Pump shall have built in electric panel as per safety norms as manufacturer standard. It shall be Suitable for electric supply of 415 + 10% volts & 50 Hz. The Heat pump shall have an in-built facility to start / stop depending on variation in demand at different periods. All

interconnecting wiring / cabling between heat pump and electrical panel shall be part of the equipment.

The Heat Pumps shall be installed in required number at terrace level of hospital building.

Commissioning & Testing

After completion of the pre-commissioning stage, check for flow of water flow in all floorsto ensure that COLD WATER flows through the taps smoothly and uniformly. In case of UN evenflows balance the flow by throttling floor level valves.

DO NOT ENERGIZE THE BACK UP SYSTEM. Allow the solar panels to heat up the water for a day or two and check for hot water flow AFTER the temperature in the hot water tankhad reached the desired limit.

Adjust the common thermostatic valve to ensure that the water in the taps is not overheated. During the day. THIS TEST WITHOUT POWER SUPPLY SUPPORT MUST BE CARRIED OUT FOR THREE DAYS.

On successful commissioning of the panels with power back, the power back heating elements be switched on sequentially according to a set pre-determined order and ensure that hot water is available during night time or during cloudy days when the sun imploration is minimum.

Commissioning of the system must be accompanied with measurement of water and powerconsumed to assess the performance of the system.

Contractor shall hand over a record of all readings of measurements mentioned above.

2.7 SIGNAGES & ASSOCIATED WORKS

General

i. The item of work for the respective signage shall be conforming to Specifications/ tender drawings and shall cover all operations, fabrications and their installations and materialsrequired for finished product.
ii. The signage work shall be got executed through specialized fabricator having experience of similar works. The EPC Contractor shall submit the credentials of such fabricator for the approval of the Employer's Representative.
iii. The EPC Contractor shall submit the Design, Size and installation procedure along with samples to Employer's Representative for approval. Approved samples will be kept at site till the whole work is completed. Employer's Representative has right to modify the design of the approved samples and Contractor is bound to follow these written instruction/ changes in design/ size etc. from Employer's Representative.
iv. The typical patterns shown in the drawings are only indicative. The Contractor shall submit shop drawings, for approval of the Employer's Representative, for fabricating signage with detailing of frame work, if any, along with the fixing details. The details of the signage including location, etc. shall be shown in the shop drawings.
v. The Contractor shall submit to the Employer's Representative, samples of various materials for the signage work, for approval. After approval of samples of materials, the Contractor shall prepare sample(s) for approval of Employer's Representative. The material shall be procured and the mass work taken up only after the approval of the mock up by the Employer's Representative. The mock-up shall be dismantled and removed by the Contractor as per the directions of the Employer's Representative. Nothing extra shall be payable on this account.
vi. The finished surface shall be free of any defects like dents, waviness, scratches, stains etc. and shall have uniform finish. Any defective work shall be rejected and redone by the Contractor at his own cost. The finished surface shall therefore be protected using protective tape which shall be removed at the time of completion of the work. The surface shall then be suitably cleaned using nonabrasive approved cleaner for the material. Nothing extra shall be payable on this account.
vii. The signages shall be fixed with stainless steel anchor fasteners or other suitable arrangement for fixing the signage.
viii. The entire work shall be carried out to the satisfaction of Employer's Representative.
ix. The Pictures shown for Internal Signages are for reference. The shape & Size of the Signages shall be as per the reference pictures. All the Internal Signages shall Bilingual (English/Hindi). The colour of the print to be finalized after having a careful study of the Building Interior which shall be constant in all the buildings. The content of the Signages will be as per Architectural Plans.
x. The fabricator will keep a liberty to choose any one of the items between "IF, IG, IV, IX and IY", wherever they are mentioned/marked without hanging The text height which shall be constant. For Example, if at any particular location "IG" is marked, but the content gets fitted in "IY", the fabricator shall use "IY" in that location instead of using "IG".Similarly, if at any particular location "IX" is

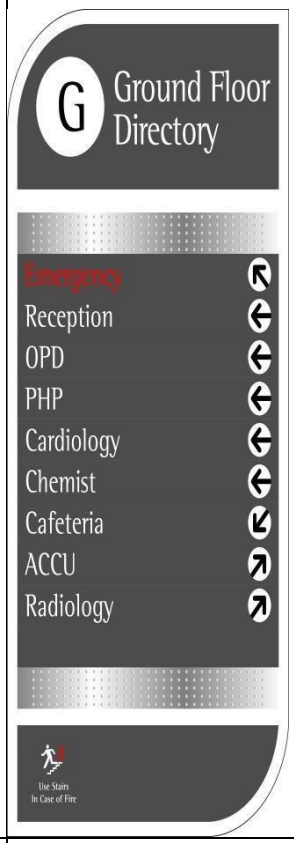
marked, but the content doesn‘t get fitted in “IX” with the standard font size used everywhere, but gets fitted in “IV”,the fabricator shall use “IV”in that location instead of using “IX”

xi. Way finding & Fire Exit signages suspended from Ceiling on corridors and other locations shall have content on both the two sides of the Signage for giving directions as per site requirement.

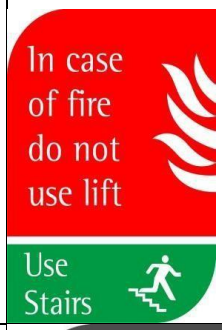
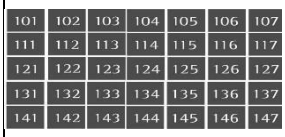
xii. General Specifications of various types of Signages are given below:-

The Signages shall be in “TRILINGUAL LANGUAGE- ENGLISH, HINDI & MALAYALAM” as per requirement and prototypes pictures are for reference purpose. The shade/ colour & content of Signages shall be as approved by Engineer-in charge

INTERNAL SIGNAGES- MAIN BLOCK (Trauma, OPD & IPD)
NOTE: The Signages shown below are for reference. The shape & Size of the Signages shall be as mentioned below. All the Internal Signages shall be in “BILINGUAL LANGUAGE” as per requirement similar to as shown in below Pictures.The colour of the print to be finalised after having a careful study of the Building Interior which shall be constant in all the buildings.The content of the Signages will be as per Architectural Plans.The fabricator may keep a liberty to choose any one of the items between “IF,IG,IV,IX and IY, wherever they are mentioned/marked without changing the text height which shall be constant. For Example, if at any particular location “IG” is marked, but the content gets fitted in “IY”,the fabricator shall use “IY” in that location instead of using “IG”. Similarly, if at any particular location “IX” is marked, but the content doesn‘t get fitted in “IX” with thestandard font size used everywhere, but gets fitted in “IV”,the fabricator shall use “IV”in that location instead of using “IX”. Wayfinding & Fire Exit signages suspended from Ceiling on corridors shall have content onboth the two sides of the Signage.

Sr. No	Index	Item	Size in mm	Reference Pic/Note	Material Specification
1	IA	Building Directory	1500x 2200 or as per requirement of content	Floor Wise Content shall be provided covering major facilities of all the Floors	Signage shall be of 8mm Solid bright white acrylic.Digital Print with Matt Lamination to be pasted for content.Wall mounted signages shall be fixed by making Key Holes on back side whereas suspended signages shall be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.
2	IB	Floor Directory	900x 1500		Signage shall be of 8mm Solid bright white acrylic.Digital Print with Matt Lamination to be pasted for content. Wall mounted signages shall be fixed by making Key Holes on back side whereas suspended signages shall be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.
3	IF	Department Nomenclature / Wayfinding	900x160		Signage shall be of 8mm Solid bright white acrylic.Digital Print with Matt Lamination shall be pasted for content.Wall mounted signages shall be fixed by making Key Holes on back side whereas suspended signages shall be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.

4	IG	Department Nomenclature / Wayfinding	1800x160		Signage shall be of 8mm Solid bright white acrylic.Digital Print with Matt Lamination shall be pasted for content.Wall mounted signages shall be fixed by making Key Holes on back side whereas suspended signages shall be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.
5	IJ	Door Name Plate	250x135		3mm Black Acrylic as base.3mm Clear Acrylic as top slider.Wooden beading on both the two sides polished to match finish as per design.Note:The size of acrylic is 250x135.Wooden beading is additional
6	IK	Change Room	200x200		Signage to be made with 8mm Solid bright white acrylic.Digital Print with Matt Lamination to be pasted for content.Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.
7	IL	Fire Exit	900x160		Signage to be made with 8mm Solid bright white acrylic. Photoluminescent vinyl to be used for content.Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.

8	IM	Fire Safety in front of Lifts	200x275		Signage to be made with 8mm Solid bright white acrylic.Digital Print with Matt Lamination to be pasted for content.Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.
9	IN	Washroom Signage	200x200		Signage to be made with 8mm Solid bright white acrylic.Digital Print with Matt Lamination to be pasted for content.Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.
10	IO	Level Signage	350x350		Signage to be made with 8mm Solid bright white acrylic.Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.
11	IP	Bed No	150x150		6mm white Acrylic sheet as Base material.Digital print with Matt Lamination as per approved colour to be pasted on top of the Acrylic Sheet.Wall mounted signages to be fixed with 2 Mirror Screws.In case of suspended ones, they shall be suspended with Fish Wires.
12	IV	Department Nomenclature/ Wayfinding	750x160		Signage to be made with 8mm Solid bright white acrylic.Digital Print with Matt Lamination to be pasted for content.Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.

13	IW	Door Name Plate	380X150		3/4ll deep Wooden member polished to get colour as shownin the Picture.Two 3mm whiteacrylic on top of it to make a sandwich to hold the Print as per design. Acrlic size - 355x128.Acrylic to be fixed with the wooden panel with SS Screws.
14	IX	Department Nomenclature / Wayfinding	600X160		Signage shall be of 8mm Solid bright white acrylic.Digital Print with Matt Lamination shall be pasted for content.Wall mountedsignages shall be fixed by making Key Holes on back side whereas suspended signages shall be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.
15	IZ	Fire Exit/EXIT	380X150		8mm clear Acrylic with CNC engraving for content.GI sheetpolished LED fitted panel on top of acrylic as shown in reference picture for lighting.Size of clear acrylic- 380x150.
16	IZ-1	Room Noplate	125x75		2mm 304 Grade SS brush finish panel as per reference picture.The Room no to be itched in black colour. N.B. The Room no in this signage will come only in English Language

2.8 CURTAIN TRACK AND CURTAIN FABRIC

CURTAIN TRACK

Curtain Track V RAIL 4100-(including all accessories) strong functional and fully reversible profile confirming to HTM66, synthetic wall and ceiling brackets complying with the European NEN 1010 standards, made of aluminium 606035- T6 –F2. Shape and size tolerance in accordance with DIN 17615. White powder coating colour RAL 9010, in accordance with Qualicoat standard. Runner/Glider hooks made of nylon 6.6 with SS 304 grade hooks. Profile weight must be 394 g/m. The system is such that if required can be mounted with ANTI-LIGATURE load release components, to provide a controlled system collapse as per NHS guidelines

CUBICLE / PRIVACY CURTAIN

Curtains fabric to comply with many safety protocols it must be stain retardant and has a coating of antimicrobial and fire retardancy effect, must be certified according to international standards, must be certified by Indian govt approved laboratories. It has to contributes to the reduction of transferring bacteria, help in increasing/improvement of hygienic standards provide greater safety against infection. No need of sterilization after wash. The antibacterial component facilitate in reducing the growth of fungi, moulds and mildew that can develop in any type of an indoor environment. Effective after 100 washes and, it must be Oeko Tex certified.

IV BAG HOLDERS

1) Must suspend from EZE lock I.V Carriage
2) Made from Stainless Steel for hygiene
3) Use CE 8500 (with Ultra Cube Track) OR CE 5500 (with Optitrac) to suspend track from hardceiling for support.
4) Use CE 5400 (With Optitrac) to suspend track from slope Ceiling from Support
5) Can be Used with Ultra Cube of Optitrac track System.
6) Size Open length 41.5” Closed length 27”

WALL GUARD

The system fixed to brick wall at 900mm center high from finished floor level comprising continuous aluminum rail retainer, 2 impact absorbing strip, end cap and high impact vinyl acrylic snap-on textured surface cover. The wall guard must be 140 mm / 152 mm / 200 mm wide, as specified by the the Employer , must have 2mm thick aluminum retainer, must have 2 mm thick scratch and stain resistance rigid vinyl cover, shall be coated with antifungal and antibacterial chemical. The system shall be designed to withstand impact and provides a cushioned surface

with its integrated rubberized absorber, making it ideal for areas like high traffic corridors, loading bays and light cargo lifts. The vinyl cover shall be fire retardant according to the norms and shall have test certificates of that. It must be according to ROHS compliances. The material shall come the ROHS certification from govt approved lab. Texture to provide an anti-slip surface, it shall have adjustable end cap, corner joint and adaptor plate. Aluminum retainer shall be in mill finishand fabricated from 6063-T5 alloy.

CORNER GUARD

The system fixed to brick wall at the corner from finished floor level. Adjustable end cap. High impact vinyl acrylic snap-on matt finished. “50mm wide x 10mm thickness x 900mm length “. The corner guard must be 50 mm * 50 mm/ 55 mm * 75 mm/25mm*25mm, as specified by the the Employer in size with aluminum retainer and rigid vinyl, must have 2mm thick aluminum retainer, must have 2 mm thick scratch and stain resistance rigid vinyl cover, shall be coated with antifungal and antibacterial chemical. The system shall be designed to withstand impact making it ideal for areas like high traffic corridors and corners. The vinyl cover shall be fire retardant according to the norms and shall have test certificates of that. It must be according to ROHS compliances. The material shall come the ROHS certification from Govt approved lab. Textureto provide an anti-slip surface , it shall have adjustable end cap .aluminum retainer shall be inmill finish and fabricated from 6063-T5 alloy .

2.9 ELECTRICAL WORKS

Following codes and standards with latest amendments have to be followed for Technical Specifications during design, execution and procurement of the project:-

a. Central Public Works Department (CPWD) 2013 Part I / IS codes – Internal wiring regulations

b. Central Public Works Department (CPWD) 2003 Part III – for Lifts & Escalators

c. Central Public Works Department (CPWD) 2013 Part IV – for substation design

d. National Building Code (NBC) 2016

e. Indian Electricity Rules (IER)2010

f. National Electric Code (NEC) 2011

g. Kerala State Electrical Inspectorate guidelines latest version

h. Kerala State Electricity Board guidelines latest version

i. IEC regulations for wiring & installations, 7th Edition

j. BEE guidelines – Energy conservation

k. KSECBC:2017 guidelines – Energy conservation

l. GRIHA 2019 guidelines – Energy conservation

m. IS 3043 2018 – Earthing system design and materials

n. IEC 62305-1:2010 – Lightning protection system design and materials

o. Indian Electricity Act 2003

p. IEC /CPRI/ERDA guidelines – Circuit breakers/ Electrical Panel Board design, Fabrication & Testing

q. CPWD/PCB guidelines – DG set design & Exhaust system

r. UL guide lines/NBC-2016/NFPA 72/ IS – 2189 – Fire alarm & control system

s. UL/FCC /CE /BIS /IEC/ONVIF standards – IP based CCTV system

t. Energy management system – ISO 50001 CERTIFIED OEM

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2.10 Solar Photovoltaic Power System

The Contractor shall perform detailed design, supply, installation testing and commissioning of on-grid connected, roof top mounted on-grid solar PV station including obtaining KSEB/KSEI approvals. Direct on-line grid-connected Solar Photo Voltaic Power system of suitable capacity shall be provided as per KSECBC: 2017/NBC 2016 and relevant KMBR rules as amended.

Solar PV station consisting of Mono/ Poly (as per latest design) Crystalline silicon solar cells, net metering facility, necessary protections, earthing, mounted on Aluminium/ GI structure of suitable strength with following components complete as required:

PV module

- Solar Photovoltaic Module of capacity: 50 KWp minimum
- Country of origin: India

- Standards: IS 14286/IEC 61215, IS/IEC 61730-Part-1, IS/IEC 61730-Part-2.
- Conversion efficiency: minimum 16.5%.
- Output peak watt capacity: minimum 90% at the end of 10 years and 80% at the end of 25 years.
- Glass: Tempered Ingress protection: minimum IP67

Power conditioning unit

Power Conditioning Unit (PCU) of 350-800 V DC Input voltage range and 400 V AC, three phase, 4 wire, 50Hz +/- 2.5 Hz, output voltage suitable to generate AC Power with efficiency not less than 97%, total harmonic distortion less than 3% and suitable for ambient temperature from 0 to 50-degree C. The PCU shall adjust the voltage and frequency level to suit the Grid Voltage Frequency.

Data Monitoring System complete with accessories

Array junction box & Main junction box with IP 65 protection and termination arrangement for incoming and outgoing cable along with glands, lugs and other accessories etc. as required.

Lightning and surge voltage protection

Interconnecting cables

Connections & Interconnections by supplying & fixing required size XLPE insulated copper conductor 1.1 kV grade armoured power and control cables between solar modules, main power cable to grid supply PCU unit along with supplying & fixing of necessary channel/conduit lugs and other accessories etc. as required.

The generated power will be directly connected to the power grid/distribution panel for load sharing during day time.

The solar power system to be provided shall feed the electrical loads to comply with KSECBC:2017 guidelines.

The Contractor has to provide suitable capacity solar power system to achieve silver rating of IGBC and meet all requirements as per statutory authority.

Solar cables shall be used for interconnection of various equipment like Solar PV Panels, Inverter etc suitable for outdoor installations.

2.11 ELV SYSTEM

2.11.1 IP BASED CCTV SYSTEM

2.11.1.1 General

The system offers surveillance using IP based system to monitor designated locations by installing IP based cameras and live monitoring, recording, play back from central control room with the help of network video recorders, LED monitors, Storage disk of sufficient capacity. The system shall be designed for minimum 2 mega pixel and 30 fpsof video management andfor a storage capacity of 30 days

2.11.1.2 Standards and codes

- Products shall comply with UL/ FCC /CE /EN/ BIS /IEC/ONVIF/RoHS standards
- Design & Installation guide lines shall be referred from latest NBC/CPWD regulations.

2.11.1.3 Scope of work

Supply, installation, testing & commissioning of IP based CCTV surveillance system as per the following details:

A. IP based dome camera – Refer relevant section in DBR for locations
B. IP based PTZ camera–Refer relevant section DBR for locations
C. Network Video Recorders & video management software
D. Storage hard disk
E. Server PC
F. Joy stick
G. LED display units
H. PoE switches
I. Patch Panels
J. Racks

Technical specifications of major components are given below:

A. IP IR Dome/ Bullet camera

Resolution	:	Minimum 4 MP
Type	:	Vari focal type, IP networkable, IR LED type
Image sensor	:	1/2.7 " CMOS progressive scan or better
Lens	:	2.5 to 15 mm or better

IR distance	:	minimum 30 mtr or better
Frame rate	:	25 fps or better
Other features:		Motion detection, tampering and defocus detection,Lens distortion support
Illumination required	:	minimum 0.02 lux colourWDR : Minimum 120 dB
Noise reduction	:	3 DNR
Built in micro-SD card	:	Memory slot with 128 GB capacity Video
compression	:	H 265, H 264, MJPEC codec support Product
compliance	:	ONVIF/FCC/CE/UL/EN/ROHS
		TCP/IP, UDP, DHCP, NTP, RTSP, PPPoE, SMTP,
		FTP, SNMP, UPnP, Unicast,Multicast, ICMP, HTTP, HTTPS, DNS, DDNS, RTP, RTCP, IGMP, 802.1X, QoS, IPv4,IPv6, ARP
Protection level	:	Minimum IP66, IK1
PoE	:	12 V DC.

B. IP IR PTZ Camera

Image Sensor	:	1/3" Progressive CMOS
Optical Zoom	:	minimum 30 X
Digital Zoom	:	OFF / ON (X2 ~ X8)
Effective Pixels	:	1920 (H) x 1080 (V)
S / N Ratio	:	>50dB
Min. Illumination	:	IR LED ON - 0 Lux
Colour	:	0.15 Lux, F1.35 (50 IRE AGC ON)
B/W	:	0.01 Lux, F1.35 (50 IRE AGC ON)
Focus length	:	f=4.45 to 89mm (F1.6 - F2.9)
Angle Field of view		
Horizontal	:	Appr. 55.56° (Wide) to 3.10° (Tele)
Vertical	:	Appr. 43.32° (Wide) to 2.34° (Tele)
Focus Mode	:	Auto / Manual / One push

White Balance	:	ATW / AWC / INDOOR / OUTDOOR / Manual
Iris Control	:	Auto / Manual
Electronic Shutter	:	AUTO / MANUAL / A.FLK, X60 ~ 1/30,000
AGC Control Selectable	:	OFF, LOW, MIDDLE, High, MANUAL
Backlight Compensation	:	OFF / BLC / HLC Selectable Digital Slow
Shutter	:	Sens-up (X2 - 48)
Motion Detection	:	ON / OFF (programmable zones)
Wide Dynamic Range	:	ON / OFF
Day/Night	:	Auto, COLOR, B/W (ICR)
Image Inverse	:	Off / H-Rev / V-Rev / HV-Rev
Noise Reduction	:	Super 2+3D-NR, OFF, Low, Middle, High
Electronic Image Stabilizer	:	ON / OFF

Operation:

Pan travel	:	360° endless
Tilt travel	:	0 - 90°
Manual Speed	:	0.1° - 150°/s
Presets	:	256
Preset Accuracy	:	0.1°
Preset Speed	:	180°/s
Swing	:	8
Cruise	:	8
Pattern	:	4
Privacy Mask	:	4
Proportional Pan & Tilt	:	Auto
Home Function	:	Preset / Swing / Cruise / Pattern
Auto Flip	:	Mechanical
IR Beam Distance	:	200m
Protection	:	IP66, Vandal-proof IK10

C. NETWORK VIDEO RECORDER

1. ANR technology to enhance the storage reliability when the network is disconnected.
2. HD input H.265/H.264+/H.264/MPEG4 video formats.
3. Connectable to the third-party network cameras.
4. No of channels for camera connectivity to be as per design.
5. Recording at up to 12 MP resolution.
6. Supports live view, storage, and playback of the connected camera at up to 12 MPresolution.
7. HD Output.
8. HDMI and VGA outputs provided.
9. HDMI Video output at up to 4K (3840 × 2160) resolution.
10. HD Storage.
11. Up to 4 SATA interfaces connectable for recording and backup.
12. Storage space effectively saved by 50% to 70% with the use of H.264+decoding format.
13. HD Transmission.
14. 1 self-adaptive 10M/100M/1000M network interface.
15. 8/16 independent PoE network interfaces are provided.
16. Centralized management of IP cameras including configuration, information import/export, real-time information display, two-way audio, upgrade etc.
17. Connectable to smart IP cameras, recording, playback and backing up of VCA alarmscan be realized.
18. VCA detection alarm is supported.
19. Instant playback for assigned channel during multi-channel display mode.
20. Smart search for the selected area in the video and smart playback to improve theplayback efficiency.
21. Supports HDD quota and group modes; different capacity can be assigned to differentchannels.

D. 42 inch LED monitor

Screen type	:	LED
Display size	:	42 inch
Panel	:	grade A
Screen resolution	:	1920X1080 pixel, full HD
Aspect ratio	:	16:10
Viewing angle	:	178/178 degrees
Contrast ratio	:	30000:1 dynamic
Colour system	:	PAL/NTSC/SECAM,

Interface input, Audio output,	:	TV, VGA, AV, YPBPR, USB, HDMI & audio
Type of mounting	:	Wall mount or table mount kit
PAP facility	:	Variable
PIP facility	:	must be provided
Voltage range	:	90 to 270 v ac

E. PoE Network switch

Network Ports: 8/16//24 auto speed-sensing 10/100 RJ-45 ports –to be selected as per design

Network Protocol and Standards:

a) IEEE 802.3i 10BASE-T
b) IEEE 802.3u 100BASE-TX
c) IEEE 802.1p priority tags
d) IEEE 802.3x Flow Control
e) IEEE 802.3af DTE Power via MDIPerformance Specifications:

Forwarding modes	:	Store-and-forward
Bandwidth	:	1.6Gbps
Network latency	:	Less than 20 µs for64-byte frames in store-and-forward Mode for 100Mbps to 100Mbpstransmission
Buffer memory	:	96KB embedded memory per unit Address
database size	:	1000 media access control (MAC) addresses per system
Addressing	:	48-bit MAC address Mean time between failures
(MTBF)	:	927,000 hours
Acoustic noise	:	0dB (fanless)Environmental Specifications:
Operating temperature	:	32˚ to 104°F (0˚ to 40°C) Storage temperature
	:	-40° to 158°F (-40° to 70°C)
Operating humidity	:	90% maximum relative humidity, non-condensingStorage humidity
	:	95% maximum relative humidity, non-condensingElectromagnetic Emissions
	:	CE mark, commercialFCC Part 15

Class BVCCI Class BEN 55022 (CISPR 22), Class BC-Tick, Class B

F. Server PC

Intel i7 processor, 24 inch LED monitor, Gigabit LAN port, USB port, 8GB DDR3 RAM,1TB HDD,1GB dual graphic card, 100/1000 LAN ports, optical mouse, Keyboard, DVD Writer. Genuine Win 8.1 Pro - Down grade to Win 7 professional

This is a minimum requirement and to be modified if any updation occurs before finalizationof contract

2.11.2 PUBLIC ADDRESS SYSTEM

2.11.2.1 General

EPC Contractor shall engage only authorized agency appointed by OEM to carry out the work. The system utilized to serve the dual purpose of providing back ground music, making generalannouncement or to transmit evacuation message under fire condition.

2.11.2.2 Codes and Standards

NBC 2016 – to finalize the locations and spacing of speakers/Equipments EN 54 – Material specifications

CPWD 2013 part I – Internal wiring

2.11.2.3 Scope of Work

The EPC Contractor shall carry out the entire work of the system which consists of following devices/items/works:

a) Ceiling/wall mounted speakers, provided in waiting areas, nurse stations and corridors
b) Wall mounted column speakers, provided in entry/exit staircases
c) Amplifiers, located in central control room of the building
d) Gooseneck microphone, located in central control room of the building
e) Zone selector, voice alarm router, voicealarm controller, Key pad extension located incentral control room of the building
f) MP3 player with provision to plug in USB device or DVD
g) Rack, located in central control room of the building
h) Speaker cable armoured FRLS type

i) Cable support system

Amplifiers

All amplifiers shall be Class D, mixing type for combining speech and music.

Power amplifiers shall have adequate continuous (RMS) power output to meet the requirement ofthe configuration. The unit shall be capable of delivering the rated output watts with less than 0.05% harmonic distortion in the design band width. The amplifier shall have a broad band frequency response of 20 Hz to 20 KHz. The output voltage and impedance shall meet with the system requirements.

Amplifiers shall be protected against over loads and output shorts and a special thermal overloadon the heat sink. Minimum 4 numbers of channel shall be provided for each amplifier.

The amplifiers shall be magnetically coupled switch mode type with two input signal sources selectable manually or automatically by the fire alarm system. The amplifier shall incorporate a push-to-talk switch.

Output wattage and volts shall be as shown in the schedule of work or as required to meet the needs of the PA system.

Amplifiers shall be mounted in suitable sized metal racks placed in the central control room in the ground floor of the building.

Speakers

Speakers shall be especially designed for broadcasting high quality voice communications and approved by an appropriate authority for use in such situations.

Speakers shall be ceiling or wall mounted as shown in the schedule of work and shall be completedwith mounting brackets accessories etc.

Speakers shall be of high efficiency yielding maximum output at minimum power across 200 – 12000 Hz frequency range. Speakers shall have a line matching transformer for direct connectionto amplifiers with multiple taps. Speakers shall be mounted in a rugged housing with vandal resistant grille. Speakers shall be interconnected in the zone configuration.

Speakers may be provided in waiting areas, nurse stations and corridors at particular intervals, andfire escape staircase exits.

Ceiling mounted speakers

The loudspeaker shall have built-in protection to ensure that, in the event of a fire, damage to the loudspeaker does not result in failure of the circuit to which it is connected. In this way, system integrity shall be maintained; ensuring loudspeakers other areas can still be used to

inform peopleof the situation. The speaker shall have ceramic terminal blocks, thermal fuse and heat-resistant, high temperature wiring.

The Ceiling speaker unit shall be a 6 W dual-cone loudspeaker with an integrated circular metal grille and 100 V matching transformer. The speaker cabinet shall be of neutral white colour.

The speaker assembly consists of a single-piece, 6W dual cone loudspeaker and frame, with a 100 V, matching transformer mounted on the back. The wide frequency range means better speech and music reproduction. Ceiling speakers are supplied with a 100 V matching transformer with taps on the primary winding for full power, half-power, quarter-power and eighth-power radiation. It has integral spring clamps on the rear which can be used to easily fix the loudspeaker into the falseceiling. Above ceiling part of the speaker may be protected against dust ingression by suitable material. A circular metal grille is an integrated part of the front. The appearance and neutral whitecolourhas been selected to be unobtrusive in virtually all interiors. The metal grille can be paintedto any colour to match the background.

Wall mounted column speakers

The Wall mounted speakers shall have built-in protection to ensure that, in the event of a fire, damage to the loudspeaker does not result in failure of the circuit to which it is connected. The 14 W bi-directional column loudspeakers shall provide good speech intelligibility and background music reproduction

Call station

The user interface to the entire public address system shall be the Zone Selection Panel. It shall be able to address all zones. The Panel shall have one Microphone for announcements. The selectionof announcement is done through the Panel. The announcement/Fire message can be made zone wise. The Control Panel shall have individual zone selection switches as well as ALL CALL switch.

a) Controls and indicators:
b) PTT-key
c) PTT status LED
d) Six zone selection keys
e) Six zone selection LEDs
f) All-call key
g) All-call status LED
h) DIP switches

Voice alarm controller

General

The central controller shall be the integrated solution for BGM and emergency voice alarm system (EVAC). The voice alarm system shall be designed for public address and emergency evacuation. All the essential EVAC functionality such as system supervision, spare amplifier switching, loudspeaker line surveillance, digital message management and a fireman's panel interface shall be combined.

It shall have the following functions:

a) The messages can be merged to allow even moreflexible use of pre-recorded announcements andevacuation messages. The controller can be used as a stand-alone system with minimum six zones.
b) All zones shall be individually selectable from the front panel and the BGM output level in each zone shall be individually settable in steps.
c) The router shall have a set of relays for zone-switching the power amplifier output(s) to different loudspeaker groups. Each of the zones shall be switched between the call channel (upon call-station selection or all-call microphone or emergency activation), the BGM channel (upon front panel selection), or off.
d) The call station shall be a stylish high quality call station with a stable metal base, a flexible microphone stem and a unidirectional condenser microphone. It shall be intended for making calls to selected zones. The special design shall allow for neatly flush mounting indesktops. Using dipswitches on the bottom of the call station, the call station ID shall be selectable. The call station shall have selectable gain, speech filter and limiter for improvedintelligibility.
e) It shall have LED indications for zone selection, fault and emergency state. The call stationextension shall provide seven additional zone and zone group keys.

Voice alarm router

The Voice Alarm Router is an expansion unit that can add six zones and 12 input contacts to the Voice Alarm System. It can use the built-in amplifier on the Voice Alarm Controller, and provides inputs and outputs for one or two amplifiers in a multiamplifier one or two-channel system.

It provides dual channel operation for calls and BGM simultaneously to a maximum of six different zones,using more amplifiers. Additionally, single channel operation is possible with only one amplifier. Multiple routers can also share one amplifier, including the internal amplifier on the controller unit. It is possible to use any number of amplifiers from one up to the number of routers used. The controller supports A/B wiring.

Gooseneck microphone

The gooseneck microphone is a stylish high quality unidirectional condenser microphone, mainlyintended for public address applications.

The flexible stem base has a screw fitting, and themicrophone comes with a multi-thread adaptor (3/8",1/2", and 5/8") for mounting onto floor-stands, panels or desktops. The microphone runs offthe phantom power supply from the amplifier to which it is connected. The on-off sliding switch, not only switches on the microphone, but also provides priority contacts forremote controlswitching purposes. If the prioritycontacts are not required, the microphone can be connected to amplifiers with 3-pin XLR-inputs, using the DIN to XLR adapter.

2.11.2.4 Testing

Entire PA system shall be tested to establish the following:

a) Functionality of the PA system
b) Combined systems shall be tested for the overriding feature for prioritizing fire alarm andlife safety requirements.
c) Acceptable audibility of the public address in all spaces and record sound pressure levelsof the Public address Vis a Vis the ambient noise levels.
d) The Provision of speakers is proposed so as to cover the entire area uniformly to have bettercommunication system in the Hospital.
e) The Speakers shall be distributed in the entire floor and shall be configured in different zones. The announcement can made in zone wise or to all the speakers simultaneously in ALL CALL mode. Fire message shall be announced immediately on receipt of fire signalfrom the panel to all zones.

2.11.3 DATA SYSTEM

2.11.3.1 General

Proposed network/data system provides network connectivity to all work stations, Wi-Fi points, Access control system, Information Display system, BMS, etc at 1 Gbps with CAT6 wiring with the support of Patch panels, Ethernet switches, Network racks, OFC connectivity between floor racks to main rack.

2.11.3.2 Scope of work

EPC Contractor shall carry out the entire work of the system which consists of followingdevices/items/works:

a) Data outlets, RJ45

b) pair UTP Cat 6 data cable
c) Uplink using either Cat 6 or OFC as per design
d) Patch panels
e) Ethernet switches
f) LIUs
g) Single mode OFC
h) Patch cords
i) Metal racks
j) Cable containment system

2.11.3.3 Technical specifications

Face plate of RJ45 socket

Face Plate - Single (Square) with shutter, Screws / hole covers to supplied with face plate, labelling on transparent plastic window, Face Plate - ABS, UL94-HB, Dust Cover - ABS, UL94-HB

Cat 6 UTP cable

Universal labels color coded for T568A/568B, suitable for 23-26 AWG stranded and solid wire, ETL verified unshielded EIA/TIA connecting hardware, Category 6, TIA568 C.2, Contact Bracket - PC, UL 94V-2, Use insulation displacement connectors (IDC), IDC Housing - PC+ Glass Fiber, UL 94V-2, 50 µinches gold on plug contact area, Phosphor bronze with Nickel plated IDC Contact

24-Port Category 6 - Patch panel fully loaded

Powder coated steel in 24 port configuration, shall support port identification numbers on the panel, IDC: Suitable for 22-26 AWG stranded and solid wire compatible with both 110 & Krone punch down tools, Cat-6 transmission performance. UL 94V-2, IDC Housing - PC+ Glass Fiber, UL 94V-2

Category 6 - Patch cords (1 & 2 Meters)

Shall comply to TIA/EIA-568-C.2 Standard, 24AWG stranded bare copper conductor, HDPE Insulation, Phosphor bronze Contact with Nickel Plated, 50 µinches gold on plug contact area

Core OS2 Single Mode Fiber

a) Core Single Mode 9/125 Micron Outdoor Fiber Optic Cable
b) Outdoor Steel Tape Armored (STA) construction
c) Shall support moisture resistance & shall have water proof layer
d) Shall be central loose tube with jelly compound
e) Operating temperature up to 60°C
f) Outer Sheath – HDPE
g) Bend radius as per IEC 60794-1-2, E6/E11
h) Shall support ISO 11801, EIA/TIA 568-B.3 & EIA/TIA 455 standards.
i) Max attenuation shall be 0.36db/km or better @ 1310nm and 0.22 db/km or better @1550 nm.

6/24-Port LIU Loaded

Standard 19" Rack mountable Aluminum base material

LIU shall be constructed of 16-gauge steel, powder-coated loaded with 06 SC SM Duplex Ports & required pigtails, shall have Atleast 2 fiber spools, removable front and rear coversfor better access,mounting & termination accessories to be supplied

Patch cords OS2 - SC-LC 2 meters

Single Mode Fibre Patch cord with SC to LC connectors, minimum 2 meter in lengthCompliant with TIA/EIA-568- C, IEC standards)

9U Floor Rack

Supply and installation of 9U (550W x 450D) wall Mount Rack with tinted, toughened Glassdoor with Lock & Key, PDU, Cable Manager, FAN, Mounting Accessories, Provision for earthing, Grounding and Bonding(Reputed Brand, DIN 41494 OR equivalent ISO Standards)

15U Wall Mount Rack

Supply and installation of 15U (550W x 450D) Wall Mount Rack with tinted, toughened Glass door with Lock & Key, PDU, Cable Manager, FAN, Mounting Accessories, Provisionfor earthing, Grounding and Bonding(Reputed Brand, DIN 41494 OR equivalent ISO Standards)

6U Wall mount Rack

Supply and installation of 6U (550W x 450D) Wall Mount Rack with tinted, toughened Glassdoor with Lock & Key, PDU, Cable Manager, FAN, Mounting Accessories, Provision for earthing, Grounding and Bonding(Reputed Brand, DIN 41494 OR equivalent ISO Standards)

Core Layer 3 10G Switch

Product Details	-	Make, Model No / Product Code
I/O Ports & Slots	-	12-port 10G SFP+ Switch including 2 10GBASE-T/SFP+ combo ports
Performance	-	Minimum 512MB or higher RAM, 4MB Packet Buffer, 240Gbps Switching Capacity, 178 Mpps Packet Forwarding, 8K or more Mac Address support,
Layer 2 Features	-	Shall support 4K VLAN Groups with 4K configurable VLAN ID, support STP, RSTP, MSTP, Loop Detection in downstream switches, Link aggregation, IGMP Snooping, MLD Snooping, QoS, Port Mirroring, ACL
L3 Services	-	Min 8 or More SVI / IP Interfaces, ARP / Gratuitous ARP, IPv4 and IPv6 Default & Static Routes
Security	-	SSH V1/V2, SSL V1/V2/V3, Port Security, IP Source Guard, DHCP Snooping, RADIUS, Port based /Host based 802.1X Authentication, Management access control via Local/Radius
Management	-	Web-based GUI, Console management, Telnet, SNMP v1/v2c/v3, TFTP or HTTP File transfers, IPv4 / v6 Dual Stack, Syslog, IPv4 and v6 DHCP Relay, LLDP,NTP/SNTP.
Electrical characteristics	-	Power inlet (AC): 100-240 VAC, 50-60 Hz.
Environmental specifications	-	Operating Temperature- 0oC to 50oC

Compliance/Certification	-	CE, FCC, C-Ticket, VCCI, BSMI, CCC
Industry Recognition	-	OEM shall have appeared in Gartner's Magic Quadrant for LAN infrastructure.

Layer 2 + Distribution switch

a) I/O ports and slots - Min 24 or more RJ-45 auto-negotiating 100 / 1000 Mbps Ports,minimum 4 1000/10000 SFP+ Ports
b) Performance - Min 95 Mpps or higher throughput, Min 120 Gbps or Higher SwitchingBandwidth
c) Connectivity- Auto-MDI/MDIX, IEEE 802.3X flow control, Packet storm protection, Fully I Pv6 capable (IPv6 host, IPv6 static routing, MLD snooping, IPv6 ACL/QoS)
d) Layer 2 features - Minimum 1000 VLANs with 4000 VID support, VLAN tagging, STP,
RSTP, Loop Detection in downstream switches, Link aggregation, LLDP
e) Layer 3 features- Address Resolution Protocol (ARP), Min 4 or More SVI / IP Interfaces, IPv4 & IPv6 Static & Default routingIPv4/v6 DHCP Relay, IPv6 Neighbor Discovery (ND)
f) Security - IP Access Control Lists (ACLs),IEEE 802.1X and RADIUS network logins, ARP attack protection, STP root guard, Port Security, IP Source Guard, DHCP Snooping,
Dynamic ARP Inspection
g) Management features - Command Line Interface (CLI), Web browser-based management, HTTPS / SSL, SNMPv1, v2c, and v3, SNMP Traps, NTP/SNTP, IPv4 / v6 Dual Stack,IPv6Ready,
h) Electrical characteristics - Voltage 100 - 240 VAC, Frequency 50/60 Hz
i) Environment - Operating temperature 32°F to 113°F (0°C to 45°C)
j) Certifications & Conformance - CB,LVD,CE, FCC, VCCI, and IEEE802.3az (EEE)
k) Industry Recognition - OEM shall have appeared in Gartner's Magic

10GbE Single Mode Fiber Transceivers

a) Hot Pluggable
b) Form Factor: SFP+
c) Distance Support: Min 10Km
d) Duplex LC Connector
e) Transceivers shall be from same OEM as switch

Wiring

4 pair unshielded twisted pair cable shall be used for data system wiring. Cat6 cable shall be Gigatrue 550Hz Solid Cable UTP of 23 AWG. The cat 6 cable must be drawn through 25 mm dia very heavy gauge PVC conduit from each data outlet to the nearest patch panel located in the service room of each floor.

4 pair cat 6 cables must be used for wiring from each data outlet. For each floor, wires from each data socket shall be taken to the patch panel installed in a metal rack. Cable shall be provided with identification labels on both ends. Cable must be terminated in patch panel in a neat manner. Before termination, cable must be tested for its performance as per the standard specifications.

4 pair cat 6 cables must be drawn in PVC conduit embedded in concrete slab or installed on surface of wall. PVC conduit must be either embedded in concrete or installed below RCC slab on surface as per site condition. The PVC conduit shall be very heavy gauge rigid type of minimum 25mm dia. When conduits are to be taken open, it can be either installed on wall or beneath concrete slab by using GI saddle spaced at 60cm intervals. Contractor must use standard fittings like bend, couplers etc. from the same manufacturer to ensure good workmanship.

Data outlets shall be of modular type. Type and finish of data sockets must match with other electrical wiring accessories of the project. Data socket and back box must be from same manufacturer. Data socket must be modular type matching with other electrical wiring devices. Cable tags must be provided at both ends to identify the cable.

2.11.4 TELEPHONE SYSTEM

2.11.4.1 Scope of work

The Contractor shall carry out the entire work of the system which consists of following devices/items/works:

a) Telephone outlets
b) pair telephone cable
c) Terminal blocks & Floor Junction box
d) Multi pair telephone cable
e) Main distribution box
f) EPABX
g) Cable containment system

2.11.4.2 Standards and Codes

CPWD standards for wiring installations

IEC 60364 -5 -523 for Installation method of electrical conductors/cables

2.11.4.3 Technical specification

Telephone wires

Telephone wires to be used must be one or more twisted pairs of copper wire as per UL -444 & EIA/TIA 568 B for application up to 16MHz, with annealed bare high conductivity copper, PVC/PE/Cellular PE insulated overall sheathed cores, twisted to form a pair, individual or overall shielding using aluminium-mylar tape/copper tape.

2 pair, 0.5 mm dia cable must be used for wiring from each telephone outlets to the floor terminalbox.2 pair telephone cable must be drawn in PVC conduit embedded in concrete slab or installedon surface of wall.

The PVC conduit shall be medium gauge rigid type of minimum 25mm dia.

Contractor must use standard fittings like bend, couplers etc. from the same manufacturer to ensuregood workmanship.

Cable tray to be used shall be perforated pre-painted GI cable trays with perforation not more than17.5%, in convenient sections. Accessories like couplers, Tees, Bends, etc. must be from same manufacturer.

Telephone outlets shall be of modular type. Contractor must refer make list provided for wiring devices in electrical part of the specification for type and finish of the telephone socket.

Installation

For each floor, 2 pair wires from each telephone outlet must be taken to the terminal blocks fixedin lockable junction boxes. The junction boxes shall be suitably located in services room or in a convenient place located in each floor, preferably in the lobby at high level close to the false ceiling. 25 mm dia rigid medium gauge PVC conduit must be used to contain the 2 pair telephonecable. PVC conduit must be either embedded in concrete or installed below RCC slab

on surface as per site condition. When conduits are to be taken open, it can be either installed on wall or beneath concrete slab by using GI saddle spaced at 60cm intervals.

When a bunch of PVC conduits are to be installed above false ceiling, cable support system usinganchor fasteners, threaded rods and GI slotted C channel of appropriate size must be used. GI back boxes of suitable size must be concealed in the block/RCC wall to accommodate telephone sockets. Type and finish of telephone sockets must match with other electrical wiring accessories of the project. Telephone socket and back box must be from same manufacturer. Telephone socket must be modular type matching with other electrical wiring devices. Cable tags must be provided at both ends to identify the cable.

Multi pair unarmoured telephone cable must be used for connecting floor terminal box to main distribution frame located in the main telephone room within the building Multi pair cable must be laid in a suitable sized containment system(cable tray/cable trunking) which runs between floordistribution frame & MDF. Tray/Trunking shall be pre-painted GI cable trays perforated type andinstalled on wall or hanged from RCC slab using proper support system/ anchor fasteners at regular intervals. Cable laid in the tray shall be neatly dressed using heavy gauge cable tie at regular intervals.

Floor distribution frame shall be located in the service room of each floor. It consists of multi pair terminal blocks located inside lockable type junction boxes. The work includes terminal blocks, cable manager, jumper wire etc.

Main distribution frame shall be consists of metal rack, terminal blocks, cable manager, jumper wires, power supply outlets etc.

EPABX

Basic Requirements

The OEM of EPABX shall have minimum 5 years' experience in supply, installation, testing and commissioning of exchanges with minimum 500 analogue lines or exchanges with higher configurations.

The EPABX bidder must submit project reference list for consultant's review. Minimum requirements of the system aregiven below:

a) 250 nos of Analogue Extensions with CLI Expandable to 500 Ports
b) nos of PRI cards
c) nos of Analogue trunk lines
d) 1 no of Operator Console.
e) nos -500 pair MDF
f) 1 No - Call Billing and monitoring Software.
g) Charger/UPS with Batteries for backup of 1 hour

h) The system shall be highly reliable and shall ensure an uptime of 99.99%.
i) System shall have hot standby duplication. The system shall be equipped with hotstandby PSU, CPU and all other control cards with duplicated Software.
j) System shall be a fully digital switch based on PCM/TDM technique of 32-bit microprocessor or higher. The system offered shall be TEC approved.
k) The offered system shall be a fully digital switch based on PCM/TDM technique based onRISC/Pentium or any other powerful 32-bit microprocessor or higher.
l) The system offered shall be TEC approved.
m) The TEC shall be in the name of the EPABX Vendor/ supplier. A copy of the valid TECfor the offered EPABX shall be attached with the submission.
n) The EPABX vendor shall be an ISO 9001 Certified company. The valid ISO certificatecopy to be enclosed along with the offer.
o) The system shall be of 100% non-blocking type and with universal port architecture.
p) The system shall be highly reliable and shall ensure an uptime of 99.99%.
q) System shall have hot standby duplication. The system shall be equipped with hotstandby PSU, CPU and all other control cards with duplicated Software.
The System shall operate with 48V DC.

System shall offer connectivity for the following:

a) Analogue Trunk card with CLI facility
b) ISDN PRI
c) Analogue Line (Extension) card with CLI facility
d) Both Way Trunk
e) Digital Line Card
f) Operator Console – Digital/IP
g) VOIP
h) E&M – 2 / 4 wire with Type I to Type V Signalling
i) The system shall have IP networking facility.

Following features are required to be provided:

a) Extension shall be able to have flexible programmable 4 digit extension numbers.
b) The offered system shall provide 100% Power fail transfer for all C.O trunk lines to the pre-designated extension. The process shall be automatic without any manual intervention.
c) The offered system shall provide least cost routing.
d) The system shall support both pulse and tone trunk lines.
e) The EPABX shall support PC based data logging.
f) Call billing facility with software (without PC) for on line printing as well as printingthrough PC (with window based software).
g) Programmable time based class of service for each Extn.

h) Programmable facility for selectively assigning various trunk lines to various Extns.
i) System shall provide voice instructions for commonly used features. Example – voiceinstruction on how to set call back in case dialled extension is busy.
j) In case trunk lines are busy, as in the case of call back facility, there shall be provisionto call back or alert the extension when the trunk line gets free.
k) The system shall have automatic online self-diagnostic and reporting system complete with visual/ audible indication facility, fault isolation and recovery features.
l) System shall have in-built 8 port voice guided auto-attendant facility and shall be able to answer minimum eight calls simultaneously. The system shall provide voice guidance with DID facility with welcome message and provision for directly connecting to the required Extension. If the extension is not known or is busy, the caller shall be able to connect to the operator.
m) Storage of outgoing, incoming and internal call reports shall be generated on SMDR port of the system.

Features given to an extension shall be accessed from any other extension by dealing the secret codes.

a) System shall have call buffer storage (call details) for at least 1500.
b) The EPABX shall have minimum 3 nos. of RS232 for various CTI applications like,CRMintegration, call billing data output, etc.
c) The analogue extensions shall have a loop resistance of at least 1800 ohms.
d) Exchange shall offer connectivity to P.A System.

Voice assisted features to be provided for following:

a) All CO lines to be provided with voice guidance/auto attendant facility
b) The system shall have voice guided feature assistance for system features .Voice assistedfeature to beachieved without using any 3rd party hardware.
c) All the related hardware/software shall be from the same OEM for better integration.
d) If rack is required for system, the same shall be supplied by bidder.

The Exchange shall have following programmable features also for all Extensions:

a) Call waiting service.
b) Call transfer
c) Ring back facility on engaged extensions and trunk lines
d) Last number Redial facility.
e) Call picking.

f) Call forwarding (Internal & External)
g) Follow me
h) Call hunting.
i) Incoming call beep alarm while conversation.
j) Call appointment / reminder
k) Conference
l) Wakeup call
m) Automatic call back
n) Mobi-call Facility (Forwarding of intercom extension to a pre-defined external/cellnumber).
o) Operator Console
p) The operator console shall be a full-fledged operator console as well as a maintenance console.
q) The Operator Console shall have minimum features like recall, serial call, privilege extension/trunks, extension/trunk lines status enquiry, etc. If the operator console is not a full-fledged maintenance console, then the vendor shall supply a PC for system maintenance. It shall have minimum 2 line 16 character display.
r) Console shall have minimum 20 programmable key apart from the function keys.
s) Console shall work on line voltage; it shall not use any external power source for powering up the console. It shall be possible to prioritize all the incoming calls by assigning separate key.
t) Operator console shall have provision for assisting extension, attendant call transfer, call intercept, indication of call waiting, night service control etc.
u) Main distribution Box with adequate protection for over voltage and over current for junction shall be in the supplier's scope.

2.11.5 FIRE ALARM SYSTEM

2.11.5.1 Standards

UL guidelines: Fire detection and alarm system materials/manufacturing codes NBC 2016: Fire detection & alarm system installation guidelines
CPWD 2013 Part I: Standards of wiring installations

2.11.5.2 Scope of work

EPC Contractor shall carry out the entire work of the system which consists of followingdevices/items/works:

a) Addressable fire alarm control panel with loop cards, network card, built in battery, power supply unit, event logging with real time stamping and provision for connecting to BMS.
b) Addressable type smoke detectors
c) Addressable type heat detectors
d) Addressable type multi sensor detectors
e) Response indicators
f) Addressable type interface modules
g) Addressable type control module
h) Addressable type fault isolator module
i) Addressable type manual call point
j) Addressable type horn/strobe
k) 2 core 1.5 sq mm twisted, shielded pair, armoured, FRLS copper cable
l) Cable support system

The control panel shall be intelligent device addressable, analogue detecting, low voltage and modular, with digital communication techniques, in full compliance with all applicable codes and standards. Fire Alarm control Panel shall have capability to accommodate minimum 125 devices and 125 detectors in one loop or combination of 250 numbers of both detectors and devices. The panel shall have Alpha numeric QWERTY key pad LCD display to indicate all events with addressand shall comply ULstandards.

The panel shall have 485 network cards, loop cards, BMS interface module through any protocol available in market (BACnet, Modbus etc.), Printer port, in built battery, power supply unit etc The system shall include all required hardware, raceways, interconnecting wiring and software to accomplish the requirements of this specification and the contract drawings, whether or notspecifically itemized herein.

All equipment furnished shall be new and the latest state of the art products of a single manufacturer, engaged in the manufacturing and sale of analogue fire detection devices.

2.11.5.3 Mandatory Requirements

Addressing / labeling of detectors and devices

Addressing or Labelling of detectors and devices shall be done by means of using DIP/Rotaryswitches.

Other means of addressing by employing special tool from OEM or Soft addressing methods arenot acceptable.

Replacement of a faulty detector OR refitting the detector or device after cleaning shall not involvere programming / changing the address of the devices and detectors by OEM expert.

Visible indicators in the Detectors/Devices

Detectors or devices shall be either single LED with two stage OR dual LED type for indicating alarm/fault status.

Fire alarm control panel

The functional operations, modification procedure and access of the fire alarm control panel shallbe achieved by simple steps and to be user friendly from the service and operation point of view. Except for a major trouble within the control panel, the involvement of OEM expert shall not beanticipated after expiry of Defects Liability Period.

The display of fire alarm control panel shall be of LCD model, with Alpha Numeric, QWERTY type.

LCD screen dimensions shall be as per OEM's recommendations.

The panel shall be provided with suitable battery, charger etc. to work for 24 hours in normalcondition and 30 minutes in alarm condition, in case of main power failure.

Loop capacity

The loop capacity of the proposed system shall be as follows:

In a single loop having both 125 nos of detectors and 125 devices combination minimum

or

Minimum 250 nos of (detectors + devices) combination

Any loop shall not be loaded for 100% loop capacity keeping an eye on the future addition ofdevices in the loop.

The system shall be a complete, electrically supervised fire detection system, with a microprocessor based operating system having the following capabilities, features, and capacities: System shall provide an output port for monitoring purposes by external systems. Communicationsto an external system shall be Ethernet, RS-232 or RS-485 communications.

The system shall provide the remote access connection via Ethernet to completely program and control the fire detection system.

The local system shall provide status indicators and control switches for all of the following functions:

1. Audible and visual notification alarm circuit zone control.
2. Status indicators for sprinkler system water-flow and valve supervisory devices.
3. Any additional status or control functions as indicated on the drawings, including but not limited to; emergency generator functions, fire pump functions, door unlocking and security with bypass capabilities.

Each intelligent addressable device or zone on the system shall be displayed at the Central Alarm Receiving Terminal and the local fire alarm control panel by a unique alphanumeric label identifying its location.

Intelligent Addressable Photoelectric Detectors

Smoke detectors shall be microprocessor based, intelligent and addressable devices, and shall connect with two wires to one of the Fire Alarm Control Panel loops. Loop capacity shall be minimum 125 devices and 125 detectors in one loop or combination of 250 numbers of both detectors and devices. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density. The detectors shall be ceiling mounted type and shall include a twist-lockbase.

The detectors shall provide a test means whereby will simulate an alarm condition and report that condition to the control panel. Such a test may be activated remotely on command from the controlpanel.

The detectors shall provide addressable-setting by automatic polling. Systems which use binary jumpers or DIP switches to set the detector address shall not be acceptable. The detectors shall also store an internal identifying code, which the control panel shall use to identify the type of detector.

The detector shall provide dual LEDs or single LED with dual colour, normal & alarm condition shall be identified by separate colours.

The integral microprocessor shall dynamically examine values from the sensor and initiate an alarm based on the data. Systems using central intelligence for alarm decision shall not be acceptable.

The detector shall continually monitor any change in sensitivity due to the environmental effects of dirt, smoke, temperature, aging and humidity. The information shall be stored in the integral processor and transferred to the analogue loop controller for retrieval using a laptop PC hand-held programming tool.

Using software in the FACP, the detectors shall compensate for dust accumulation and other slow environmental changes which may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.

The area covered by each smoke detector shall be as per IS – 2189/NBC codes

Addressable Manual Call points

The addressable manual call points shall monitor and signal to the FACP the status of a switch operated by a “break glass” assembly. They shall be red in colour and suitable for surface or flush mounting. The addressable call points shall be provided with an integral red LED to indicate activation.

The addressable call points shall be capable of operating by means of thumb pressure and not require a hammer. They shall be capable of being tested using a special ‘key’ without the need forshattering the glass.

The addressable call points shall incorporate a mechanism to interrupt the normal addressable loop scan to provide an alarm response within 3 seconds and shall be field programmable to triggereither an alert or an evacuate response from the FACP.

Addressable horn/strobe

The addressable horn/strobe shall be capable of monitoring and controlling two independent circuits of alarm sounders using a single loop address.

24 V DC power to drive the sounders shall be derived independently from the FACP or from external power source with sufficient backup. Power supply shall be supervised in the control panel.

The addressable horn/strobe shall be capable of operating both sets of sounders in a pulsing or continuous mode as determined on the module. Each circuit shall be individually programmable. Sounder circuits shall be capable of synchronization.

The addressable horn/strobe shall provide the facility to monitor the wiring to the sounders for open or short-circuit and transmit the necessary fault signal to the FACP. Each sounder circuit shall be separately fused.

The addressable horn/strobe shall provide the facility to monitor for failure of the power supply for the sounders and transmit the necessary fault signal to FACP.

The addressable horn/strobe shall provide a green LED indication when the FACP is polling it. Horn/strobe shall have a minimum sound output of 95 Db (A) at 3 metre distance, and shall havea maximum current consumption at 24V DC of 30 Ma.

Addressable Control Module / interface Module / Monitor Module

The control module / Relay Module / Monitor Module shall provide address-setting and shall also store an internal identifying code which the control panel shall use to identify the type of device. Modules which use binary jumpers are not acceptable. An LED shall be provide which shall flash under normal conditions, indicating that the control module is operational and is in regular communication with the control panel. The addressable monitoring module shall be capable of monitoring two independent voltage free contacts, each normally open or normally closed, using a single loop address.

a) The unit shall be powered directly from the addressable loop.
b) The addressable interface module shall be capable of switching two independent relays; either normally open or normally closed, each rated at 24V, 2Amp.
c) A single input shall provide open and short circuit monitoring facilities, set locally at theunit.
d) The addressable relay interface module shall use a single loop address.
e) The unit shall be powered directly from the addressable loop.
f) The addressable interface module shall provide an LED indication when the FACP is polling it.
g) The isolator module shall provide protection on the addressable loop by automatically disconnecting the section of wiring between two modules where a short circuit has occurred.
h) The short circuit isolator module shall derive power directly from the addressable loop and shall provide an LED indication that the module has tripped. A base mounted version is available.

Multi-Sensors – Analogue Addressable

The multi-sensor shall be capable of monitoring two different sensing elements: Photoelectric Thermal

The design of the point-type multi-sensor photoelectric smoke detector sensing chamber shall be optimized to minimize the effect of dust deposit over a period of time. The chamber cover shall be removable for ease of cleaning or replacement.

The point-type multi-sensors shall incorporate screens designed to prevent all but the very smallest of insects from entering the sensing chamber, (50 holes per square 267entimetre or more).

The multi-sensors shall be designed to have high resistance to contamination and corrosion and shall include RFI screening to minimize the effect of radiated and conducted electrical interference.

The sensor shall be able to operate in the following modes:

a. Combination Mode:

The sensor shall be able to operate as a photoelectric sensor but when the ambient temperature reaches 40 degree C or above, the thermal elements shall be capable of sensing the 'Rate of Rise' and adjust the sensitivity of the photoelectric element automatically. The sensitivity of the photoelectric shall be increased via an internal algorithm.

b. Photoelectric mode

The sensor shall be able to return the analogue value for the photoelectric element during a normal polling sequence.

The sensor shall also be able to signal to the FACP if the thermal sensing element exceeds a fixed temperature threshold.

c. Thermal mode:

The sensor shall be able to return the analogue value for the thermal element during a normal polling sequence. The sensor shall also be able to signal to the FACP if the photoelectric sensing element exceeds a pre-defined threshold.

The multi-sensor shall incorporate LED's, clearly visible from the outside, to provide indication of alarm actuation. The LEDs shall be controlled from the FACP if the LED's flash during the normal polling sequence.

The modes of the multi-sensor shall be controlled by the FACP, when the FACP changes from one mode to another the FACP shall re-calibrate the multi-sensor.

In locations where the detector is not readily visible, remote indicator units shall be provided. The multi-sensor shall have the capability of monitoring both sensing elements, if either and both of the elements fail it shall be reported and displayed at the FACP.

Response indicator

The response indicator unit shall provide a remote indication for any detector that may be locatedin an enclosed or locked compartment.

The response indicator unit shall be driven directly from its associated local detector. It shall be either flush or surface mountable.

In addition to built-in response indicator of each detector, secondary response indicator of LED type shall be provided outside the room wherever asked for by the Consultant, for indication of fire through detector in the room.

Cable

The cable shall be 2Cx1.5 sq mm, twisted shielded, FRLS type, armoured double insulated coppercable

2.11.5.4 Installation

The entire fire alarm system shall be installed in accordance with BS 5839 / UL /NBC Standards, specifications, approved shop drawings, and to the satisfaction of the Employer, consultant and local approving authority.

Armoured fire alarm cable shall be used to connect the devices in a loop system. Cable when used above false ceiling shall be installed on brick/concrete walls by means of GI saddles of proper size at regular intervals of 60cm. Contractor must coordinate with other services before finalizing the cable route and ensure that radio interference is avoided by keeping safe distance from other communication/electrical cables as mentioned in the specifications. When cable needs to be terminated in any device located above false ceiling, suitably sized glands and check nuts must be used and fixed on the back box. When cable run on RCC slab, has to be taken to a device located on false ceiling, it shall be dropped down along MS channel fixed on the RCC slab. Cable must be properly attached to the channel by using cable tie.

When cable has to be terminated in devices located below false ceiling at lower levels (e.g., manual call points or in horn/strobe), cable must be drawn through a pvc pipe of minimum

diameter 25mm from the nearest device above false ceiling. PVC pipe used to draw this cable must be concealed in block wall from a location 10 cm above false ceiling grid to the back box of horn or manual call points. When cable run along walls or concrete slabs the plumb and line must be maintained to ensure good workmanship.

When loop cable has to be taken from each floor to the central control room, cable trays must be used. Cable tray size must be decided based on the no of cable to be installed on the tray. Cable tray must be installed in the service shaft as shown in the layout. Cable tray must be installed on the wall by means of GI slotted C channels, threaded rods & anchor fasteners. Cables laid on the cable tray must be neatly dressed by means of cable saddles and bolts or by using heavy duty cable ties. Cable shall not run at angles other than 90 degrees (vertical or horizontal) to the wall or slab.

When loop cables have to be connected to the control panel, it can be done in one of the followingmethods:

a) Provide a GI glanding box of suitable size above false ceiling in the control room, terminate all cables in the box by using glands & lock nuts and drop the cables down in PVC pipes to the back box of the control panel. PVC adaptors must be used to connect the pipes in the back box.
b) Draw all cables through PVC pipes and terminate cable directly in the panel. PVC adaptors must be used to connect the pipes in the back box.

Contractor must submit method statement and inspection report before commencing any installation.

Contractor must submit shop drawings clearly indicating mounting heights of all devices used in the system, which is mentioned in the standard codes. For position/location of devices, Contractor must coordinate with other services and architect. All devices of the system must be installed in neat manner keeping an eye on the aesthetic view.

Number of devices in a loop must be decided based on the specification clauses pertaining to the item.

Fault isolator module must be provided in each loop as per the requirement mentioned in the specification clause. It may isolate the faulty part of the loop and keep the other healthy part in theloop so that system may be put back in service.

Monitor module must be provided near fire hydrant/sprinkler shafts of the building to monitor the operation of flow switches/tamper switches provided in the fire protection system by the FPS Contractor.

Interface module must be provided to activate close/open/start/stop commands for HVAC or lift equipments. In case of fire signal has initiated in the building, control panel shall generate

triggering signal (usually volt free signal) to shut down motorized fire dampers located in HVAC ducts. Also, It will provide command signal (volt free signal) to lifts in the building

HVAC & Lift Contractor must ensure that necessary interfacing facility is provided in their control panels to enable the activation of their equipments in the appropriate mode under FIRE condition.

Contractor must submit and take approval of cause-and-effect matrix before commencement of the work.

Location of devices to be installed on false ceiling must be finalized after coordination with lighting/sprinkler/speakers/diffusers in HVAC system/CCTV cameras or any other services' Contractors.

Fire alarm control panel shall be located in the central control room. Panel shall be installed flushin the wall. All loop cables must be concealed in the wall for exposed portion. Cable must be terminated in the panel by using properly sized glands and check nuts. Location of panel may be decided by coordinating with CCTV/Public address/Voice and Data services system installers andkeeping an eye on the aesthetic view of the room.

2.11.5.5 System Operation

Contractor must submit cause & effect schedule before carrying out system testing & commissioning

The system shall monitor and act accordingly for the following conditions:

2.11.5.6 Fire alarm condition

The system shall enter the fire alarm condition upon:

1. Activation of any manual call point.
2. Receipt of an alarm signal from any individual automatic detector.
3. Receipt of pre alarm signals from more than one detector.
4. Activation of sprinkler pressure switch.
5. Fire alarm signal from sub system.

The fire alarm condition shall:

1. Illuminate the general fire alarm indicator.
2. Be indicated on the control panel display giving details of the device & zone number, alarmtype, number of devices in alarm and a programmable location text with a minimum of 640characters.
3. Sound the control panel internal warning sounder.
4. Activate the required sounders as per the attached cause & effect schedule.
5. Activate the required outputs as per the attached cause & effect schedule.
6. Activate the required detector remote LED outputs as per the attached cause & effect schedule.
7. Display alarm verification concept delay time remaining.
8. Return all lifts to the ground floor.
9. Operate fire dampers as described in the attached cause and effect schedule.
10. Shut down air handling equipment as described in attached cause & effect schedule.

2.11.5.7 The pre-alarm condition

The system shall enter the pre alarm condition upon receipt of a pre-alarm signal from any automatic detector.

The pre-alarm condition shall:

1. Be indicated on the control panel display giving details of the device & zone number, number of devices in alarm and a programmable location text with a minimum of 80 characters.
2. Sound the control panel internal warning sounder.
3. Activate the required sounders as per the attached cause & effect schedule.
4. Activate the required outputs as per the attached cause & effect schedule.

The fault condition:

The system shall enter the fault condition upon any short circuit, open circuit on the detectionloops, sounder circuits and fire brigade connection equipment.

1. Any earth fault capable of affecting the reliable operation of the system.
2. Any CPU fault as per UL-2.
3. Any power supply fault.
4. Any functions of addressable devices.

The fault condition shall:

1. Display the device number and/or description of the fault.network fault.
2. Removal of any addressable device.

3. Fault signals from connected input modules.
4. Any fault signal generated by internal monitored
5. Sound the control panel internal warning sounder.
6. Activate the required outputs as per the attached cause & effect schedule.
7. Activate fire brigade communication fault output or initiate the fault intervention conceptas required in attached cause & effect schedule.
8. Display fault intervention concept delay time remaining.

2.11.5.8 Degrade mode functionality:

a) The system shall include a degrade mode functionality such that shall a networkparticipant fail or the network cease to function a common fire alarm may still be generatedsuch that the fire brigade communication equipment is still activated.
b) Software redundancy: The system shall include a software redundancy mode such that in case of failure, a reboot is triggered. Shall reboots fail, the panel goes into software redundancy mode. As last resort, the panel goes in degrade mode.
c) Fire brigade communication: The system shall be connected to a secure fire brigade communication system via separate monitored fire & fault outputs. The system shall also be capable of receiving a common fault signal from the fire brigade communication equipment.
d) The system shall provide signals to the fire brigade communication system in accordancewith the following alarm verification concept:
e) Mode Manned – Alarms from automatic detectors will activate the system sounders and initiate a timer (T1) programmable from 10s to 5 minutes. Providing a responsible person acknowledges the panel within this time period no signal will be sent to the fire brigade communication equipment. Upon acknowledgement a second timer (T2) programmable from 10s to 10 minutes will be initiated. Again providing the system can be reset within this time period no signal will be sent to the fire brigade communication equipment.
f) Operation of any manual call point will immediately cancel the delay timers and a signal will be sent to the fire brigade communication equipment.
g) Mode unmanned – Alarms from any manual call point or automatic detector will immediately send a signal to the fire brigade communication equipment.

2.11.6 NURSE CALL SYSTEM

Nurse call communications system with a comprehensive range of signaling and speech connections between patients and nursing staff shall be provided. The complete system must satisfy the criteria of the standards of UL1069 / VDE0834 part 1 and part 2 in full that apply for call systems and all other standards and regulations mentioned therein.

The Nurse Call System shall consist of the following components.

➢ Nurse Call Station

➢ Bed Head Unit

➢ Software

A. Nurse Call Station

The Nurse Call station shall be installed at each nurse station and shall be designed to function as a desktop unit that provides communications and control for the system. Each nurse console station is capable of displaying active calls, service requests, and staff locations in either graphical area map or list format. The system shall communicate directly with the server and shall support running offline.

Nurse console stations shall consist of following features:

● Touch screen with integrated handset.

● The Console shall be able to display the calls based on priority status first, then in chronological order.

● The Console shall provide one-touch call answer operation

● The Console shall provide the ability to establish two-way voice communications

● Cancellation of emergency and code calls only at the originating calling device.

● The Console shall provide call-related information, including station, call type, and response information.

● Exchange of patient, staff, and other data between nurse consoles

● The system shall provide call recording Function

● The Console shall provide Infusion Progress Monitoring

B. Bed Head Unit

The system shall be installed at each patient room. The call shall be momentarily activated either from the bead head unit or from the handset. On pressing the call button, the door indicator shall glow and the call shall be displayed at the nurse station terminal. The message shall last till the call is cleared at the patient side. On getting a call, the nurse shall come to the room, and Pressing the clear button, shall clear the call.

The bed head unit shall have the following features.

● Call Cancel Button

● Call transfer function

● Doctor/Nurse Operation Function

● Intercom and talkback function

● Nursing level Indication

● Hand switch pluggable to the bedside module

C. Software

The software shall be a high-end and fully scalable PC-based management tool to visualize all system events and shall have full control over standard system operations. Software shall be of Client server architecture and shall automatically log all events in the entire communications system, such as calls, presence markings, call acknowledgements and reminders.

The software shall have the following features:

● Real Time Patient Information
● Call Escalation if pending for more than pre-configured duration
● Call Level Priority Function
● Generate management information reports and alerts for unattended calls
● Average Response time, Record of escalated calls and calls profiles
● Outpatient Operation Support
● Graphical representation of reports for comparing performance

2.11.7 ACCESS CONTROL SYSTEM

The primary function of the Access Control System shall be to regulate personnel access at the various doors and entry points. The Access control systems shall be integrated with fire alarm systems such that in the event of fire, the access doors and emergency exits are opened automatically.

The ACS system shall consists of the following components

➢ 2 Door Controller
➢ Card Readers
➢ Exit Switches
➢ Electromagnetic locks
➢ Emergency break glass
➢ Access Control Software

A. IP Based Door Controller

The controller shall support two readers and shall be with TCP/IP communication support. The system shall be designed to operate offline, and in event of communication loss, the controller panel shall continue to function without degradation of operation. System should be capable of receiving direct fire alarm control inputs to release the access control in doors on fire condition. System shall support an anti-pass back mode, where cardholders are required

to follow a proper in/out sequence. The control panel shall recognize up to 255 days as holidays, for override of normal system operation.

B. Card Readers

The required card reader should be a multiclass smart card reader with support for proximity, smart card and other credentials. The Reader shall be connected to the controller on a interface. The card readers for the doors shall have a read range of 5 cm and a size of 3 – 3.5 inches, and shall include multi-color LED to indicate normal/pass status.
The reader shall have an audio beep tone feature to indicate to the user that the card was read and an access decision was made.

C. Electromagnetic Lock

All doors shall have an electromagnetic lock installed on the secure side of the door using suitable brackets. The EM Lock shall have a minimum holding force of 600 lbs for single door and 1200 lbs for double door as per the site requirement. The door controller shall control the lock and the operating voltage of the device shall be 12V/24V DC.
The ACS shall be interfaced with the fire alarm system so that Electro - mechanical locks release automatically in the event of a fire within that zone. Locks shall be 'fail- safe' in nature in the event of power loss. A lock shall be de-energized when the emergency glass break is activated in any emergency conditions. The EM Lock shall have a dry contact sensor for door condition indication. Single leaf and double leaf electromagnetic locks are used. Double leaf locks can be used for either a single double door connection or two individual single door connections each within 5 m.

D. Exit Switch
Exit switches shall be a momentary SPDT micro switch provided at the exit side to release the EM lock. The switch shall be of NO/ NC type. The exit switch shall be made with ABS plastic with a steel faceplate. The exit switch shall have a life cycle of minimum 50,000 Cycles.

2.11.8 BUILDING MANAGEMENT SYSTEM

A. SCOPE OF WORKS
The proposal under this part is to give complete IBMS solution for the MEP services for the project. For the same IO summary shall be prepared by the Contractor asper the directions/approval of EIC.

The scope of works covered in this section includes the supply, installation, testing and commissioning of the following items.

I. Supply, install, test and commission Workstation computer along with monitor printer and all other hardware and software as required for complete installation along with workstation furniture.
II. Supply, install, test and commission the central BMS software as per technical specification attached for monitoring and control of MEP services as per IO summary
III. Supply, install, test and commission DDC control panels/modules in separate enclosure and providing all connections and accessories as required
IV. Supply, install, test and commission field devices as per technical specification for obtaining values as required.
V. Supply, install, test and commission signal cables as per technical specification in conduits and trays complete as per approved make.
VI. Integrating the SCADA & EMS software and other third party soft points with IBMS.
VII. Integrating the IBMS software with IGBC portal to share the IP address for two way communication.
VIII. Providing all minor civil works as required for installation of hardware and control panels and finishing the same as required.
IX. Preparation of shop drawings before executing works at site, preparation of GA arrangement drawings, obtaining the technical catalogues and GA drawings from manufactures, providing client with necessary maintenance coaching and planning, preparation of final as-built drawings, liasoning with all authorities, testing and commissioning and handing over the installed system
X. Any other works deemed necessary and needs to be done for the successful completion of the work not mentioned above will also be a part of the scope of works.

Major works

- Verification of Actual final requirement of the Direct Digital Controllers per the final architectural, interior layout.
- Preparation of Data point (I/O) summary in line with design requirements.
- Selection of DDC as per the Data Point (I/O) Summary for various HVAC, Electrical,PHE & other service equipments.
- Selection of cables as per I/O summary and preparation of detailed cable schedule as per the I/O summary
- Selection of protocol convertor for various components of MEP system.
- Listing out IP ports.
- Preparing shop drawing and working out the Actual final requirement of the system.
- Submission of the supplier component / material technical data sheet.

- Obtaining approval from all the necessary agencies before procurement and execution.
- Procurement of component/ material as per the tender technical specifications and as per the schedule given by the Client.
- Procurement of materials within the battery limits as per the schedule given by Client / as per BOQ of the tender document.
- Manufacturing as per standards & details furnished in the specifications
- Assembly and Installation at site
- Testing of all components of IBMS at site prior to commissioning.
- Periodic Inspection of works at site by senior representative during execution.
- Insurance of component up to handing over
- Packing & Forwarding
- Transportation
- Installation at Site as per the schedule given by Client.
- Submission of method statements for execution
- Testing, System balancing and Commissioning in the presence of specialized agency (manufacturer's representative)
- Performance Guarantee of entire IBMS through simulation.
- Handing over

Handing over requirements

The IBMS shall be handed over after satisfactory testing along with following the test reports, pre commissioning and commissioning documents.

- Detailed equipment data in the approved format
- Manufacture's maintenance and operating instructions.
- Technical data sheet of all the major equipment including accepted & actual power consumption, GA drawings etc.,
- Set of as built drawings, layouts, control schematic, cable routing, cable schedules etc
- Approved test readings of all equipment and installations through simulation from IBMS PC.
- Inspection certificates
- Certificates of approval from statutory or Local Authorities for the operation and maintenance of the installations, wherever such approval or certification is required. This shall include Application filed along with enclosures and receipts of fees paid and deposits made.
- List of recommended spares
- Certificate from the Contractor that he has cleared the site of all debris and litter caused by him without violating the norms during the construction.

However, Contractor has also to periodically clear the site from all the debris, which is generated from his part of scope.

- Undertaking that all the materials supplied by him at site are fully tax paid and shall produce all documentation for satisfaction of Client / Project Managers or taxation authorities.

The handing over documents shall be furnished through hard copies and soft copies for records.

B. Associated civil works like drilling and punching holes and openings in concrete floors, slabs, chasing of brick walls, fabrication of supporting structures, drainage of water from required trenches, cleaning and clearing of all debris like cables, conduits, unused conduits, bolts etc due to IBMS installation.
C. Coordination with other subContractors with regard to installation of items in other Contractor's scope.
D. The water and electricity required for construction, testing and commissioning to be included under the part of scope.

CODES OF REGULATION & STANDARDS

The installation shall support compliance with the relevant requirements of "IS/ISO 50001 - Energy Management Systems - Requirements with Guidance for Use".

In case of discrepancy among specifications, drawings and other documents, the specifications take precedence over all other documents. In case of discrepancy between specification, drawings etc and codes & Standards, the bidder shall assume the more stringent of the two.

ASHRAE Standard 135-2004 - Data communication protocol for building Automation and communication network
Copper Wire - IS-694-1977
Rubber Insulated Braided Wire - IS-9968 (Pt-1)-1981
PVC Insulated cables - IS-1554 (Pt-1)- 1976
Paint Shade for main equipments/accessories Shade No.536 of IS-5-1978

Integrated Building Management System (IBMS) should provide monitoring & controlling of the building mechanical equipment and electrical and other electro - mechanical components installed in the building. The proposed system shall be a Direct Distributed Digital Control (DDC) system. BMS shall do real time monitoring and control of all the Electro-Mechanical equipment in the facility and external perimeter. It should collect data, perform alarm analysis, schedule

equipment operations and provide interface to other services such as Ventilation, fire and other miscellaneous alarm monitoring.

The various functions that this system shall perform are as follows:
a) The system shall ensure sequential and automatic start/stop of the various air-conditioning equipment based on time schedule and ambient temperature.
b) It shall maintain design inside conditions, within the specified limits, throughout the year.
c) It shall monitor the start/stop and faults of units.
d) It shall duty cycle to provide equal run time for all equipment and start the standby unit on a similar unit failure.
e) It shall provide automatic startup of standby equipment in case of failure of the operating unit and indicate fault status of the unit.

The installation shall conform in all respects to ASHRAE / Indian Standard Code of Practice for Air conditioning Installation, tender specifications and drawings.

System shall be logically structured into distinctive levels based on the functions, performance, modularity and autonomy required at each level. Based on these requirements, the most appropriate technology shall be used. The levels are defined as Management Level, Automation Level and Field Level.

Some of list of major equipment list are as follows.

a. Central Work station with associated accessories like graphical User interfacing cards, etc.,
b. Inkjet Printer
c. Direct Digital Controllers
d. Routers
e. Multiprotocol gateways
f. Cables
g. Conduits
h. Field devices like, temperature sensor, RH sensor, Air flow switch, differential pressure switch, Ultrasonic flow meter, etc.,
i. Cable tray
j. Any other items for successful functioning of the system whether specifically mentioned or not to be considered as scope of works.

Contractor is advised to study the site conditions regarding ambient, geological & metrological data & ensure that the component of entire IBM system supplied has been designed & manufactured to suit the same.

Management Level

The management station shall be capable of the following
Display the graphical representation of the plant / electro-mechanical equipment with live data.
Monitor and operate the devices by changing the set points.
Receiving the alarm messages from process level and directing / routing them to the appropriate reporting device e.g. printer, short messaging system (SMS), fax, e-mail.
Monitor the devices to update about the communication problems and other device faults.
Adjusting time strategies in the process level.
Long term storage of logged data from the process devices.
Archive / retrieve data to / from storage device.
Display graphically the logged data.
Custom application programming.

The head-end of management shall be BMS PC stations and operation of the BMS PC shall include process visualization, data analysis. Central management of user-specific information such as passwords and protected access to data and programs shall thus be made easily possible. The management system shall also support software updates and changes in the project data. The BAS software shall support Remote Access management. The level at which the actual processing takes place is based on the logic written on the DDC. The processes are carried out at the DDC controllers for autonomous control (all controls functions are independent of the network/other DDC's).

Automation Level
The level at which the actual processing takes place is based on the logic written on the DDC. The processes are carried out at the DDC controllers for autonomous control. Common functions like grouping, integration, etc., shall be completed within a system controller on automation level. Each system shall have the ability to perform any or all the following routines:
Process control & interlock functions.
Generate alarms / events based on comparing measured values against set points.
Time control strategies.
Runtime tantalization.
Trend logging of specific data-points with transmission of the logged values to the management level
Backup of the data / program
Energy calculation of data / program

Field Level

The field level is where the action takes place, and refers to application specific controllers, s and control peripherals, such as sensors and valves or actuators.

The Building Automation System comprises the following components –
a) DDC Substations
b) Field control devices/components like temperature sensors, humidity sensors, differential pressure
Switches, duct static pressure sensors, chilled water valve actuators, fire damper actuators etc.
c) BMS PC, which processes the data from the field through, required interfaces.
d) Field Communication cabling

Central Station Hardware
The IBMS PC shall comprise of windows based function units necessary for full data acquisition directly or through a gateway / router, storing, visualizing and communication with others providing high-level operator interface with the system. Minimum specification of the server shall be as follows:
Intel i7 processor latest version with at least four cores or better
2 x 500 GB hard disk (RAID 1) with 40 GB free space Configure RAID 1 (mirroring) with disk write-caching turned on.
DVD drive,
Graphics card (4 GB RAM],
DVD Writer,
Lan Card 10/100/1000 base-T,
Optical Mouse,
106 Keys Keyboard,
Windows 10 operating system (64 bit),
It shall have minimum 8 serial and parallel ports operation facility and a Super Video Graphics Array (SVGA) driver.
The system shall have a 10/100 Mbps Ethernet Card/LAN card & Modem.
Clock Frequency - 3 GHz or Higher
Memory - Minimum 16 GB
Cache memory - Minimum 4 MB
Network Card - 4 x 1Gbit/s network Card
Operating System - Windows 10
Inkjet Printer
Workstation table & chair
Microsoft office suite, Adobe acrobat and other relevant and required software’s
Anti-virus with minimum 3 year license
Minimum 24” monitor
Keyboard

The BMS PC and shall be complete with detached 106-keys keyboard which includes full upper/lower case ASCII key set, a numeric pad, dedicated cursor control pad, and a minimum of 10 programmable functional keys.
The color monitor shall be with a 24-inch minimum diagonal non-glare screen and minimum super VGA resolution of 1024 pixels horizontal, 768 lines vertical and minimum 16 bit or better color. The monitor shall be with tilt and swivel facilities.

For ease of operation, an optical USB mouse shall also be provided as an alternative user interface for day-to-day system operation.

The BMS PC and shall be provided with a colour inkjet printer, 12ppm shall be provided for BMS. It shall be possible to connect printers directly to the IBMS PC.

Building Management System Software
The system offered shall be completely modular in structure and freely expandable at any stage. Each level of the system shall operate independently of the next level up. The system shall fully be consistent with the latest industry standards, operating on Windows 7 on a network environment, allowing the user to make full use of the features provided with these operating systems. The BMS system shall be compatible to standard industrial OPEN protocols like Native BacNET, Modbus RTU etc., for integration of equipment's. However the standard protocols will be intimated by the supplier of the equipment. System architecture shall be truly client server in that the Workstation shall operate as the client while the controllers shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery. The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments. Programming of controllers shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the controller. Graphic displays shall feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through the mouse.
The BMS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups The software shall enable the system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or

LAN/WAN. Web Stations shall have the capability to automatically redirect to an HTTPS connection to ensure more secure communications. Personalized layouts and panels within workstations shall be extended to webstations to ensure consistent user experiences between the two user interfaces. Servers and clients shall have the ability to be located in different time zones, which are then synchronized via the NTP server. Workstation shall indicate at all times the communication status between it and the server.

The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system.

The workstation software shall use a familiar Windows Explorer-style interface for an operator or programmer to view and/or edit any object in the entire system. In addition, this interface shall present a network map of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.

The configuration interface shall also include support for user defined object types. They shall be created from the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all child objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse. At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible. The system shall support both Java and HTML5 enabled graphics. A built-in library of animated objects shall be dropped on a graphic through the use of a software configuration wizard. These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels. Support for high DPI icons shall be included and automatically

chosen if viewing on a high definition display such as Retina or 4K displays. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries. Graphics should rescale based on whatever monitor or viewing device is being used. Be able to create graphics on varying layers that can be moved and repeated. Be able to create graphics within varying window panes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, therefore not rebuilding thus allowing for a single spot for updates that get pushed to all the pages that reference it. Graphics should have the ability to create re-usable cascading menus and to have multiple instances of a graphic and edit one instance to change all. Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:

Create and save pages.
Group and ungroup symbols.
Modify an existing symbol.
Modify an existing graphic page.
Rotate and mirror a symbol.
Place a symbol on a page.
Place analog dynamic data in decimal format on a page.
Place binary dynamic data using state descriptors on a page.
Create motion through the use of animated .gif files or JavaScript.
Place test mode indication on a page.
Place manual mode indication on a page.
Place links using a fixed symbol or flyover on a page.
Links to other graphics.
Links to web sites.
Links to notes.
Links to time schedules.
Links to any .exe file on the operator work station.
Links to .doc files.
Assign a background color.
Assign a foreground color.
Place alarm indicators on a page.
Change symbol/text/value color as a function of an analog variable.
Change a symbol/text/value color as a function of a binary state.

Change symbol/text/value as a function of a binary state.
All symbols used by Schneider Electric EcoBuilding Business in the creation of graphic pages shall be saved to a library file for use by the owner.
The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.
The software shall be capable of accepting alarms directly from controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm shall be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports. Alarm management features shall include: A minimum of 1000 alarm notification levels at the controller, workstation, and webstation levels.
Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence.
Playing an audible sound on alarm initiation or return to normal.
Sending an email page to anyone specifically listed on the initial occurrence of an alarm.
Individual alarms shall be able to be re-routed to a user at user-specified times and dates.
An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.
The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms.
The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.
The alarm viewer can be configured to auto hide alarms when triggered.
An operator shall have the capability to assign an alarm to another user of the system.

Reports shall be possible to generate and view from the Workstation and reports Server process the data and produce meaningful reports for facilitating analysis. Reports shall be downloadable, transferrable, and importable. Each report shall be capable of being automatically emailed to a recipient.
Minimum supplied reports shall include:
Activities Per Server Report and user Report
Alarm report by Category and amount
Alarms Per Sever Report
System Errors Report

Top System Errors Report
Trend Log Comparison Report
User Logins Report
The energy reports shall include
Energy Monitoring Calendar Consumption Report
Energy Monitoring Consumption Breakdown Report
Energy Monitoring Consumption Report
From the workstation it shall be possible to configure and download schedules for any of the controllers on the network. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation shall be automatically updated to the corresponding schedule in the controller. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view. The schedules shall be programmable for a minimum of one year in advance. It shall be possible to assign a list of exception event days, dates, date ranges to a schedule.
Each operator shall be assignable an access level for system use as follows:
Level 1: View data
Level 2: Modify time programs
Level 3: Modify intermediate level data such as set points and alarm limits
Level 4: Modify high-level data such as control parameters.
Programming shall be either in graphical block format or line-programming format or both. Programming shall be available offline from system prior to deployment into the field. The system shall support both script programming language as well as the graphical function block programming language. For both languages, the programmer shall be able to configure application software for custom program development, and write global control programs. Both languages shall have debugging capabilities in their editors.
The system shall be capable of creating binding template' allowing the user to bind multiple points to multiple objects all at once.
The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.

The installed system shall be able to use web services to consume information within the controllers and other products and systems. Inability to perform web services within the NSCs will be unacceptable.

The supplier shall provide a tried-and-trusted, ready-to-use system that is based on standard hardware suitable for commercial technology plus well-tested software (basic-operation and user software for AHU/FCU controllers and central CMS. The system shall be 'open', i.e. fully upgradeable.

The system shall be designed with safety and reliability in mind. Should the BMS PC ever fail, the running of the substations shall be unaffected. Should a substation ever fail, and then the other substations shall function normally.

NETWORK TOPOLOGIES PROPOSED:

BacNET: Native BacNET (ASHRAE Standard 135-2004). The DDCs shall be connected in suitable numbers over IP. The protocol shall be Native BACNET all through with BACNET over IP. All major air-handling unit controllers shall be IP based and connected directly to the owner's network.

Modbus RTU: Modbus is a standard popular with the process control industry. Certain equipments like UPS communicate over native MODBUS protocol.

PLANT VIEWER

The plant viewer shall support the following features

- Hierarchically linked animated high-resolution bit-map color graphics.
- Choice of 2D and 3D symbols with animation based on status.
- Direct access to set points, parameters, operating modes, alarms, time programs, on-line and off- line trend features.
- Dynamic multi-tasking with all active pages
- Monitoring and operation of plant at several levels
- Navigation to all other management station software applications
- User definable page size.
- Jump tags for jumps on the same level or between levels
- Capable of graphics to be printed in color or monochrome
- All graphic file formats supported by Windows can be imported (e.g. jpeg, bmp etc.,)

ALARMS HANDLING & ALARM VIEWER

As a minimum, the system shall support the following features

- Operation and manipulation of alarms (based on user privileges)
- Alarm message printing
- Alarms printed independently of the central station (direct connection at automation level)
- Automatic pop-up windows for immediate display and operation of alarms
- Audible or multimedia alarm indication
- Continuous overview of all active alarms from site (updated automatically, displayed in order of priority, option of personalized view)
- Option of displaying detailed information

- Direct access to associated plant graphics
- Comprehensive filter and search criteria (time, date, priority, discipline, alarm status etc.,)
- Color-coding based on alarm priority/alarm status
- Alarms for out of limit values (high, low), change of status, run time limits exceeded etc.,
- Option of repeating unacknowledged alarms at regular intervals
- Facility to save user-defined criteria
- User-specific configuration of the alarm view including on-line configuration

Alarm management services shall also report the system alarms such as

- DDC failure
- Network failure
- Communication error with DDC/PLC
- Login
- Disk full

ALARM ROUTING

In order to monitor alarms round the clock, alarm routing is an important feature of the BMS. The BMS shall have the following features

- Routing of alarms to alarm printer, fax pager or mobile phone.
- Time schedule for each message recipient
- Alarm routing based on priority
- Alarm routing based on discipline (HVAC, Security etc.)
- Alarms routing to person responsible at site
- Alarm routing based on text
- Alarm routing to person(s) responsible for specific equipments or systems
- Option of manual transmission of messages from the management system

TIME SCHEDULING

The time scheduler shall have the following features

- 7-day time programs.
- Exception programs (local, building wise or system wise).
- Direct display of time programs within Plant viewer graphics.
- Direct entry of various operating modes.
- Easy creation, modification and deletion of all time programs.
- Scroll features for fast access to specific weeks or days
- Printed reports in various display forms.

TREND VIEWER

The trend viewer shall have the following features

- On-line or off –line real time data.
- Simultaneous display of up to ten signals per window.
- Absolute or relative time intervals.
- Zoom, scroll and cursor features for faster data analysis.

- Flexible, easy to use scaling feature with charts displayed in 2D or 3D.
- Management station display and archiving of on-line and off line trend data
- Printouts of trend data.

EVENT SUMMARY

The Event Summary enables the operator to see the active alarms and events and to acknowledge the alarms. The features are as follows.

- It displays the active alarms and events according to the events summary profile definitions that have been set by the system integrator.
- The system integration enables the operator to change some of the settings of the Event summary and can also prevent such changes from being made by the operator.
- The Event summary profiles file should contain the filter (zones, severity, stations), security/feature options, default display options, default color and default sort order.
- Event summary displays filtered alarms and events by using filter.
- Event summary enables to assign colors to the alarms and events displayed in the browser.

REPORTS

Reports shall provide the user with the latest information from the system at specific times or when specific events occur. The following features shall be supported

- Reports routed on basis of time and /or priority.
- Manual or automatic triggering.
- User-definable or standard reports.

DDC Controllers

DDC controllers shall be capable of fully stand- alone operation i.e. in the event of loss of communication with other DDC's or Control Station, they shall be able to function on their own. The controller shall be LONWorks/ BAC net/ Modbus based products. The DDC's shall be true autonomous with peer-to-peer communication and shall have minimum the following features. In case of systems using master / slave communications, the master shall be redundant. The proprietary controllers will not be acceptable. The controllers shall consist of single 16-bit / 32 bit microprocessors for reliable throughput, based with EEPROM based operating system. Controllers shall communicate at a minimum of 156 Kbps. The memory available to the controller board as working space for storage of the Operating system software and data files shall be decided on the basis of the number of points being controlled by them. The Controllers shall have proportional control, Proportional plus Integral (PI) Control, Proportional plus Integral plus Derivative (PID) Control, Two Position Control and Time Proportioning Control and algorithms etc., all in its memory and all available for

use by the user, i.e. all the control modes shall be software selectable at any time and in any combination. The analog output of Proportional Control, PI Control, and PID Control shall continuously be updated and output by the program shall be provided. Between cycles the analog output shall retain its last value. Enhanced integral action in lieu of Derivative function shall not be acceptable.

DDC Controllers shall be able to access any data directly to any other DDC Controllers or combination of controllers on the network without dependence upon a central processing device. Autonomous DDC Controllers shall work without dependence upon a Process Data Manager.

The DDC controllers shall be chosen with minimum amount of I/O points (including spares as mentioned in the I/O list) as required in the I/O schedule, expansion of I/Os shall be possible either by modular expansion with low I/O density expansion modules, or in rack execution with plug-in cards. The selection of DDC controller shall be as per I/O schedule and the quantity of DDC controller shall be as in the BOQ given here in the specification no deviation shall be expectable. The controllers shall have a resident real time for providing time of day, day of week, date, month and year. These shall be capable of being synchronized with other clocks in the network. The microprocessor based DDC's shall be provided with power supply, A/D and D/A converters, memory. DDC's with a lower capacity of points shall preferably be provided at the locations with relatively less input/output points. One DDC can be connected to a maximum 2 Nos. AHU only.

All DDC controllers shall be capable of handling voltage, mille-ampere, resistance or open and closed contacts inputs in any mix, if required.
Analog inputs/outputs of the following minimum types shall be supported :
4-20 mA.
0-1 volts.
0-10 volts.
0-5 volts, and
2-10 volts.
Resistance Signals

Modulating outputs shall be true proportional outputs and not floating control type.

The Controllers shall have a self-analysis feature and shall transmit any malfunction messages to the Control Station. For any failed chip the diagnostic tests, printout shall include identification of each and every chip on the board with the chip number/location and whether the chip Passed or Failed the

diagnostic test. This is a desired requirement as it would facilitate trouble-shooting and ensure the shortest possible down time of any failed controller. Controllers without such safety features shall be provided with custom software diagnostic resident in the EEPROM. The tenderer shall confirm in writing that all controllers are provided with this diagnostic requirement.

In the event of failure of communication between the controllers and/or Control Station terminal, alarms, reports and logs shall be stored at the controllers and transmitted to the terminal on restoration of communication.
The DDC's shall be true autonomous with peer-to-peer communication and shall have minimum the following features. In case of systems using master / slave communications, the master shall be redundant.

- 32-bit processor with cycle time less than 150 milliseconds.
- Inbuilt real time clock (time stamping from external devices are not acceptable) with a battery backup for a minimum of 5 years.
- Inbuilt memory for viewing any historic data base at least for 1MB of data in each controller.

Parameters like various temperatures, RH, pressure and any other stipulated parameters should be possible for storing within each controller and shall be available for viewing/uploading in the event central system is switched off or the communication network is under maintenance. (Storing of buffer database at other locations other than individual DDC is not acceptable).

- Provision shall be available for connecting laptops or PC or portable operator terminal directly to DDC for any detailed evaluation locally in the AHU room for any exigency.

The autonomous controller for each unit shall be with EPROM chip of required capacity with function blocks for performing required closed loop and open loop (interlocks) functions at the various locations shall be a part of the controller. The controller shall be housed in proper enclosure, providing all required data acquisition, processing capability as required. The controllers shall be completely wired and all interface relays required for interfacing to external system like MCC etc. should be provided.

Autonomous DDC Controllers shall be able to access any data directly to any other DDC Controllers or combination of controllers on the network without dependence upon a central processing device. Autonomous DDC Controllers shall work without dependence upon a Process Data Manager.

The DDC controllers shall be chosen with minimum amount of I/O points (including spares as mentioned in the I/O list) as required in the I/O schedule, expansion of I/Os shall be possible either by modular expansion with low I/O

density expansion modules, or in rack execution with plug-in cards. The selection of DDC controller shall be as per I/O schedule and the quantity of DDC controller shall be as in the BOQ given hear in the specification no deviation shall be expectable.

FUNCTIONS

It must be possible to set the parameters and structure the application programs by using a graphic and element oriented programming language.

For generation of the application programs, the following function elements are required

- Arithmetic operations
- Addition/subtraction
- Exponentiation
- Multiplication /Division
- Sign
- Root functions
- Logic Operations
- Logic AND
- Logic ANDb
- Logic OR
- Logic ORb
- Logic EXOR
- Logic EXORb
- Logic NOT
- Logic NOTb

- Comparison Operations

Four levels of comparison functions available

- Limit 2
- Limit 4
- Limit 6
- Limit 8
- HVAC
- Enthalpy calculation
- Split range
- VAV modules
- Optimizer
- Run time equalization modules

- Controllers

- PID controllers
- 2 point PID controllers
- 3 point PID controllers

• Selection Operations
- Maximum value
- Minimum value
- 4 inputs multiplexer
- 7 inputs multiplexer
- Selector module

• Timer Functions
• Four timers

- Timer A
- Timer B
- Timer C
- Timer D

Special Functions
- Power failure
- Watch dog
- Pulse counters

Above blocks shall be resident in the DDC controllers and independent of any high level interfaces/controllers.

Further, the DDC unit software must have the following additional functions:

• Free selection of range and unit (dimensions) of all signals (measured values, accumulated values, calculated values, etc.).
• Free allocation of access protection in accordance with operating priorities.

Field Device

Temperature Sensor
Temperature sensors for space, pipes and ducts, shall be of the Resistance Temperature detector (RTD) type or thermistor. These shall be two wire type and shall conform to the following specifications :
Temperature sensors shall be high accuracy type with a high resistance versus temperature change. The accuracy shall be minimum ± .3° C
Immersion sensors shall be provided with separate stainless steel thermo well

The connection to the pipe shall be screwed 1⁄2 inch or 3⁄4 inch NPT (M). An aluminum sleeve shall be provided to ensure proper heat transfer from the well to the sensor. Terminations to be provided on the head.
The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections.
Duct temperature sensors shall be with rigid stem and of averaging type. These shall be suitable for duct installation.
Outdoor air temperature sensors shall be provided with a sun shield.
The temperature sensors may be of any of the following types : PT 100 , NI 100

Humidity Sensor
Space and duct humidity sensors shall be of capacitance type with an effective sensing range of 10% to 90% RH.
Accuracy of Temperature sensor shall be ± .3°C and humidity sensor shall be ±5% or better.
Duct mounted humidity sensors shall be provided with a sampling chamber.
Wall mounted sensors shall be provided with a housing. The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections.

Air Differential Pressure Switch
These shall be diaphragm operated. Switches shall be supplied with air connections permitting their use as static or differential pressure switches.
The switch shall be of differential pressure type complete with connecting tube and metal bends for connections to the duct. The housing shall be IP54 rated.
The pressure switches shall be available in a minimum of 3 ranges suitable for applications like Air flow filter, clog etc.
The contact shall be 230 VAC, 1 A rating.
The switch shall be supplied suitable for wall mounting on ducts in any plane. It shall be mounted in such a way that the condensation flow out of the sensing tips. Proper adaptor shall be provided for the cables.
The set point shall fall within 40%-70% of the scale range and have differentials adjustable over 10%-30% of the scale range.
The switches shall be provided with site adjustable settings and with 2 NO/NC contacts.

Air Flow Switch
Air flow switches shall be selected for the correct air velocity, duct size and mounting attitude.
If any special atmospheric conditions are detailed in the Schedule of Quantity the parts of the switches shall be suitably coated or made to withstand such conditions.
These shall be suitable for mounting in any plane.

Output shall be 2 NO/NC potential free.
Site adjustable settings shall also be provided

Pressure Transmitter for Water
Pressure transmitters shall be piezo-electric type or diaphragm type.
Output shall be 4-20mA or 0-10V DC
Power supply shall be either 24 V AC, 24 V DC or 230 V AC.
The pressure detector shall be capable of withstanding a hydraulic test pressure of twice the working pressure.
The set point shall fall within 40%-70% of the sensing range shall have sensitivity such that a change of 1.5% from the stabilized condition shall cause modulation of the corrective element.
The sensor must be pressure compensated for a medium temperature of -10°C to 60°C

CO2 Sensor
The sensor should measure and transmit CO2 level ranging from 0 to 2000 parts per million(ppm) from return air path. These shall work on 24 vac or 24 vdc supply with the output being standard type i.e. 4-20 mA, 0- 10 Volts etc.

Level Switch
The level switches shall have to meet the following requirement:
Type : Capacitance type/Conductivity type
Mounting : To suit application.
Float material : SS
Stem Material : SS
Output : 2 NO, 2 NC potential free
Switch Enclosure: IP

Level Transmitter
The level transmitter shall have to meet the following requirement
Type : Float Type/Capacitance type/Conductivity type
Mounting : To suit the application.
Connection : Flanged ANSI 150 lbs RF Carbon steel
Float material : 316 SS
Stem Material : 316 SS
Output : 2 NO, 2 NC potential free
Switch Enclosure : IP 55
Output : 4-20mA
Accuracy : ± 0.25% of full scale

CONDUITS
General

Prior to laying and fixing of conduits, the Contractor shall carefully examine the drawings indicating the layout; satisfy him about the sufficiency of number and sizes of conduits, sizes and location of conduits, sizes and location of conduits and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of Consultant/Project Manager. The Consultant/Project Manager shall be approved any modifications suggested by the Contractor before the actual laying of conduits is commenced.

Conduits

Conduits and accessories shall conform to relevant Indian Standards. PVC conduits of min. 1.5mm thickness and 20/25mm dia, shall be used as called for in the schedule of quantities. Buried cabling passing under floor of ground floor, if any, shall run in galvanized steel conduit. Joints between conduits and accessories shall be securely made, to ensure earth continuity. The conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

Connections:-

All jointing methods shall be subject to the approval of the Consultant/Project Manager. Separate conduits shall run for all power outlet wiring. Conduit connections for MS conduits shall be screwed metal to metal with white lead and exposed threads shall be painted with one coat of self-etching zinc chromate and two coats of enamel paint.

The threads and sockets shall be free from grease and oil. Connections between screwed conduit and controller metal boxes shall be by means of brass hexagon smooth bore bush, fixed inside the box and connected through a coupler to the conduit. The joints in conduits shall be free of burrs to avoid damage to insulation of conductors while pulling them through the conduits.

Bends in Conduit:-

Where necessary, bends or diversions may be achieved by means of bends and / or circular inspection boxes with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with a finished wall surface. No bends shall have radius less than 2-1/2 times the outside diameter of the conduit.

Fixing Conduits:-

The conduits, junction boxes, outlet boxes and controller boxes once installed in position, shall have their outlets properly plugged or covered so that water, mortar, insects or any other foreign matter does not enter into the conduit

system. Surface conduits shall be fixed by means of spacer bar saddles at intervals not more than 500mm.

The saddles shall be 2mm x 19mm galvanized mild steel flat, properly treated, prime red and painted, securely fixed to supports by means of nuts and bolts/ raw bolts and brass machine screws.

Drawing of Conductors:-
While drawing insulated wires/cable into the conduits, care shall be taken to avoid scratches and kinks, which may cause breakage of conductors. No joint shall be allowed in the breakage of conductors. No joint shall be shaved off like length of the conductors. Insulation shall be shaved of like sharpening of a pencil and it shall not be removed by cutting it square to avoid depression/cutting of conducting material.

Strands of wires shall not be cut to accommodate and connect to the terminals. Terminals shall have sufficient cross-sectional area to take all the strands.

No wire shall be drawn into any conduit all work of any nature that may cause injury to wire in completed. Before the wires are drawn into the conduit, the conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction. Where wires are connected to detectors, or panel, sufficient extra length of wires shall be provided to facilitate easy connections and maintenance.

Only licensed supervisors/wiremen shall be employed for cabling and other connected work. Only approved make of cables shall be used. The cables shall be brought to the site in original packing.

Signal Cable
The signal cable shall be of the following specifications:

a) Wire : Multistrand Copper
b) Size : 1 Sqm, Multistrand
c) No. of conductors : Two (One pair)
d) Shielding : Overall belt foil aluminium polyester shield.
e) Jacket : Chrome PVC

Communication Cable
The communication cable shall be of the following specification:

a) Wire : Multistrand Copper
b) Size : 1.5 Sq.mm Multistrand

c) No. of conductors : Two/Three
d) Sheilding : Overall blend foil Aluminium polyester shield

e) Jacket : Chrome PVC

Execution

DRAWING:-
The IBMS Contractor shall furnish detailed working drawings (using latest edition Computer Aided Design - CAD) drafting package, Two-dimensional schematic and information page, graphics of all system, controlled by a monitored by the BAS shall be furnished. The sizing of control valves, actuators etc. should be provided as a part of submittal.

System Overview:-
This gives the overall distribution of systems and the automation stations should be clearly indicated with input/output details. Such a detailed diagram shall be a part of the preliminary drawing for approval and in as-built document.

Electrical Wiring Diagram:-
Electrical wiring diagram indicating the wiring connections of controllers with the connectors and the field devices with the numbering system adopted shall be clearly explained and such a diagram shall be a part of the preliminary drawing for approval and in as-built document.

Interfacing diagram:-
A detailed interfacing diagram which corresponds to software and hardware interlocks of various system interfaced (fire alarm, access control etc.) shall be a part of the preliminary drawing for approval and in as-built document.

GA Diagram:-
GA diagram gives the details of the controllers, relay cards, internal terminals placed in the panel layout.

Schematics
A well developed schematic diagram of the DDC controller interfaced and its field devices distributed on the air flow diagram with their corresponding logic for all equipments like air handling unit, chillers, TFA etc.; shall be clearly indicated.

Signal List:-

A detailed input/output list with detailed terminal numbers, signal type, cable type, device codes, device type, device ordering reference shall be clearly explained in the preliminary document and in as-built document.

Installation

The Contractor shall provide necessary details to maintain the quality of installation mentioned as per the manufacturer's instruction to his engineers and shall be a part of the preliminary document.

Safety instructions

The Contractor shall comply with all applicable safety regulations in his design, access arrangements and operations on site. The Contractor shall equip his engineers and technicians with necessary wares for safety operation.

Testing

Testing should be carried out in the presence of the consultant and the client for all equipment means typical equipment of each category to the best of their satisfaction and the corresponding result shall be documented and submitted as a part of the document.

- Fine-tuning of all temperature, humidity and pressure control loops with a suitable building load shall be carried out by IBMS Contractor. If necessary, an artificial building load shall be generated by HVAC Contractor.
- Documentary evidence to the Owner of full commissioning, prior to offering a system for demonstrator shall be provided.
- Demonstrate each and every hard-wired point, software control strategy and graphic points of the entire fully commissioned IBMS to the Owner.
- Programming configuration and commissioning of the entire PPM (Planned Preventive Maintenance) system and project software shall be demonstrated to the Owner.
- Comprehensive operation and maintenance document (both system and proper equipments for BMS and PPM package) shall be provided before demonstration.

Commissioning Report

Detailed commissioning report indicating all the parameters such temperature, set temperature, Rh%, set Rh%, pressures, set pressures, proportional bands etc., of each individual system shall be carried out and their corresponding reports shall be maintained on a case to case basis and shall be a part of the document submission on the as built document.

Training

All comprehensive training shall be by the IBMS Contractor and shall utilize specified manuals and as built documentation.

Operator training shall include total seven sessions each of six-hour encompassing.

- Modifying text and graphics
- Sequence of operation review
- Selection of all displays and reports
- Use of all specified OS functions
- Trouble shooting of sensors (determining bad sensors)
- Password assignment and modification.

The training shall be under taken in two phases. One training session shall be conducted at system completion, and the other shall be conducted within forty-five days of system completion. The period of training after commissioning shall not be less than 60 days.

O&M Reports

Prior to commencement of the test on completion, the Contractor shall prepare and submit to the employer's representative, operation and maintenance manuals in accordance with the Design Basis Report and in sufficient detail for the employer to operate, maintain, dismantle, reassemble, adjust and repair works.

Ful life Cycle System Support

The IBMS Contractor shall provide the full life cycle in the form of

- System warranty of all products and services
- Training services at manufacturers office / employer's plant sites
- Site support, resident specialist availability full time during plant start up and part time after plant startup.
- Spare parts management programs to suit specific site requirements
- System consultant and network support services
- Technical assistance center to provide trouble shooting over phone
- Complete organization to back-up for local support services

2.12 ELEVATOR

GENERAL

All lifts shall be VVVF operated, gearless,centre/ side opening and Machine Room Less (MRL). The Lifts shall be with facility for duplex/triplex selective/collective operation. Car enclosure finish shall be SS (as per OEM) scratch proof moonrock/honeycomb. SS handrail not less than 600mm long at 900mm above floor level to be provided inside the lift car as per requirement. Suitable lights and fans as perrequirement shall be provided. Lift car size, Lift well size, Lift pit overhead, entrance width, carheight etc. shall be as per NBC 2016 or OEM standards. The dimensions of Lift well shown in drawings are only indicative and EPC Contractor shall provide the same as required by OEM. The equipment and installation covered by these specifications shall conform to codes of practiceand highest standards of workmanship and materials. This work shall be done in accordance with the provisions of the Lifts Act, and subsequent provisions, as also any state or local Act in forceand latest Indian Standard 14665, 15330.

The Electrical wiring shall strictly comply with IS:732 and the entire installation shall be in accordance with the Indian Electricity Act 2003 and Indian Electricity Rules 1956 as amended to-date. The electrical works shall also conform to CPWD General Specifications for Electrical works Part - I (Internal) 2013 and Part – II (External) 1994 as amended up to date wherever relevant.

The Contractor shall follow all statutory requirements as well as best trade practices in the manufacture & installation of elevators. The Contractor shall arrange to obtain the approval of the Inspectorate of Lifts for commissioning of the Elevators and handover for operation after satisfactory tests.

TRACTION MACHINE AND DRIVE

The motor shall be controlled by a variable voltage variable frequency (V.V.V.F.) micro- processor control system which shall control and monitor every aspect of elevator operation at all stages of the car motion cycle on real time basis.

The A.C. V.V.V.F. drive system shall control A.C. voltage and frequency concurrently with the hoist motor to regulate the elevator's actual performance to match closely the ideal speed pattern to obtain maximum efficiency of operation and provide a very smooth ride.

Frequency shall range fully between zero and rated value.

The Controller shall be provided with a self -diagnostic program to keep downtime to a minimum possible.

The controller shall intelligently adjust door times in response to car calls, hall calls and "Door Open" button operation.

An Inspector's changeover switch and set of test buttons shall be provided in the controller. Operation of the Inspector's changeover switch shall make both the car and landing buttons inoperative and permit the elevator to be operated in either direction from machine room for test

purposes by pressing corresponding test buttons in the controller. It shall not however interfere with the emergency stop switches inside the car or on the top of the car.

SAFETY

In the addition to other specifications the Elevator shall be provided with safety devices asfollows:-

Safety gear on car so that in the event of rope breaking or loosening the car will be brought to restimmediately by means of grips on the guides.

The over speeding car shall be automatically brought to a gradual stop on guide rails and powersupply to the hoist motor shall be switched off.

Car gate lock so that in the event of car gate gets opened when passengers are in the car, theelevator shall be brought to rest.

CAR Cabin Size

The internal clear dimensions of the cabin shall not be less than those specified in IS 14665-Part I and as per CPWD specifications.

Car Display Panel

The Car Display panel shall be of LED. This shall indicate the Car capacity, floor indication, direction of travel, current time and date at the minimum.

Frame and Safety Device

The car frame shall consist of steel channel top and bottom securely riveted or bolted and substantially reinforced and braced so as to relieve the car enclosure of all strains when the safetydevice comes into action due to over speed or when the capacity loaded car is run on the buffer springs at normal speed.

The safety device mounted on the bottom members of the frame operated by a centrifugal speed governor shall be arranged to bring the car to a gradual stop on the guide rails in the event of excessive descending speed; and provision shall be made to shut off the power supply to the motor.

Doors

Provision shall be made for vertical and horizontal fine adjustment of doors.

Door Operators

The door operators shall be VVVF inverter controlled heavy duty A. C. motor, allowing variable opening and closing speeds, and with full synchronization of car and landing doors.

Emergency Lighting
Emergency lighting with battery backup shall be provided.

Evacuation
An emergency key shall be provided on each landing to unlock the doors for evacuation andmaintenance.

The doors shall be capable of being opened manually during power failure from inside the carwhen the car is within a landing zone.

Intercom
The intercom system in the lifts shall be capable of two way communication. Necessary arrangements shall be provided for communication between the lift cars, respective machine room,Fire Control Room, Reception and the room of the Facility Manager.

The main control for the EPBX / Intercom shall be placed at Fire control room. The intercom system shall be provided with a power backup of at least 30 minutes.

Manual Cranking Facility
Manual cranking facility shall be provided in the machine room to facilitate evacuation of passengers in case of power failure. The manual mode shall be in addition to automatic car failureoperation specified elsewhere.

Emergency Stop Switch
A stop switch in the machine room / top of car shall be provided for use by maintenance crew to cancel all car and landing calls for a particular elevator.

Maintenance Switch
On operation of the maintenance switch located on top of the car by the maintenance crew, the carshall travel at slow speed not exceeding 0.85 m / sec by continuous operation of a button

Overload Indicator
An overload indicator with buzzer shall be provided in the cabin to indicate to the passengers thatthe car will not start as it is overloaded.

Operating Panels, Buttons & Switches
Car operating panels, buttons and switches shall be located on the front wall panel next to the cardoor and as specified.

All buttons and switches shall be clearly legible with fade-proof text and figures, and shall be easily accessible, especially for disabled persons in Elevator L-2.

Other Features

All features specified in the Schedule shall be provided.

PAINTING

All exposed metal work furnished in this specification, except as otherwise specified shall be given one shop coat of anti-corrosive primer after approved surface treatment of metal surfaces and two coats of approved enamel paint of approved shade.

TESTS AT SITE

The following tests, in addition to those mentioned in the CPWD specifications, shall be carried out to the satisfaction of the Employer's Representative.

The car shall be loaded until the weight on the rope is twice the combined weight of the car and the specified load. The load must be carried on for about 30 minutes, without any sign of weakness,temporary set or permanent elongation of the suspension rope strands.

The following items shall be tested:

No load current and voltage readings both on 'Up' and 'Down' Circuits. Full load current and voltage readings both on 'Up' and 'Down' Circuits.

One and quarter load current and voltage readings both on 'Up and 'Down' Circuits. Stalling current and voltage and time taken to operate overload.

Overload protection.

Car and counterweight buffers with contract load and contract speed. Manual operation of elevator at mid-way travel.

Emergency operation.

Tests on completion shall also be performed to the satisfaction of Inspector of Lifts.

STATUTORY APPROVALS

All statutory approvals from commencement to commissioning of elevators shall be obtained by the Contractor from the Inspector of Lifts, Chief Fire Officer and other authorities. All expenses to be borne by EPC Contractor.

ADDITIONAL FEATURES REQUIRED

i. **Fireman's Switch**

A fireman's toggle switch shall be provided in a break glass for the specified elevator at ground floor to enable firemen to bring the elevator non-stop to ground floor from any location and to cancel hall calls until the car is operated on attendant control.

ii. Anti - Nuisance

If number of calls registered is in excess of corresponding car load, all car calls shall be cancelled.

iii. Home Landing Facility

A car shall return to a pre-determined landing after the last call is answered.

iv. Load Non stop

When the car load exceeds a predetermined limit the elevator shall not respond to hall calls.

v. Separate door times

When a car responds only to hall calls or only to car calls, the door shall open for a shorter timethan when responding to both car and hall calls.

vi. Door Failure Operation

When an obstruction prevents a door from opening, the controller shall attempt its removal byrepeated opening and closing, failing which the car shall travel to the next floor.

vii. Nudging Door Operation

When the doors remain open for more than a predetermined period a buzzer shall sound and the door shall close automatically. The door sensing device shall be rendered inoperative but the DoorOpen button and the safety shoe shall remain operative.

viii. Self - Diagnostic Facility

The Controller shall perform self - diagnostic tests and report the health of the system. The systemshall take care of minor faults like door operation and motor overheating.

ix. Car Failure Operation

In case of car mal-function, the system shall make a self - diagnostic check and then allow the carto travel to the nearest floor at slow speed, if safe.

x. Selective floor Service

Programming for selective floors services shall be software driven.

xi. Auto Fan Off

In case no calls are registered for pre-set time, the cabin fan shall be automatically switched off.

xii. Automatic Rescue Device

In case of mains power failure and elevator control system failure, the elevator's own rechargeableand maintenance free battery power shall move the car to the nearest floor and the door shall openautomatically for automatic rescue of passengers. A battery run-down indicator shall be provided.

Automatic Rescue Device shall be provided for all the Elevators.

PERFORMANCE PARAMETERS

The following parameters shall be achieved in the installation:

Leveling Accuracy : + 3 mm

All other parameters as per CPWD Specifications and IS shall be achieved. Refer Lift Schedule.

GUARANTEE

The Contractor shall guarantee the equipment against all defects of materials and workmanship during the Defects Notification Period. Any defects arising during the guarantee period shall be rectified and replaced by the tenderer, at his own expense, to the satisfaction of the owner.

2.13 HVAC WORKS

2.13.1 MATERIAL TESTING

The E-I-C shall have full power to get any material of work to be tested by an independent agencyat Contractor‘s expense in order to prove the soundness and adequacy.

2.13.2 INSPECTION AND TESTING

a) All equipment shall be inspected and tested as per an agreed Quality Assurance Plan before the same is packed and dispatched from the Contractor‘s works. The Contractor shallcarry out tests as specified/ directed by Engineer-in-chrage.

b) The Engineer-in-chragemay, at his sole discretion, carry out inspection at different stagesduring manufacturing and final testing after manufacturing.

c) Approvals or passing of any inspection by the engineer or his authorized representative shall not, however, prejudice the right of the engineer to reject the plan if it does not comply with the specification when erected or give complete satisfaction in service.

2.13.3 TRAINING OF DEPARTMENT PERSONNEL

a) The Contractor shall train the THE EMPLOYER/ EMPLOYER‘s personnel to become proficient inoperating the equipment installed.

b) The period of training shall be adequate and mutually agreed upon by the Employer’s Representative and Contractor.

c) The THE EMPLOYER/ EMPLOYER‘s personnel shall also be trained for routine maintenance work andlubrication, overhauling, adjustments, testing, minor repairs and replacement.

d) Nothing extra shall be paid to the Contractor for training THE EMPLOYER/ EMPLOYER‘s personnel.

2.13.4 WATER COOLED SCREW CHILLERS

i. GENERAL:

Each unit will be completely factory-packaged including evaporator, unit mounted VFD starter complete with power/ control cabling etc. by chiller supplier and condenser, sub-cooler, compressor, motor, lubrication system, view control center and all interconnecting unit piping and wiring. Condenser & evaporator water circuits shall be even pass design. The chiller will be painted prior to shipment.

Performance will be certified in accordance with ARI Standard 550/590 and ECBC 2017. Only chillers that are listed in the AHRI/ Eurovent Certification Program for Centrifugal are acceptable.

The initial charge of refrigerant and oil will be supplied, shipped in containers and cylinders for field installation or factory charged in the chiller.

Chiller must unload up to 20% at constant lift conditions without surging, environment stability control and hot gas bypass (i.e. at design chilled out water temperature of 44 Deg. F and design condenser entering water temperature + 2 Deg F). AHRI certified computerized sheet mentioningpower consumption at part loads at AHRI turndown and constant ECWT (83.25 deg F & 85.25 Deg F) of tender conditions must be submitted along with tender for verification from AHRI. Onlyverified performance sheets will be qualified or approved. BMS card to be provided by chiller vendor. Chiller sound level at 1 mtr distance shall be max 85 d BA as per AHRI 575. Vendor to submit AHRI certified sheets for sound levels. Refrigerant shall be R410A/R 134 A/R1233 zd (E)as per ASHRAE A1 safety of classification.

Variable speed must be used.

BMS Compatible &Bacnet/ Modbus output must be provided for integration with 3rd party BMS

ii. COMPRESSOR

The compressor will be single/multi-stage screw type in open type / hermetic / semi-hermetic construction. Driven by) electric motors. Compressor shall be designed for 200 psig working pressure and hydrostatically pressure tested at 355 psig for R410A/R134A units. The rotor assembly will consist of a heat treated alloy steel drive shaft and impeller shaft with cast aluminum, shrouded impeller. The impeller will be designed for balanced thrust, dynamically balanced and over speed tested for smooth, vibration-free operation. The bearing design shall be as permanufacturer/OEM.

Internal single helical gears with crowned teeth will be designed so that more than one tooth is in contact at all times to provide even load distribution and quiet operation. Each gear will be individually mounted in its own journal and thrust bearings to isolate it from impeller and motor forces. Shaft seal if provided shall be provided in double bellows, double-seal, and cartridge type. Auxiliary forced fed oil reservoir will be built into the compressor to provide lubrication during coast down in the event of a power failure. Capacity control will be achieved by use of pre-rotation vanes to provide fully modulating control from maximum to minimum load. The unit will be capable of operating with lower temperature cooling tower water during part-load operation in accordance with ARI Standard 550/590. Pre-rotation vane position will be automatically

controlled by an external electric actuator to maintain constant leaving chilled water temperature. Semi- Hermetic motors shall be liquid refrigerant cooled with internal thermal overload protection devices embedded of winding in each phase. Chiller shall be able to operate till 60 deg F condenser water temperatures. In case chiller is not able to run at 60 deg F or below condenser entry temperatures, manufacturer shall provide head pressure controller to modulate two way butterfly valve in condenser return to cooling tower to ensure chiller operation at start upwith 60 deg F condenser water temperature.

iii. LUBRICATION SYSTEM

Lubrication oil shall be force-fed to all compressor bearings, gears, and rotating surfaces by an external fixed / variable speed oil pump or as per manufacturer compressor design. The oil pumpshall vary oil flow to the compressor based on operating and stand-by conditions, ensuring adequate lubrication at all times. The oil pump shall operate prior to start-up, during compressor operation and during coastdown. An emergency lubrication system shall be incorporated in the system to provide lubrication during coast down incase of power failure.

An oil reservoir, separate from the compressor, shall contain the submersible 2 HP oil pump and a suitable capacity oil heater, thermostatically controlled to remove refrigerant from the oil or as Oil reservoir integral to compressor design as per manufacturer / oem design complying to the functional requirement is also acceptable. The oil reservoir which are separate to the compressor shall be designed and stamped in accordance with ASME or GB pressure vessel code or shall be ETL marked**.**

Oil shall be filtered by an externally mounted 10micron replaceable cartridge oil filter equipped with service valves. Oil cooling shall be done via a refrigerant cooled oil cooler, with all piping factory installed (No separate arrangement to be done at site). Oil side of the oil cooler shall be provided with service valves. An automatic oil return system to recover any oil that may have migrated to the evaporator shall be provided. Oil piping shall be completely factory installed and tested.

iv. MOTOR DRIVELINE

The compressor motor shall be 3 Phase squirrel cage induction type as required, protected againstdamage by means of built in protection devices. The motor shall be rigidly coupled to the compressor to provide factory alignment of motor and compressor shafts.

v. EVAPORATOR

Evaporator will be of the shell and tube, flooded type designed for working pressure as per ASME/GB on the refrigerant side and tested against leaks with a pressure of not less than 1.11times of working pressure. Shell will be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tubesupports spaced no more than four feet apart. The refrigerant side will be designed, tested and stamped in accordance with ASME or GB Pressure Vessel Code. Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube will be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable. Water velocity through the tubes will not exceed 10 fps. The evaporator will have a refrigerant relief device sized to meet the requirements of ASHRAE 15 Safety Code for Mechanical Refrigeration. The chiller shall be insulated with 25 mm thick factory installed elastomeric insulation with vapour barrier. The insulation shall be applied in such a manner that water boxes and covers can be removed without damaging it. Pressure drop on water side shall not exceed, 10m (ten meters) WC. Water boxes and cover plates will be removable type to permit tube cleaning and replacement. Stub out water connections having flanged connections will be provided. Vent and drain connections withplugs will be provided on each water box.

vi. CONDENSER

Condenser will be of the shell and tube type, designed working pressure as per ASME /GB on the refrigerant side and tested against leaks with a pressure of not less than 1.11times of working pressure. Shell will be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart. The refrigerant side will be designed, tested and stamped in accordance with ASME or GB Pressure Vessel Code, Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube will be roller expanded into the tube sheets providing a leak proof seal, and be individually replaceable. Water velocity through the tubes will not exceed 10 fps.

Pressure drop shall not exceed 10m (Ten metres) water boxes and cover plates will be removable to permit tube cleaning and replacement. Stubout water connections having flanged connections will be provided. Vent and drain connections with plugs will be provided on each water box.

vii. REFRIGERANT FLOW CONTROL

Refrigerant flow to the evaporator will be controlled by a variable orifice/ fixed orifice with modulating valve / thermostatic expansion valve for improving unloading capabilities as per the

manufacturer standard complying to functional requirement and unloading percentage required inthe specifications.

viii. COMPRESSOR MOTOR STARTER

The starter will be variable speed drive type and will be factory installed and unit mounted/Field mounted only. VFD shall be Air/liquid/refrigerant cooled. It will vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. It will also have inbuilt circuit breaker too isolate electrical supply. The adaptive capacity control logic shall automatically adjust motor speed and compressor pre-rotation vane position independently for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller.

Drive will be utilizing IGBT's with a power factor of 0.95 or better at full load and speeds.

The variable speed drive will be unit mounted/floor standing with NEMA-1/IP54 enclosure with all power and control wiring between the drive and chiller, including power to the chiller oil pump. VFD must be supplied with active harmonic filters (Floor/Unit Mounted) with THDI and TDD less than 5% at chiller source itself.Bothvoltage and current harmonics must be displayed in main chiller control panel/AHF panel.

In case of free standing VFD complete scope of interconnecting cable works, conduit works, cablestand shall be in the scope of chiller vendor.

The following features will be provided:

- Door interlocked circuit breaker capable of being padlocked.
- Ground fault protection.
- Over voltage and under voltage protection.
- 3-phase sensing motor over current protection.
- Single phase protection.
- Insensitive to phase rotation.
- Over temperature protection.
- Digital readout at the chiller unit control panel of output frequency, output voltage, 3-phase output current, input kilowatts and kilowatt-hours, self-diagnostic service parameters.

KW Meter - The unit's input power consumption will be measured and displayed digitally via the unit's control panel.

KWh Meter – The unit's cumulative input power consumption is measured and displayed digitally via the unit's control panel.

Ammeter – Simultaneous three-phase true RMS digital readout via the unit control panel. Three current transformers provide isolated sensing. The ammeter accuracy is typically +/- 3% of readning.

Voltmeter – Simultaneous three-phase true RMS digital readout via the unit control panel. The voltmeter accuracy is typically +/- 3% of reading.

Elapsed Time Meter – Digital readout of the unit's elapsed running time is displayed via the unit control panel.

ix. GRAPHIC CONTROL CENTER

The chiller shall be controlled by a unit mounted microprocessor based control center. The chiller control panel shall provide control of chiller operation and monitoring of chiller sensors, actuators,relays and switches.

The control panel shall have touch screen control. The screen shall detail all operations and parameters, using a graphical representation of the chiller and its major components. Panel verbiage shall be available in other languages as an option with English always available. Data shall be displayed in either English or Metric units.

The sophisticated program and sensor shall monitor the chiller water temperature to prevent freeze up. When needed hot gas bypass is available as an option. The panel shall display countdown timer messages so the operator knows when functions are starting and stopping. Every programmable point shall have a pop-up screen with theallowable ranges, so that the chiller cannot be programmed to operate outside of its design limits.

The chiller control panel shall also provide:

1. System operating information including:
a. return and leaving chilled water temperature
b. return and leaving condenser water temperature
c. evaporator and condenser saturation temperature
d. differential oil pressure
e. percent motor current
f. evaporator and condenser saturation temperature

g. compressor discharge temperature
h. oil reservoir temperature
i. oil temperature
j. operating hours
k. number of compressor starts

2. Digital programming of setpoints through the universal keypad including:
a. leaving chilled water temperature
b. percent current limit
c. pull-down demand limiting
d. schedule for starting and stopping the chiller, pumps and tower
e. remote reset temperature range

3. Status messages indicating:
a. system ready to start
b. system running
c. system shutdown
d. system safety shutdown-manual restart
e. system cycling shutdown-auto restart
f. system prelube
g. start inhibit

4. The text displayed within the system status and system details field shall be displayed as acolor coded message to indicate severity.

5. Safety shutdowns enunciated through the display and the status bar, and consist of system status, system details, day, time, cause of shutdown, and type of restart required. Safety shutdownswith a fixed speed drive shall include:

a. evaporator – low pressure
b. evaporator – transducer or leaving liquid probe
c. evaporator – transducer or temperature sensor
d. condenser – high pressure contacts open
e. condenser – high pressure
f. condenser – pressure transducer out of range
g. auxiliary safety – contacts closed
h. discharge – high temperature
i. oil – high temperature
j. oil – low differential pressure
k. oil – sump pressure transducer out of range
l. oil – variable speed pump – pressure setpoint not achieved (if applicable)
m. control panel – power failure
n. motor or starter – current imbalance
o. thrust bearing – high oil temperature

p. thrust bearing – oil temperature sensor
q. software reboot

Safety shutdowns with a VFD Shall include:

a. VFD shutdown – requesting fault data
b. VFD – stop contacts open
c. VFD – 110% motor current overloadVFD – high phase A, B,C inverter heatsink temp.
d. VFD – high converter heatsink temperature

6. Cycling shutdowns enunciated through the display and the status bar, and consists of system status,system details, day, time, cause of shutdown, and type of restart required. Cycling shutdowns with a fixed speed drive shall include:

a. multiunit cycling – contacts open
b. system cycling - contacts open
c. oil - low temperature differential
d. oil – low temperature
e. control panel - power failure
f. leaving chilled liquid - low temperature
g. leaving chilled liquid - flow switch open
h. motor controller – contacts open
i. motor controller – loss of current
j. power fault
k. control panel - schedule
l. starter – low supply line voltage
m. starter – low supply line voltage
n. proximity probe – low supply voltage
o. oil - variable speed pump - drive contacts open (if applicable) Cycling shutdowns with a VFD shall include all necessary parameters.

7. Security access to prevent unauthorized change of set points, to allow local or remote control of the chiller, and to allow manual operation of the prerotation vanes and oil pump. Accessshall be through ID and password recognition, which is defined by three different levels of user competence: view, operator, and service.

8. Trending data with the ability to customize points of once every second to once every hour.The panel shall trend different parameters from a list of over 140, without the need of an externalmonitoring system.

9. The operating program stored in non-volatile memory (EPROM) to eliminate reprogramming the chiller dueto AC power failure or battery discharge.

Programmed setpoints shall be retained in lithium battery-backed RTC memory for a minimum of 10 years with power removed from the system.

10. A fused connection through a transformer in the compressor motor starter to provide individual over- current protected power for all controls.

11. A numbered terminal strip for all required field interlock wiring.

12. An RS-232/RS 485communication port to output all system operating data, shutdown / cycling message, and a record of the last 10 cycling or safety shutdowns toa field-supplied printer. Data logs to a printer at a set programmable interval. This data can be preprogrammed to print for desired time interval.

13. The capability to interface with a building automation system to provide:
a. remote chiller start and stop
b. remote leaving chiller liquid temperature adjust
c. remote current limit setpoint adjust
d. remote ready to start contacts
e. safety shutdown contacts
f. cycling shutdown contacts
g. run contacts

x. Tests at Factory:

At least one chiller shall be tested on AHRI/Eurovent certified test bed(test bed capacity >= chiller capacity) at 100%, 75%, 50% and 25% load to establish stable operation at constant entry condenser water temperature of 90° F at the manufacturer's works and shall be witnessed by the Employerand consultant's representatives at factory. The Employer will also witness harmonics voltage and current less than 5%. Chiller shall also be tested at 100% load with 60 deg F condenser entry temperaturecontinuously for 30 minutes. All expenses including the expenses of the Employer & Consultant representatives shall be included in the cost. Nothing extra shall be paid in this regard.

The scope of work of Contractor shall include suitable capacity of chillers with factory installed unit mounted VFDs as specified in DBR & as per technical specification meeting the requirements complete with refrigerant (ozone friendly, HFC A1 category in ASHRAE classification), open / semi hermetic / hermatically sealed single /multiple centrifugal compressors complete with single/twin refrigerant circuit, driven by suitable KW Squirrel Cage induction motor complete with water cooled shell & tube condenser, refrigerant cooled oil cooler only, insulated shell and tube flooded chiller, with S.S braided pipe flexible connector, insulation to be mechanically protected similar to chilled water piping insulation, flanged end for chiller & condenser, electronicauto setting water flow switches at condenser & chiller outlet, factory done

refrigerant piping, refrigerant and oil first charged, microprocessor based control panel with non-volatile memory &color display, motor driven by chiller / unit mounted VSD/VFD with active harmonic filters with THDi less than 5% & accessories, factory installed electrical disconnect circuit breaker integrating main fuses etc. all mounted on M.S. frame. Motor shall be suitable for 415 volts ± 10%,50Hz ± 5 %, three phase A.C. supply.

It shall include flow switch/DP switch at chiller and condenser, Spring isolator, including oil separators, pressure relief devices, filter drier moisture indicators, refrigerant economizer if applicable, integral refrigerant piping and wiring, accessories as required and called for, automaticand safety controls mounted in central console panel.

IEEE519, 1992 recommendations shall be used for the basis of calculation of total active harmonicdistortion (THD).

Suitable PCC/RCC foundation (PCC foundation in PCC (1:2:4) type B-1 using 20 mm graded stone aggregate 30 cm above floor level including making connection of inlet & outlet with fittings including nut, bolts, packing etc.) with plaster to be provided.

CODES & STANDARDS

ASHRAE 15	Safety code for Mechanical refrigeration
ASHRAE 23	Methods of testing and rating positive displacement refrigerant compressors and condensing units.
ASHRAE 30	Methods of testing liquid chilling packages
ASME SEC VIII DIV I	Boiler and pressure vessel code
ANSI B 31.5	Code for refrigeration piping
AHRI 550/590 (2003)	Standard for Air Cooled Screw water chilling packages
AHRI 575	Standard for method of measuring machinery sound within an equipments space
ISO 1940	Mechanical vibration – Balance quality requirements of rigid rotors
ISO 10816-1	Mechanical vibration – Evaluation of machine vibration of measurements on non-rotating parts.General guidelines

	TEMA – C/R Heat Exchanger with acceptable deviation
	ASTM: C591 Specification for Polyurethane/ Poly isocyanurate Foam

TITLE WATER COOLED CHILLER PACKAGE – DATA SHEET A		
S. No.	**Description**	**Requirement**
1.	Number Required	3 Nos 2W+1 S
2.	Location	Terrace floor
3.	Duty:- Continuous	(24 hrs/day) (Approximate)
4.	Capacity required at specified design conditions per chilling package	360 TR(2 X180TR)
5.	Refrigerant (as per ASHRAE A1 category in safety classification)	R/410A/R134a
6.	Maximum noise level at a distance of 1 metersas per AHRI 575	85 dBA
7.	Compressor – type	Semi-hermetic/hermetic/Open/screwcompressor
8.	Lubrication	Forced feed with an oil pump/differential pressure
9.	Capacity control	Automatic
10.	**EVAPORATOR**	
10.1	Type	Shell and tube, flooded
10.2	Liquid to be cooled	Water
10.3	Chilled water quality	Potable water
10.4	Chilled water inlet temperature	12.22 Deg C/54 Deg F
10.5	Chilled water outlet temperature	6.7 Deg C/ 44 Deg F
10.6	Minimum chilled water flow per chilling package	@2.4 USGPM /TR
10.7	Fouling factor-water side (FPS unit)	0.0005
10.8	Chiller and suction line insulation	25 mm Closed cell polyvinylchloride foam
10.9	Maximum water side pressure drop	10m of water
11.	**CONDENSER**	
11.1	Type	Water cooled, Shell and tube

11.2	Liquid to be cooled	Water
11.3	Condenser water quality	Potable water
11.4	Condenser water inlet temperature	28.47 Deg C/83.25 deg F
11.5	Condenser water outlet temperature	34.03 Deg C / 93.25 deg F
11.6	Minimum chilled water flow per chilling package	@3 USGPM/TR
11.7	Fouling factor-water side (FPS unit)	0.001
11.8	Maximum water side pressure drop	10m of water
12.	Motor	415 V +/- 10%, 3 phase, 50 Hz
13.	Control Panel	Microprocessor based control panel
14.	Control panel to be interfaced with building automation system	BMS Card to be provided by chiller vendor
15.	Type of starter	Unit mounted VFD/Floor Standing with active harmonic filter maximum THID of 5% atchiller source
16.	Type Refrigerant	R410A/R134a/R1233 zd (E)
17.	COPMin	5.5
18.	IPLV Min	9
19.	Ikw/TR at 100% load	0.67
20.	NPLV	0.36
21.	COP & IKW/TR shall be considered with inclusion all losses such as VFD and AHF (Active Harmonic Filter).	

All the data mentioned above are indicative only. EPC Contractor to design the system with actual conditions

CHILLER PACKAGE -DETAILS TO BE FURNISHED BY TENDERER			**DATA SHEET B**
S.No.		Description	Tenderer Furnish To
1.0		Water Cooled Chilling Unit	
		General Data	
	1.1	Number of chillers	

	1.2	Location	
	1.3	Make and country of origin	
	1.4	Model number and year of introduction model fromsame factory	
	1.5	Detailed list of installations of that model in Indiafrom same factory	
2.0		Operating Parameters	
	2.1	Minimum refrigeration capacity (TR)	
	2.2	Minimumchilled water flow rate (USGPM)	
	2.3	Maximum chiller pressure drop (Feet of water)	
	2.4	Entering chilled water temperature (deg F)	
	2.5	Leaving chilled water temperature (deg F)	
	2.6	Evaporating temperature (deg F)	
	2.7	Fouling factor for chiller	
	2.8	KW/TR at full load conditions	
	2.9	Entering Condenser water temperature (deg F)	
	2.10	Leaving condenser water temperature (degF)	
	2.11	Fouling factor for condenser	
3.0		Compressor	
	3.1	Manufacturer	
	3.2	Model	
	3.3	Type of compressor	
	3.4	Speed (operating)	
	3.5	Speed (maximum)	
	3.6	Refrigerant used	
4.0		Evaporator	
	4.1	Manufacturer	
	4.2	Model (No)	
	4.3	Shell dia. (mm)	
	4.4	Tube length (m)	
	4.5	No of tubes (No.)	
	4.6	Material of tubes (Name)	
	4.7	Dia. of tubes (mm)	
	4.8	No of integral fins / cm (No.)	
	4.9	No of refrigerant circuits (No.)	

	4.10	No of water passes (No.)	
5.0		Compressor Motor	
	5.1	Manufacturer	
	5.2	Type	
	5.3	Motor Voltage	
	5.4	Rated output	
	5.5	Power characteristics	
	5.6	No of Motors	
6.0		Starter for Compressor Motor	
	6.1	Manufacturer	
	6.2	Type of starter	
	6.3	Active Harmonic Filters wiyh THDI at chiller source (must be < 5% (Yes or No)	
	6.4	Hot gas by pass/Environment stability control (Yes/No)	
7.0		Miscellaneous Details	
	7.1	Type of capacity control	
	7.2	Noise level of chiller (in dBA) at 1 m distance forloads	
	7.3	Equipments size (LXBXH)	
	7.4	Equipments operating weight (kg) / pounds	
	7.5	Full refrigerant charge quantity	
8.0		Documents to be furnished with bid.	
	8.1	Computerized printout (AHRI certified) from chiller manufacturer (without hot gas by pass/environment stability control) indicating power consumption in IKW/TR at full load and 75%, 50% & 25% conditions as per AHRI reducing ECWT	
		• full load and 75%, 50% & 20% conditions asper constant ECWT of 90 deg F 100%, 75%, 50% & 25% conditions as per constant ECWT of 93 deg F	
	8.2	Catalogues furnishing detailed technical data for compressor, evaporator, condenser, VFD with active harmonic filter microprocessor or micro- computer control panel etc.	

2.13.5 AIR COOLED SPLIT AIR CONDITIONING UNITS (Energy saving Inverter type compressors)

TYPE

The Split Units shall consist of hermetically sealed compressor, motor, air cooled condenser, strip heaters, integral refrigerant piping and wiring, all mounted on a steel frame.

Indoor unit to be installed for Split Unit within building, shall be housed in insulated cabinet consisting of cooling coil, blower with motor, filter & insulated drain pan. Split unit must deliver specified capacity after taking into account loses due to piping length & site conditions.

COMPRESSOR AND MOTOR

Compressor shall be hermetically sealed, swing type, serviceable type and shall have dual pressure stat, and an operating oil charge. The motor shall be suction gas cooled and shall be sealed against dirt and moisture. The motor shall be suitable for 415±10% / volts or 230±6 % volts, 50 Hz, A.C. supply.

REFRIGERANT PIPING AND CONTROLS

Refrigerant piping and fittings interconnecting compressor condenser shall be all copper and valves shall be brass / gunmetal construction. The refrigerant used shall be ozone friendly HFC.

CASING

The indoor & outdoor units shall be sectionalised/ cabinet construction. Indoor units shall be consisting of fan section, coil section, filter section, and drain pan. Outdoor unit shall consist of condenser coil, fan & compressor. In case of package units, the compressor shall be mounted within the indoor units and in case of split unit, the compressor shall be mounted with the outdoor units. Each section shall be constructed of thick sheet steel all welded / bolted construction, adequately reinforced with structural members and provided with sufficient access panels for proper lubrication and maintenance. Base panel shall be constructed of fabricated steel structure provided with an under frame suitably braced. Each unit shall include one piece drain pan constructed of 20 gauge galvanised sheet steel plate or stainless steel. Drain pan shall extend under coil and fan sections with drain connections. Removable panels in fan and coil sections shall provide access to all internal parts. Panels shall be internally lined with 2.5 cm thick fibreglass asper section “Insulation” for the thermal insulation and acoustic lining.

FAN MOTOR AND DRIVE

Fan motor shall be suitable for 415 ± 10% volts or 230±10% volts, 50 Hz, A.C.Supply, Single phase, motors shall be provided with permanent capacitor. Motors shall be especially designed for quite operation and motor speed shall not exceed 1440 rpm.

FAN

Fan wheels and housing shall be fabricated from heavy gauge steel. Fan wheels shall be of double-width, double inlet forward-curve, multi-blade type enclosed in a housing and mounted on a common shaft. Fan housing shall be made of die-formed steel sheets with stream-lined inlets to ensure smooth air flow into the fans, fan shaft bearing shall be oil/grease lubricated. All rotating parts shall be dynamically balanced individually, and the complete assembly shall be statically and hydraulically balanced. Fan speed shall not exceed 1000 rpm and maximum fan outlet velocityshall be 550 meters per minute.

COOLING COIL

Cooling coils shall be of fin and tube type having aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and air velocity across each coil shall not exceed 100 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory-tested at21 Kg. per sq.cm air pressure under water. Tube shall be mechanically / hydraulically expanded for minimum thermal contract resistance with fins. The no.of fins per cm. shall be 4 to 5.

VIBRATION ISOLATORS

The indoor and outdoor units shall be provided with ribbed rubber pad vibration isolators.

PAINTING

Split units shall be factory finished with durable alkyd spray enamel. Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, then coated with enamel paint to match the finish over the adjoining shoppainted surface.

PERFORMANCE RATING

The unit shall be selected for the lowest operating noise level. Capacity rating and power consumption with operating points clearly indicated shall be submitted with the tenders and verified at the time of testing and commissioning of the installation.

i. Refrigerant shall be R-4R10A, Noise level shall be less than 40Db, with wireless remote controller LCD typewith LED panel display, with sleep mode, auto restart, auto air swing(up- down), high EER Rotary, dual protection & micro protection filters.

2.13.6 AIR COOLED PACKAGED UNIT

Type

The Air-cooled Packaged units shall be factory fabricated and supplied with factory test certificates.

Cabinet Construction

The cabinet of packaged units shall be fabricated out of heavy gauge corrosion resistant sheet with powder coating / enamel. The cabinet shall have removable panels to allow easy servicing of unit, giving easy access into the unit. The fan section of the packaged unit shall be acoustically insulated at works.

Compressor

The air-cooled packaged units shall comprise of one / two number Scroll compressor. The compressor section shall have all four walls acoustically insulated with 50mm thick fiberglass insulation, tissue paper & perforated Aluminium sheet to keep the sound level within 50db. The compressor shall be suitable to withstand voltages varying from 340 to 460 volts.

Air-cooled Condenser

The condenser frame shall be constructed from heavy duty aluminium and incorporate a copper tube and aluminium fins coil. The coil shall be minimum of 3 rows deep, with a minimum fin spacing of 2.0 mm. The copper tubes of the condenser shall be integrally firmed of minimum OD of 19 mm.

Refrigeration Circuit

The refrigeration system shall be of direct expansion type and shall incorporate one/ two no. hermetic scroll compressors complete with crankcase heaters.

Cooling Coil

The cooling coil shall be constructed of rifled bore copper tubes and louvered aluminium fins,with the frame and drip trays fabricated from heavy gauge aluminium. The drip tray must be double angled for condensate flow and easily removable for cleaning. The cooling coil shall be a minimum of 4 rows deep. The distance between the fins shall not be less than 1.8mm and the face velocity shall not be more than 2.5m/s.

Fans

The fans shall be of the forward curved centrifugal type, double width, double inlet and statically and dynamically balanced. Each fan shall be driven by a high efficiency motor, through a self-tensioning belt drive arrangement. Each fan shall be mounted on a vibration isolated deck.

i. The unit shall be factory aligned, tested and complete with starter mounted inside the cabinet, refrigerant piping, complete with charging valves, thermostatic expansion valve, distributor, liquid strainer, dehydrator, liquid line shut off valve and HP/LP cut out etc. The selector switch shall be concealed behind the hinged door and be suitable for operating the fan only or along with the cooling unit. The selector switch shall be able to turn the unit on cooling and air temperature shall be regulated with the thermostat which automatically starts and stops the compressor as required. In case of multiple compressors installed in one cabinet each shall have independent refrigerant circuit. The blower of the packaged unit shall be statically and dynamically balanced and driven by three phase motor of repute make. The air quantity of packaged unit shall have at least of 400 CFM / Ton capacity.

The fan & fan motor shall be able to take static pressure drop in coil, ducts, grills / diffusers.

The unit shall be factory wired and tested.

The air filter shall have large surface and duct holding capacity which must be easily removable type for cleaning purposes.

For Hi CFM Packaged Unit

a) Evaporator, Condenser, Fan etc. of the unit shall be designed to meet the high sensible load of the air-conditioned area.
b) Cooling coil shall have minimum four rows and fan shall be capable of delivering 500 CFM/TR.
c) Evaporator shall have large surface area as compared with normal unit.
d) Tonnage rating of unit shall be based on 35 deg. C ambient.

2.13.7 COOLING TOWERS(FRP construction)

Type

Cooling tower shall be open circuit single/ twin cell, Induced draft side suction Cross Flow Cooling tower in accordance with requirement of tender drawings and of the bill of quantities.

Cooling towers shall meet the following.

- Cooling Tower shall be CTI certified for construction, thermal performance and Soundand shall carry relevant certification label.
- Sound performance shall be in accordance with CTI ATC-128
- Heat rejection Performance shall be in accordance with ASHRAE 90.1-2016
- Cooling tower shall be OSHA certifies for safety standard & CQC Certified for waterSavings
- Performance (Power) requirement shall be minimum as per ASHRAE 90.1 – Standard
  189.1 and higher performance if specifically required as per bill of quantity.

Seismic design requirements shall be in accordance with relevant provisions of IS Code/ National Building Code of India.Induced Draft Cooling Tower

Cooling tower shall be FRP type suitable for outdoor use. Tower shall be vertical Induced draft / forced draft with cross/counter flow type. Cooling Tower shall be FRP / Zinc Coated steel (Min G-235/ Z-700) Grade Galvanization/SS 304/ SS 316 construction, in rectangular/ square/ circular/profile, complete with fill, fan, motor, water distribution system, eliminators, steel supports. Soundattenuation equipment as called for in bill of quantities.

Capacity & Performance

The cooling tower capacities shall be as per the actual working conditions suitable to chilling unit. Performance required for cooling tower shall not be more than 50 HP when tested according CTI ATC-105 procedure.

Cooling tower approach at WBT-70 °F shall not be more than 9 °F i.e. Condenser in: 79 °F. Software generated curves to be submitted by manufacturer.

Casing

FRP casing

The casing shall be made out of FRP construction of suitable thickness and UV retardant fibre glass reinforced polyester stabilized with finished surface outside and smooth surface in side. It shall have sufficient structural strength to adequately withstand high wind pressure of not less than 0.99 psf and siesmic load upto 0.9 g> class 8 on any external surface and vibration.

The tower supporting structure shall be made out of, Hot dipped galvanized steel framework of suitable thickness. Galvanizing process shall be carried out in accordance to ISO 1461: 1999 standard with minimum galvanization thickness equivalent to G-235/ Z-700 grade.

Zinc Coated Steel/ SS 304/ SS 316 casing

The Structure shall be made out of zinc coated steel / SS304/SS316 construction as specified in the BOQ. Galvanized sheet steel shall comply with ASTM A 653/ A 653 M and the zinc coating on galvanized steel shall conform to G-235/ Z-700. All the joints shall be sealed watertight. Fasteners shall be of corrosion resistance zinc or cadmium coated bolts or tapings screws for assembly with galvanized steel washers, neoprene backing where required for preventing leaks. Welded connections shall be continuous and watertight. It shall have sufficient structural strength to adequately withstand high wind velocities and vibration as specified above.

RCC Basin

The casing may be installed in the reinforced cement concrete basin if so identified in tender drawing or in the bill of quantities otherwise standard FRP basin shall be provided of suitable thickness. RCC suction tank with easily removable double brass strainers may be provided with this basin.

Cold Water Basin

Cold water basin construction shall be of the same material as of casing and shall be of minimum300 mm depth or as per manufacturer standard, so as to hold the shut-down volume of water. Cooling tower super structure shall be supported on Cooling Tower Basin. Basin shall be constructed and installed to ensure that air will not be entrained in outlets when operating andwater will not overflow on shutdown. Each individual basin shall be provided with an individualoutlet. The outlet shall be from the bottom if not anything specified in the BOQ.

Cooling tower shall be provided with factory mounted sweeper piping inside water basin complete with filtration system if specified in the BOQ. (Project design engineer to specify basin sweeper arrangement depending on the profile of the project)

Basin fitting shall include the following:

a. Bottom/side outlet.

b. Screened suction assembly.

c. Drain connected to the side / underside of basin

d. Overflow connected to the side / underside of basin.

e. Built-in bleed off attached to inlet header discharging through polyethylene tube intooverflow pipe.

f. Quick fill connected to the side of basin.

g. Equalizing line

h. Each cell is provided with one make-up valve with unsinkable float arranged for operation level. The make-up valve shall be suitable for water supply pressures between 15 psig (103 kPa) and 50 psig (345 kPa). The make-up valve shall be made of copper and the float ball of SST304.

Distribution System

Hot Water distribution system shall be open basin, with spray nozzles spaced for even distribution of water over fill surface. System shall be self- draining and non-clogging. Spray nozzles, shall be cleanable stainless steel, bronze or high impact plastic, non-clog, removable type properly spaced for even distribution. Cover shall be provided for entire nozzle area or flume / trough area so that it is not exposed to the ambient environment thus making the system more hygienic and free from dust and bacteria. The hot water basin covers shall be provided to prevent debris from entering the hot water basin, ensuring reliability of the system. They also assist in lowering sound levels.

Cooling Tower Fill

Fills shall be of PVC hanging type for cross flow technology resistant to rot, decay and biological attack and thermo vacuum formed design to facilitate for an even spread of water over fill heat transfer surface. Fill sheets shall be suspended from tower deck structure under side & shall be elevated above the floor of the cold water basin to facilitate cleaning and easy replacement for cross flow towers. Fill shall be arranged in such a manner to ensure negligible resistance to air flow and eliminate water spots and prevent fouling through scales that may form. Fills shall having thickness of minimum 13 mil thickness The fill shall be suitable for entering water temperatures up-to and including 130 deg F.

The Fill with integral louvers and integral drift eliminators are formed from self-extinguishing (per ASTM D-568) polyvinyl chloride (PVC), having a flame spread rating of 5 per ASTM Standard E84-77a, and are impervious to rot, decay, and fungus or biological attack.

The eliminators are designed to effectively strip entrained moisture from the leaving airstream with a minimum of air resistance.

Drift Eliminator

In order to reduce carry-over losses through entrainment of moisture drops in air stream, UPVC drift eliminator shall be installed to limit drift losses to less than 0.0009% of the total water circulated.

Mechanical Equipment

The tower shall be provided with low speed fan driven thru Direct / Gear reducer to achieve soundnoise level specified. Direct driven fan speed shall not exceed 700 rpm.

Fan shall be axial propeller type light weight rotor fitted with multiple aero foil blades with extruded aluminum / aluminum alloy / FRP construction for induced draft towers.

Fan shaft bearing of the self-aligning, grease lubricated ball or roller bearings with moisture proof sealed and premium moisture resistance grease suitable for between minimum 29 deg C and 149 deg C temperatures. Tube axial fan shall be provided for forced draft cooling tower. The fan shallbe installed in closely fitted cowl for maximum efficiency. The entire fan assembly shall be statically and dynamically balanced. Fan shall be driven by 415±10% volts, 3 phase, 50 cycles, AC supply, energy efficient IE-3 **(**Design engineer can upgrade the efficiency of motors depending on the profile of the project) totally-enclosed, Air Over (TEAO) with IP 55 / air over motor (TEAO), weather-proof construction to operate in humid air stream. The motors shall be VFD compatible. Fan shall be protected by a fan guard of galvanized steel Construction to prevent birds from nesting during idling period and shall be easily accessible for inspection and maintenance. The mechanical equipment assembly shall be adequately supported on a rugged steel/ FRP base assuring vibration-free support.

The sheaves shall be aluminum alloy, if located inside the airstream. The bearings shall be heavy duty, self-aligning pillow block with extended lubrication lines to side access door for easy lubrication. Minimum L 10 life for bearings shall be 75,000 Hours

A mechanical vibration cutout switch shall be provided to de-energize the motor in case of excessive vibrations Noise levels (Design Engineer to select the noise level criteria as per project category such as Hotel, Hospital, Mall, Residential etc., site conditions and location of cooling towers). The noise shall be as per BOQ and the CTI Certified performance curves shall be submitted.

Provide sound attenuators, if necessary to meet the noise criteria specified.

Internal walkway/ Service platforms

Access door constructed of UV retardant FRP / openable grilles/ louvers shall be provided to enterinto inner section of the cooling tower for inspection, cleaning and maintenance.

An internal walkway with ladder and elevated working platform or working platform constructed out of fill media duly supported from the bottom shall be provided to service the motor and drive.

External Ladder to Top of Unit & Handrail unit:

A galvanized ladder is provided to access the top of the unit. The elevated platform shall be provided over the top of the cooling tower so that person can go to the top of the tower for easy maintenance. The ladder & Handrail shall meet pertinent OSHA standards and ships loose for field installation by others.

Performance Submittals

- Manufacturer shall submit certificate from CTI validating capacity and sound performance of cooling tower at tender design conditions (entering and leaving condenser water temperature, entering air wet bulb temperature, water flow rate, fan kW).

- In addition, manufacturer shall also provide certificate that the cooling tower, accessories and components withstand the seismic force as per zone defined by National Building Code of India.

- Sound level along with sound curves and characteristics of sound attenuators, if requiredto meet the noise criteria.

- Manufacturer shall submit complete performance rating and power consumption at varying loads & varying outdoor wet bulb temperatures. The same shall be verified at the time of testing and commissioning of the installation.

Testing at Site

Capacity of the cooling tower shall be computed from the measurements of the water flow, incoming/ outgoing water temperatures and ambient air wet bulb temperature using accurately calibrated mercury –in-glass thermometers. Computed ratings shall conform to the specified capacities and quoted ratings. Power consumptions for cooling towers shall be computed from measurements of incoming voltage and input current.

TITLE COOLING TOWER – DATA SHEET A		
S.No.	**Description**	**Requirement**
1.	Number Required	3 Nos (2W+1S)

2.	Location	Terrace floor
3.	Duty:- Continuous	(24 hrs/day) (Approximate)
4.	Wet bulb approach	less than 2.77°C
5.	Capacity	As per design
6.	Maximum noise level at a distance of3 meters	Less than 75 dBA
7.	Motor efficiency	(IE-3) VFD Controlled
8.	Ladder material	MS ladder

TITLE COOLING TOWER – DATA SHEET B DETAILS TO BE FURNISHED BY TENDERER		
S. No.	**Description**	**Requirement**
1.	Manufacturer	
2.	Type	
3.	Model	
4.	Wet bulb approach	
5.	No. of Fans / HP	
6.	Overall dimensions (mm)	
7.	Weight with water (kg.)	
8.	Outlet velocity (mts. Per min)	
9.	Tip speed (Mts per min)	
10.	Drift loss (LPH)	
11.	Total water loss (LPH)	
12.	Noise level at a distance of 3 meters	
13.	Capacity at Flow Rate: 10206 LPM Water Temp. IN:34.03°C Water Temp. OUT:28.47°C	
14.	Motor efficiency	

2.13.8 VARIABLE & CONSTANT SPEED PUMPING SYSTEM – SPECIFICATIONS (Motors Efficiency IE-3 rated with VFDs)

Split Coupled Horizontal split Case/Vertical Inline Primary, Condenser, Secondary Water Pumps

Supply and install of Split Coupled (long coupled) Type Horizontal split case/Vertical In-Line Centrifugal pumping unit. The pumps shall be radially split, single stage centrifugal type with CI/GM casing with equal size suction and discharge flanges and having separate tapped flush line and pressure gauge connections, Gunmetal Bronze (BS1400 LG2C) dynamically balanced impeller, stainless steel shaft, lower carbon throttle bushing, Outside Balanced type mechanical seal with Resin Bonded Carbon rotating face, Sintered Silicon Carbide stationary seat and Viton secondary seal. Pump shall be PN-16 ratings

Pump shall be complete with all accessories like pressure gauge, butterfly valves at pump suction and discharge, suction guide, reducers (if reqd.) etc. All the valves and fittings shall be PN-16 at 50 Deg C and suction guide has to be sourced from pump manufacturer only.

Pump Construction: Pump Casing - Cast Iron with PN16 pump for working pressure Suction and discharge connections shall be flanged and the same size and shall be drilled and tapped for seal flush and gauge connections.

Impeller - Bronze, fully enclosed type. Dynamically balanced. Two-plane balancing is required where installed impeller diameter is less than 6 times the impeller width.

Shaft - Provide Stainless Steel pump shaft.

Coupling - Rigid spacer type of high tensile aluminum alloy. Coupling to be designed to be easily removed on site to reveal a space between the pump and motor shafts sufficient to remove all mechanical seal components for servicing and replacement without disturbing other components of the pump or motor. The coupling shall be provided with a fully enclosed guard complying withthe Machinery Directive.

Mechanical Seals - Shall be Stainless Steel multi-spring outside balanced type with Viton secondary seal, carbon rotating face and silicon carbide stationary seat. Provide a 316-stainless steel gland plate.

The pump is to be fitted with a factory installed flush line. Supply in the flush line to the mechanical seal, a 50 micron cartridge filter (alternatively, a cyclone separator when pump differential pressure exceeds 30 PSIG) and floating ball type sight flow indicator suitable for the working pressure encountered. The mechanical Contractor shall change the filters after the system has been flushed and on a regular basis until the pumps are turned over to the owner. The squirrel cage induction type motor, with TEFC enclosure and shall be connected to the pump through a high tensile aluminum, split type spacer coupling to permit Servicing of the mechanical seal without disturbing pump, motor or electrical wiring. Coupling shall be protected by a guard

Integrated Variable Frequency Drive (VFD) (For Variable Pumps)

1. Fundamental Requirements

VFD shall be of the VVC-PWM type providing near unity displacement power factor (cos Ø) without the need for external power factor Correction capacitors at all loads and speeds.

VFD shall incorporate DC link chokes for the reduction of mains borne harmonic currents to reduce the DC link ripple current thereby increasing the DC link capacitors lifetime. VFD shall be CE Marked showing compliance with both the EMC Directive 2004/108/EC and the Low Voltage Directive 2006/95/EC.

RFI filters shall be incorporated within the drive to ensure it meets the emission and immunity requirements of EN61800-3 to the 1st Environment Class C1 (EN55011 unrestricted sales class B).

2. VFD and Motor Protection

VFD and motor protection shall include: motor phase to phase fault, motor phase to ground fault, loss of supply phase, over voltage, under voltage, motor over temperature, inverter overload, overcurrent. Over current is not allowed ensuring Intelligent variable speed.

Units will not overload the motor at any point in the operating range of the unit.

3. User Interface

VFD shall incorporate an integrated graphical user interface that shall provide running and diagnostic information and identify faults and status in clear English language. Faults shall be logged / recorded for interrogation at a later date. VFD shall display dynamic head and flow on the VFD.

It shall be possible to upload parameters from one VFD into the non-volatile memory of a computer and download the parameters into other drives requiring the same settings.

The keypad shall incorporate Hand-Off-Auto pushbuttons to enable switching between remote and manual control.

The VFD shall be multi-color 4.3" back-lit touch-screen Variable Pumps must be provided with a cloud-based subscription service that enables Active Performance Management. It must proactively track and manages pump performance and provides early diagnostic messaging, web accessible trends and analysis along with automated reports helping end customer to make performance-based decisions and take immediate action to deliver the best possible HVAC pump performance. The cloud based subscription shall deliver real-time alerts, such as Alarms & warnings on excessive vibration, Pump in hand, Dead head, Cavitation, Broken Coupling. The connectivity kit supplied by OEM/ authorized representative shall have ability to connect upto 8 pumps in a single plant room

4. Control Algorithm

a) Control software (Sensor-less) shall be embedded in the Integrated Variable control unit to provide automatic speed control in variable volume systems with/ without the need for differential pressure. The default operating mode under Sensor-less Control shall be 'quadratic pressure control' whereby head reduction with reducing flow will be according to a quadratic control curve. Control mode setting and minimum / maximum head set- points shall be user adjustable via the inbuilt programming interface.

b) If the quantity of pumps in a system is 5 to 6 maximum, including any standby, a controller shall be added to a pumping unit and set up at the factory to operate in parallel mode. The pump controls, which will be linked on site by the control Contractor, will automatically stage the units, as appropriate, to maintain the best efficiency pumping and minimum operating cost. The standby unit will be brought into the rotation to exercise and equalize wear. The sequence of controls and staging points will be submitted to the engineer for approval at the time of order.

c) Serial Communications: The VFD shall incorporate a USB port for direct connection to a PC and / or an RS485 connection with Modbus RTU protocol.

d) Optional protocols available shall include Lonworks and BACnet if required

e) Other Control Features

The VFD shall have the following additional features:

- Override for BMS
- Manual pump control or closed loop PID control
- Programmable skip frequencies and adjustable switching frequency for noise /vibration control
- Auto alarm reset
- Motor pre-heat function
- Minimum three programmable digital inputs

- Minimum one analogue inputs
- One programmable analogue / digital outputTwo volt-free contacts
- System Control – Sensorless Control and Multiple Pumps with Pump logiccontrol.

Duty Pump & Standby pumps with Sensorless Control

1. Controller shall allow the design parameters to be loaded into each integrated drive, including pump flow, pump head and minimum pressure setting. The minimum pressure setting is a value similar to a remote system setting, if it were to be used. The control shall then set the pump control curve to control the pump in an identical manner as control with sensorless feedback. For Sensorless shall Control the remote system sensor is not required. The design parameters are to be entered into the integrated drive by means of the built-in graphical user interface.

2. Duty Pump & Standby pumps with sensorless system

The drive shall then control the motor speed to satisfy the system load requirement. For BMS control the BMS is to provide the signal to the duty integrated drive to control the speed of the motor. Sensorless Control is not required for either of these options and can be de-activated by means of the user interface or by making terminal connections.

3. Multiple Pump System Control

Supply a controller to control the pumps to satisfy all system settings at the minimum speed possible and at maximum efficiency under any flow conditions. Pump curves showing the staging points to maintain maximum efficiency shall be supplied with the submittal data.

Performance and Operating Logic

1. The pump logic controller shall determine the most efficient combination of operating pumps. The pump logic controller shall respond to the most dissatisfied zone by increasing either, the number of operating pumps, or the pump speed. In the case where all zones are satisfied the pump logic controller shall respond by decreasing either, the number of operating pumps, or the pump speed so as to optimize the energy efficiency of the pumping operation while meeting system demand. The pump logic controller shall continuously monitor all zone signals to determine an active control zone. To prevent unnecessary changes to the operating pump speed, to become the active control zone, the candidate zone must have a greater error from set-point than the current active control zone for greater than 5 minutes. This transition delay period, 5 minutes, shall be a field adjustable parameter that can be altered by the password protected users.

2. The pump logic controller shall sequence the pumps based on a field adjustable interval of operating hours with a "bumpless" transfer algorithm. The logic controller shall incorporate embedded logic to prevent hunting, pump flow surge, and motor overloading. The logic shall incorporate an adjustable PID control loop. PID control at the VFD is not acceptable.

Shall one VFD/ pump unit fail, the appropriate alarm signal shall be activated.

3. The controller shall have hand-off-automatic (H-O-A) control and shall provide the option for a remote on/off signal from a single dry type relay, or BMS communication signal.
4. The pump logic controller shall provide a data-logging feature including alarms, and events (adjustment to system parameters). The pump logic controller shall offer the option for expanded memory of 4 megabytes for a rolling record of system parameters at 10 second intervals, with a time stamp.
5. The pump logic controller shall be self-prompting. All messages shall be displayed in plain English. The operator interface shall have; Multi-fault memory and recall, On-screen helpfunctions, and separate user screens for:

- Zone setups (including calibration of DP/T/Flow sensor range)
- Pump configuration
- Design set-point and end of curve data
- Alarm history and event review
- Display of zone status, pump status and system status
- Factory default / commissioning setup data

6. The controller shall be capable of serial communications with Modbus, Lon Works, Trend, and Metasys protocols. The controller shall offer the option of gateways for both BACnet and TCP/IP protocol connection for communication over the internet.
7. The pump logic controller shall automatically disable any zone DP signals that are not within limits and alert the operator of a possible transmitter failure. Shall system failure be detected the pump speed will default to a pre-defined percent of full speed (factory default loaded as 90% of full speed). The pump logic controller shall have a minimum speed limit entered as a field adjustable parameter, factory loaded default set to 30% of full speed.

Pump Controller (with Parallel pump logic).

The variable pumps shall have an independent/ standalone IP-54 controller and shall not be an integral part of any of the pump VFD's. The controller shall be designed to control up-to 6 pumps

Mechanical and Electrical Details

1. For Intelligent Variable Speed pumping units, Pumps operating in parallel, the pump logic controller shall be Parallel Pump Controller. The pump logic controller shall be specifically designed for the control of multiple pumps in HVAC hot and/or chilled water systems that involve up to 6-variable speed pumps, with Control, in parallel, staged, sequenced, and standby configurations. The pump logic controller shall allow field adjustments of control parameters as described below.
2. The controller shall be capable of accepting, processing and displaying appropriate signals from the individual pump controls for the following values:

System Status

- Total flow
- Head
- Total power
- Pumps speed
- Alarm
- Wire to water efficiency (calculated)
- Number of pumps running
- Lead pump numberIndividual Pump Status
- Speed Ref (%)
- Speed (%) (rpm)
- Run time (hrs)
- Fault Nbr
- Run status (running/stopped)Individual Pump control status
- Current (Amps)
- Volts (VAC)
- Power (kW)
- Head
- Flow

3. The pump logic controller shall be suitable for indoor or outdoor applications and shall be capable of being integrated with Intelligent Variable Speed pumping units for pumpingpackages approved to UL 778 & CSA STD C22.2 No 108 standards and also suitable for wall mounting with separate Intelligent Variable Speed pumping units and stand-alonepump controls.
4. The controller shall have 3-levels of password security, first level to view only (No password required); the second level is for field adjustable parameters and the third level for factory/commissioning setup parameters.
5. The controller shall stage the pumping units to ensure optimum pumping energy usage and shall sequence the pumps starting order, including any standby unit.
6. The controller shall be fed with a power supply from each pumping unit controls in the control 'daisy-chain' so that a loss of power to any pump unit controls will not affect the controller pumping operation. Shall the controller go off-line, all pumps in auto-mode will operate together to provide the correct system flow needs. Staging of the units will resume as the controller is brought back online.
7. The integrated controller shall be capable of being easily integrated on any other pumpingunit shall the need occur.
   Simple mounting in pre-designed location and wiring will be all that is required.

Performance and Operating Logic

1. The pump logic controller shall determine the most efficient combination of operating pumps, and pump operating speed based from the individual pump controls input.
2. The pump logic controller shall respond to the system load flow needs by adjusting either the number of operating pumps, or the speed of the operating pumps.
3. The pump logic controller shall continuously monitor the system requirements and ensure that the operating point is maintained on the control curve to meet the system needs with optimized pumping energy usage.
4. The pump logic controller shall sequence the pumps based on a field adjustable interval of operating hours. The controls shall incorporate embedded logic to prevent hunting, pump

   flow surge, and motor overloading. The controller logic shall incorporate an adjustable PID control loop.

5. Shall any pumping unit or pumping unit controller fail, the appropriate alarm signal shall be activated. In the place of the failed assembly, a standby pumping unit shall be operatedin variable speed mode, or the next pump will start if there is no standby.
6. The controller shall have hand-off-automatic (H-O-A) control and shall provide the option for a remote on/off signal by a BMS communication signal.
7. The pump logic controller shall be self-prompting. All messages shall be displayed in plain English. The operator interface shall have multi-fault memory and recall on-screen help functions, and separate user screens for overview, pump and setup.
8. The pump logic controller shall automatically disable any flow signals that are not withinlimits and alert the operator of a possible control failure.
9. The pump logic controller shall have the system design flow, system design head and minimum head limit entered as field adjustable parameters, factory loaded. The default forthe minimum head is 40% of the design head.

Operator Screens

- Source of control: local or remote.
- Controller status: on/off.
- Pump information: running/off/alarm, HOA status, pump ID 1, pump ID 2, stand-by, etc.
- Individual pump controls information: speed, amps, power, volts AC, flow and head
- Set point and error of flow and head
- Individual cumulative pump hours of operation

- System set-point and error Alarm Screens
- Alarms with time stamp
- Alarm help
- Diagnostic indicating status (ok or bad) of PLC, memory,
- network and communication, PLC Software version Setup Screens
- Level 0. No password, allows view only access
- Level 1. Allows modification of all parameters, except pump PID and BMS setup. Allows Restoring previously saved values
- Level 2. Allows modification of all parameters. Allows saving and restoring all parameters
- Levels 1 & 2 are password protected

BMS communication (Optional)

a. The controller shall be capable of serial communication with a BMS [Optional] with either of the following protocols:
   - Modbus RTU/ BACnet MS/TP/ LonWorks

b. The following points will be available through all protocols:
   - Flow for each pump
   - Head for each pump
   - Total real-time power consumption
   - Pump speed
   - Individual pump run status
   - Alarm
   - Wire to water system efficiency
   - Number of pumps operating
   - Lead pump ID
   - Remote start/stop
   - Controller on/off status
   - Pump controls information: running/off/alarm, HOA, duty 1, duty 2, stand-by, etc.
   - Pump controls information: speed, current, power, Volts AC, flow and head
   - Pump hours of operation
   - Head and flow Set point

CENTRIFUGAL PUMPS-DATA SHEET A

Design Parameters	S.N	Pump Designation	Primary/ Secondary Chilled Water Pumps/ Condenser Water Pumps
	1	No. of Pumps	3 Nos(2 W+1 S)
	2	Design Capacity	As per detailed design

	3	Total Head	As per detailed design
	4	Location	AC plant room / As per detailed design
	5	Max. Rated Sped (AT 50 Hz)	1450 RPM / 2900 RPM(As per designer discreation)
	6	Liquid Handled	Water
Features of Construction	7	Type of Pump	Horizontzl split case/Vertical InlineLong Coupled
	8	Seal	Mechanical
	9	Nozzle Orientation	Side Suction & Side Discharge
	10	Flange Drilling	As per ISI
Materials of Constructions	11	Parts	Material
	11.1	Impeller	Bronze
	11.2	Casing	Cast Iron
	11.3	Shaft	Steel

CENTRIFUGAL PUMPS- DETAILS TO BE FURNISHED BY TENDERER DATA SHEET B

S. No.	ITEM DESCRIPTION		
1.	Make		
2.	Model		
3.	Design Capacity	USGPM (M3/ Hr)	
4.	Total Head	FT WG(MWC)	
5.	Shut off head	FT WG(MWC)	
6.	Hydrostatic test pressure	KG/SQCM (MWC)	
7.	Pump efficiency at duty point	%	
8.	Power input to pump at duty point	(BHP) (KW)	
9.	Motor efficiency at duty point	%	

10.	Power input to motor atduty point	(HP) (KW)	
11.	Rated speed	RPM	
12.	NPSH required	FTWG (MLC)	
13.	Material of construction as per specification, Ifno, indicate deviations		YES / NO
14.	Suction size		
15.	Discharge size		
16.	Impeller type		
17.	Pump weight	Kg	
18.	Pump set weight	Kg	
19.	Pump size	Mm	
20.	Pump Foundation size	Mm	

2.13.9 **CHEMICAL DOSING**

Nitrite based solution modifies the electrochemistry of the steel surface to reinforce the passive film against corrosion, because both nitrite based solution tend to react with ferrous ion, The Amount of nitrite solution ions can be a key factor in being effective in inhibiting corrosion.

Method of determining the tendency of water to deposit calcium carbonate or take it into solution. However, in most industrial systems there are considerable temperature variations and it may be more convenient to control the pH value of the water (by acid /alkaline addition),which calcium carbonate will come out of solution, and to counter the aggressive action by the use of a corrosioninhibitor like nitrite base coagulant dose as 10 % concentration in suitable quantity.

In addition to determining the tendency of pH value of water ORP based automatic dosing systems will be installing.

Chemical shall be included for one year.

2.13.10 HORIZONTAL /VERTICAL FLOOR MOUNTED AIR HANDLING UNITS

1. TYPE

The air handling units shall be double skin modular, draw through type comprising of various sections such as mixing chamber (wherever R .AIR and F.AIR are ducted.), pre filter section,

chilled water coil section, fan section supply air plenum as per details given in Drawings and design requirement.

2. CASING

For all AHU (Except Critical Areas –ICU, OTs, Sterile Corridor, Labs, CSSD)

Double skinned panels shall be 40+/-2 mm thick Double Skin Panels with thermal break profile, shall be made of 0.8mm Pre-coated GSS on outside and 0.8mm Galvanized sheet inside with 275 GSM galvanized coating for corrosion resistance and with CFC – FREE

P.U. insulation of 42 (+/- 5%) kg/Cu M injected in between with an internal gasket between the skins to interrupt the thermal bridge of the panel. Outer sheet of panels shall be made of galvanized pre-coated sheet of 0.8 mm thickness to ensure mechanical strength as per class D1 of EN 1886, air leakage as per class L1 of EN 1886, thermal bridging of minimum TB2 class and thermal transmittance of minimum T2 class as per EN 1886 and filter bypass class F9 of EN 1886.

AHU for Critical Areas –ICU, OTs, Sterile Corridor, Labs, CSSD

Double skinned panels shall be 40+/-2 mm thick Double Skin Panels with thermal break profile, shall be made of 0.8mm pre plasticized Aluminium on outside and 1.0mm Aluminium sheet inside with CFC – FREE P.U. insulation of 42 (+/- 5%) kg/Cu M injected in between with an internal gasket between the skins to interrupt the thermal bridge of the panel. Outer sheet of panels shall be made of galvanized pre-coated sheet of 0.8 mm thickness to ensure mechanical strength as per class D1 of EN 1886, air leakage as perclass L1 of EN 1886, thermal bridging of minimum TB2 class and thermal transmittance of minimum T2 class as per EN 1886 and filter bypass class F9 of EN 1886.

The entire framework shall be mounted on an aluminium alloy or galvanized steel or heavy-duty engineering composite material (depending on size) channel base as per manufacturer's recommendation. Panels shall be assembled together to form an enclosure that is capable of low air leakage potential, conforming to class A of EN 1886:2007. Handles shall be made of hard nylon and all access panels shall be openable with Allen key arrangement. Units supplied with various sections shall be suitable for onsite assemblywith continuous foam gasket. All fixing and gaskets shall be concealed.

5. Mixing Box

AHU's requiring mixing boxes as specified in drawings shall be complete with fresh and return air dampers.

6. Damper

Dampers shall be opposed blade type. Blades shall be made of double skinned aero foilaluminum sections with integral gasket and assembled within a rigid extruded aluminum alloy frame. All linkages and supporting spindles shall be made of aluminum ornylon, turning in teflon bushes. Manual dampers shall be provided with a bakelite knob forlocking the damper blades in position. Linkages shall be extended wherever specified for motorized operation. Damper frames shall be sectionalized to minimize blade warping. Airleakage through dampers when in the closed position shall not exceed 1.5% of themaximum design air volume flow rate at the maximum design air total pressure.

7. Motor and Drive

Fan motors shall be energy efficient (IE-3) and shall be 415±10% volts, 50 cycles, three phase, totally enclosed fan-cooled class F, with IP-55 protection. Motors shall be especiallydesigned for quiet operation. Drive to fan shall be provided through direct-drive arrangement.

8. Fan

Fans shall be direct driven plug fan with aerofoil design blades for Floor Mounted AHU/TFA units and Ceiling Suspended unit with Forward Curved Direct Driven Fan with three phase motor so as to give maximum efficiency for given duty condition. **All direct driven Plug fan with casing will be certified by a reputed 3rd party internationally acclaimed certifying body like Eurovent, or AHRI or AMCA,** and the entire Fan + Motor assembly will be balanced at supplier's works before despatch. Fans driven by variable frequency drive shall be backward inclined irrespective of static pressure value. Fans shall be selected for minimum efficiency of 70%. Fan wheels shall be made of galvanised steel in case of forward curved, MS epoxy coated in case of backward curved DIDW fans and **MS epoxy coated/composite material for direct driven plug fans**. **Fan array with multiple fans shall be used for capacities more than 15000 CMH. Plug fans in fan array shall have individual VFDs for every motor fan set.** For DIDW Fan shaft shall be grounded C40 carbon steel and supported in self-aligning Plummer block operating less than 75% of first critical speed, grease lubricated bearings. Fan wheels and pulleys shall be individually tested and precision balanced dynamically. Fan motor assembly shall be statically and dynamically balanced to G6.3 grade as per relevant ISO/AMCA standard. **Certified Computerized selection for AHU shall be with fan selection and sound level spectrum. Complete AHU sound level shall be given in computerized selection sheet instead of sound level of bare fan.**

Motors shall be mounted inside the AHU casing on rigid frame/ slide rails for alignment, and be totally enclosed, fan cooled, to be class `F' insulation.

Heavy duty anti-vibration mounts shall be provided for isolating the unit casing. Fire retardant, waterproof silicone rubber impregnated flexible connection shall be provided at the fan inlet/ discharge.

9. Cooling/Heating Coils

- Chilled Water Cooing/Heat Coil

Chilled water coils shall have 12.5mm (1/2") dia. tubes minimum 0.41 mm thick with aluminium fins firmly bonded to copper tubes assembled in a zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21 Kg./Sq.cm air pressure under water. Tube shall be hydraulically/mechanically expanded for minimum thermal contact resistance with fins. Fins spacing shall be 11 to 13 fins per inch (4 to 5 fins per centimeter). Water pressure drop in coil shall not exceed 10 PSI.

- DX Cooling/Heating coil

Dx cooling coil section with aluminium finned plain copper tubes (tubes thickness not less than 0.35mm & dia. 12.5mm) cooling coil. Tubes with aluminium fins firmly bonded to copper tubes assembled in a zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21 Kg./Sq.cm air pressure under water. Tube shall be hydraulically/mechanically expanded for minimum thermal contact resistance with fins. Water pressure drop in coil shall not exceed 10 PSI.

10. Filters

Shall be done as per specification.

11. Filter Assembly

Shall be done as per specification.

12. AHUs shall be certified for Mechanical performance & Rating and performance for units/component and section as a whole as per following standards

- For Mechanical performance as per EN 1886 : 2007/AHRI 1350/1351
- Mechanical Strength of Casing_D1
- Casing Air Leakage_L1

- Filter Bypass Leakage_F9
- Thermal Transmission_T2
- Thermal Bridging_TB2
- Acoustic insulation of Casing as per BSEN/ISO 25136
- For Rating & Performance for Units, Components and Sections as per EN 13053:2006 +A1: 2011.
- The real unit shall be tested at the certified laboratory for following parameter.
- Air flow: Static pressure data, power consumption.
- Octave bands for conducted sound power emissions as per EN ISO 3741, 3744 &3746
- Heat recovery as per EN 308
- Cooling Duty as per EN 1216
- Heating Duty as per EN 1216
- Air Side and Water side pressure drop
- Filter performance as per EN 779Aerodynamic testing of damper and valves as perEN 1751
- Fluid flow as per EN ISO 5167-1
- Fan performance as per ISO 5801

Note:

 Above tested parameter and selected parameter shall be strictly within the closetolerances set by the above mentioned standards.

 All the technical selections shall be from a certified selection software version that is enlisted on the third party Eurovent certifying body website. If a manufacturer submits separate selection sheets for different components, it means that the components are not included in the certification process. The complete AHU selection shall contain all components which shall carry Eurovent logo on each page with the software version.

13. Isolators

Vibration isolators shall be provided with all air handling units. The fan and motor framework shall be isolated from the AHU framework by means of spring type vibration isolators. The AHU shall be mounted on 8/9 nos. 200x200x200 P.C.C. blocks suitable for weight of the AHU. The framework of the AHU and the P.C.C. blocks shall be isolated by means of neoprene mats of size 150mmx150mm in two layers with 20g G.S.S. sheet sandwiched in between.

14. Accessories

Each air handling unit shall be complete with the accessories including but not restricted to the following.

- Insulated isolation valves, Y-strainer, header drain valves, unions and

insulated condensate drain piping upto sump or floor drain in air handling unit room/ nearestpoint, as described in drawing and specification.

- Manual air vents at high points in the cooling coil and drain plug in the bottom ofthe coil. – to be included in the cost of the AHU.
- Thermometers in thermometer wells and pressure gauges in test points in chilled water supply and return lines. – to be included in the cost of the AHU. Air and Water side control as specified under section "Control and Instruments"

15. Painting

Powder coated paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop-painted surfaces.

16. Noise Control

Air Handling Units shall be selected for the lowest operating noise level of the equipment. Fan performance rating, power consumption, and sound power data with operating points clearly indicated shall be submitted with the tenders and verified at the time of testing and commissioning of the installation. The sound level of the AHU shall be less than 60 dBA at one meter distance at room condition.

17. Connections

Piping installation requirements are specified in other section. The Drawings indicate the general arrangement of piping, valves, fittings, and specialities. The following are specific connection requirements:

- Arrange piping installations adjacent to units to allow unit servicing and maintenance.
- Connect piping to air-handling units with flanges enabling easy removal of the coil.
- Connect condensate drain pans using 50 mm (2-0 inch) minimum, insulated G.I. pipe and extend to nearest floor drain. Construct deep trap (depth as per detail) at connection to drain pan and install cleanouts at changes in direction.
- Duct installations and connections are specified in other sections. make final duct connections with flexible connections.
- Electrical Connections: The following requirements apply:
- Electrical power wiring is specified in section Electrical.
- Temperature control wiring and interlock wiring is specified in Section "Electrical Control systems."
- Grounding: Connect unit components to ground in accordance with the IndianElectrical Code.

18. Adjusting, Cleaning, And Protecting
    - Adjust water coil flow, with control valves to full coil flow, to indicate l/s (gpm).
    - Adjust damper linkages for proper damper operation.
    - Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face.

19. Commissioning
    - Final Checks Before Start-Up: Perform the following operations and checks before start-up:
    - Remove shipping, blocking and bracing.
    - Verify unit is secure on mounting and supporting devices, connections for piping, ductwork and electrical are complete. Verify proper overload protection is installed in motors, starters, and disconnects.
    - Perform cleaning and adjusting specified in this Section.
    - Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operations. Reconnect fan drive system and align belts.
    - Lubricate bearings, pulleys, belts, and other moving parts with factory recommended lubricants.
    - Set outside-air / supply air dampers to minimum outside-air setting.
    - Comb coil fins for parallel orientation.
    - Install temporary throw away filters for initial run and finally install clean filters.
    - Verify manual and automatic volume control, and fire dampers in connected ductwork system are in the full-open position.
    - Disable automatic temperature control operators.
    - Starting procedures for central-station air-handling units:
    - Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicate RPM.
    - Replace fan and motor pulleys as required to achieve design conditions.
    - Measure and record motor electrical values for voltage and amperage.
    - Shut unit down and reconnect automatic temperature control operators.

20. Testing

Cooling capacity of various Air handling units shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by a calibrated rotating vane anemometer and temperature measurements by accurately calibrated mercury-in-glass thermometers. Computed ratings shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current, whereas, noise level at various locations within the conditioned spaces shall be measured by a sound pressure level meter.

2.13.11 HEAT RECOVERY VENTILATION SECTION (ENTHALPY WHEEL)

a. Wheel: The wheel shall be made of alternate layer of corrugated and intervening flat composite material of aluminium foil of uniform width to ensure smooth surface. The wheel medium shall be bonded together to form rigid transfer medium forming a multitude of narrow channels ensuring laminar flow. The wheels shall be of proven design.
The wheel can be fully wound or on larger units, sectorised, i.e. assembled in segments. In latter case the segments are assembled between rigid spokes thus ensuring structural longevity and allowing replacement of one or specific segments only.

The wheel shall be cleanable by spraying its face surface with compressed air, low temperature steam or hot water or by vacuum cleaning without affecting its latent properties.The face velocity across the wheel shall not exceed 700 fpm (3.5 m/s).

The wheels shall be tested in accordance with ASHRAE S4-78 method of testing air to air heat exchangers. Development an manufacturers shall meet all quality assurance criteria specified in BSEN ISO 9001.

The minimum sensible and latent efficiencies shall be 75%. A computerized selectionshall be enclosed along with offer.

b. Casing: The casing shall be constructed as a single skin, self-supporting, galvanized sheet steel structure and include rotary wheel support beams and purging sector. The casing shall be supplied with access panels to facilitate inspection and service. Size 2150 mm and larger shall be in two sections to facilitate shipping and handling.

c. Seals: The casing shall be equipped with adjustable brush seals, which minimize thecarryover to max 0.05 – 0.2%.

d. Hub and Spokes: Hub and Spokes on one piece rotor shall be Aluminium and on sectorrized rotor Hub shall be made of steel, painted with anicorosion paint and galvanized sheet steel spokes.

e. Drive: The wheel shall be belt driven along its perimeter. A constant speed fractional horsepower motor shall be used. The motor shall be mounted on a self-adjusting base toprovide correct belt tension.
TESTING

The Thermal Wheel shall be tested in accordance with the parameters fixed as below.

- Supply Air Capacity - FDB/FWB.
- Exhaust Air Capacity - FDB / FWB.
- Fresh Air Capacity - FDB / FWB

Heat exchanger units(HRV) in double skin construction, constructed out of extruded Aluminium section frame with puf insulated panels,blowers,IE-3 Motor plate to plate type Aluminium heat exchanger and filters. The unit will have two separate passages one for supplyof fresh air and the other for exhaust of cool air from the rooms after the

revovery of energy. Efficiency of these heat exchangers shall be 60-65%. The plate to plate heat exchanger shall be rigid thermally bonded seamless Aluminium channels separated by extruded aluminium spacers of the following capacity.

Heat recovery need not be limited to wheels only. Other energy efficient recovery systems shall also be proposed

2.13.12 CEILING SUSPENDED AIR HANDLING UNITS

1. TYPE

The air-handling units shall be double skin ceiling suspended, draw through type comprising of various sections such as pre-filter section, chilled water coil section, fan section, as per details given in drawings and as per design requirement.

2. CAPACITY

The air moving and coil capacities shall be as shown on the drawings and as per design requirement.

3. UNIT CONSTRUCTION

The ductable unit shall be ceiling suspended type. The housing/casing of the air handling unit shall be double skin construction. The framework shall be of extruded aluminum hollow sections. All the frame shall be assembled using pressure die cast aluminum joints to make a sturdy, strong &self supporting frame work for various sections.

40mm thick double skin panels shall be made of 0.8 mm pre-plasticized GSS sheet on outside and 0.8 mm galvanized sheet inside with PUF insulation injected in between. These panels shall be screwed on to the framework with soft rubber gasket on aluminium frame to make the joints air tight. Insulation material shall be of 40 Kg./m3 density (minimum). Detachable steel insulated drain pan with necessary slope to facilitate fast removal of condensate shall be provided. Necessary outlet from the drain pan shall be provided. The unit shall be suitably insulated from inside to avoid condensation on outer surface. Necessary provision for ceiling suspension shall be provided. The drain pan shall be insulated with 12mm thick closed cell Nitrile rubber or as per manufacturer's specifications.

Manufacturer shall submit test certificate of conformity for Class D1, Class L1, Class TB3 &Class T3 issued by internationally recognized Independent Laboratory shall be submitted along with type test report.

4. FAN AND MOTOR

Plug Fans:-Fans shall be backward curved plug fan with aerofoil design blades so as to give maximum efficiency for given duty condition. The fan shall be AMCA certified and the entireFan + Motor assembly shall be balanced before dispatch. Multiple fans / single fan shall be used in AHU to suit available AHU Room at site & as per approved shop drawing. The supplyair fan shall be as per requirements. The fan impeller shall be supported to housing with angleiron frame & pillow block heavy duty ball bearing. The fan housing with TEFC Sq. Cage motor shall be mounted on a common adjustable base frame on vibration isolators / rubber turret mounts vibration isolators. The fan motor shall be installed inside the housing of air handling unit to keep low noise level. The fan & motor assembly shall be of aluminum extruded section only.

5. COIL

The chilled water coil shall be of seamless copper tubes not less than 0.4 mm thick and 12mm OD. Coil face areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched inthe unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of airflow. The fins shall be uniformlybonded to the tubes by mechanical expansion of the tube for minimum thermal contact resistance with fins. Coil size shall be selected for a max. face velocity of 500 FPM.

Fin spacing shall be 11to 12 FPI & shall be 0.17 to 0.2 mm thick. The coils shall be tested against leaks at a hydraulic pressure of 21 kg/sq.cm. This pressure shall be maintained for period of at least 2 hours.

No drop shall be observed indicating any leaks. the water headers shall be completed with water in /out connections, vent plug on top and drain at bottom and designed to provide Water velocity between 2 to 6 FPS. The coils exceeding 6 rows depth shall be in two equal parts.

6. FILTER

Shall be done as per specification.

7. ACCESSORIES

Each air-handling unit shall be provided with manual air vent at highest point in the coolingcoil. In addition; following accessories may be required at air handling units.

a. Stem type thermometer at inlet and outlet of each coil with tubing and gauge cocks and asper applicable specifications.
b. Pressure gauge with globe valves at inlet and outlet of each coil with tubing and as perapplicable specifications.
c. Butterfly valves at inlet and outlet of each coil.
d. Y Strainer at inlet of each coil.

e. Union and condensate drain piping from the unit up to the drain trap as described in sectionpiping.
f. PIB Control Valve located in chilled water lines connected to the coil. This valve shall be operated through the cooling/heating thermostat and shall control the flow of chilled/hot waterand as per applicable specifications.
g. Cooling /heating thermostat as per section
h. 'Automatic Controls and Instruments' shall be located in return air stream.
i. Double Flexible connection of fire retardant Hessian between the fan outlet and duct.
j. Vibration isolators of minimum 90% efficiency.
k. Motor & drive package
l. Air purge valve on top of coil header and drain valve at bottom.

8. DESIGN DATA FOR AIR HANDLING UNITS

i. Fan outlet velocity shall not exceed 550 MPM.
ii. The air velocity across coil shall not exceed 150 MPM.
iii. The air velocity across air pre filter shall not exceed 150 MPM.

Motor rating is tentative only and shall be suitable for the duty but not less than the specifiedHP. Motors shall be selected considering at least 20% margin over the break power.

The AHU fan shall be selected for a total static pressure as indicated under Technical Schedule for Equipment'.

9. INSTALLATION

Unit shall be installed above the false ceiling in a manner so as to permit the removal of all the parts of AHU for any maintenance work without dismantling other equipment such as plenum, pipes, ducts etc. Air handling unit installation shall be carried out as per manufacturer's recommendation. Rubber in shear type suspension hangers shall be provided for vibration isolation. Additional support shall be provided for heavy AHUs as perthe direction of E-I-C

10. PERFORMANCE DATA

Air handling unit shall be selected for the lowest operating noise level. Fan performance ratingand power consumption data with operating points clearly indicated shall be submitted and verifiedat the time of testing & commissioning of the installation.

11. TESTING

Cooling/heating capacity of various air-handling unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of air entering and leaving the coil

12. DATA/ INFORMATION: -

The Contractor shall complete the Data Sheet & submit as a part of his technical submittal at appropriate stage.

HORIZONTAL FLOOR MOUNTED AIR HANDING UNITS – DATA SHEET

1.	GENERAL	
1.1	Manufacturer	
1.2	Type of Unit	
1.3	Over All Dimensions (L x W x H) (mm)	
1.4	Weight (Including Water in circulation) Kg.	
1.5	Approximate Noise Level (DBA)	
1.6	Fan Discharge Position	
2.0	FAN SECTION	
2.1	Air Quantity (CFM)	
2.2	Total Static Pressure (mm of WG)	
2.3	Fan Speed (RPM)	
2.4	Fan Diameter (INCH) and no. Of fans	
2.5	Balancing (Static and / or dynamic)	
2.6	BHP	
2.7	Motor HP, RPM, Make & Type	
3.0	COOLING COIL	
3.1	Coil Fin Material (Aluminum or copper)	
3.2	Tube Diameter (INCH) and material	
3.3	Water through coil (USGPM) and no. of circuits	
3.4	Fin Size (INCH)	
3.5	No of Fins / INCH	
3.6	Water velocity through Coil (FPS)	
3.7	Water Coil Pressure Drop (ft of WG)	
3.8	Outside Coil Surface (SQFT)	
3.9	Face Area (SQFT) of Coil	
3.10	Rows Deep	
3.11	Water Temperature IN & OUT (DEG F)	
3.12	Air In and Out DB& WB Temp (DEG F)	

VERTICAL FLOOR MOUNTED

AIR HANDING UNITS – DATA SHEET

1	GENERAL	
1.1	Manufacturer	
1.2	Type of Unit	
1.3	Over All Dimensions (L x W x H) (mm)	
1.4	Weight (Including Water in circulation) Kg.	
1.5	Approximate Noise Level (DBA)	
1.6	Fan Discharge Position	
2.0	FAN SECTION	
2.1	Air Quantity (CFM)	
2.2	Total Static Pressure (mm of WG)	
2.3	Fan Speed (RPM)	
2.4	Fan Diameter (INCH) and no. Of fans	
2.5	Balancing (Static and / or dynamic)	
2.6	BHP	
2.7	Motor HP, RPM, Make & Type	
3.0	COOLING COIL	
3.1	Coil Fin Material (Aluminum or copper)	
3.2	Tube Diameter (INCH) and material	
3.3	Water through coil (USGPM) and no. of circuits	
3.4	Fin Size (INCH)	
3.5	No of Fins / INCH	
3.6	Water velocity through Coil (FPS)	
3.7	Water Coil Pressure Drop (ft of WG)	
3.8	Outside Coil Surface (SQFT)	
3.9	Face Area (SQFT) of Coil	
3.10	Rows Deep	
3.11	Water Temperature IN & OUT (DEG F)	
3.12	Air In and Out DB& WB Temp (DEG F)	

CEILING SUSPENDED AIR HANDING UNITS

DATA SHEET B

	GENERAL	
1.1	Manufacturer	
1.2	Type of Unit	
1.3	Over All Dimensions (L x W x H) (mm)	
1.4	Weight (Including Water in circulation) Kg.	

1.5	Approximate Noise Level (DBA)	
1.6	Fan Discharge Position	
2.0	FAN SECTION	
2.1	Air Quantity (CFM)	
2.2	Total Static Pressure (mm of WG)	
2.3	Fan Speed (RPM)	
2.4	Fan Diameter (INCH) and no. Of fans	
2.5	Balancing (Static and / or dynamic)	
2.6	BHP	
2.7	Motor HP, RPM, Make & Type	
3.0	COOLING COIL	
3.1	Coil Fin Material (Aluminum or copper)	
3.2	Tube Diameter (INCH) and material	
3.3	Water through coil (USGPM) and no. of circuits	
3.4	Fin Size (INCH)	
3.5	No of Fins / INCH	
3.6	Water velocity through Coil (FPS)	
3.7	Water Coil Pressure Drop (ft of WG)	
3.8	Outside Coil Surface (SQFT)	
3.9	Face Area (SQFT) of Coil	
3.10	Rows Deep	
3.11	Water Temperature IN & OUT (DEG F)	
3.12	Air In and Out DB& WB Temp (DEG F)	

2.13.13 VARIABLE FREQUENCY DRIVES FOR HVAC SYSTEMS

2.13.13.1 VARIABLE FREQUENCY DRIVE FOR CHILLERS AND PUMPS

CODES and STANDARDS

- The AC Drives shall be CE marked, conforming to European Low Voltage (73/23/CEEand 93/68/CEE) and EMC (89/336/CEE) Directives
- The AC Drives have to be built to comply with the IEC standards.
- The AC Drives shall be UL marked according to UL61800-5-1
- The AC Drives shall be CSA marked according to CSA 22.2 N274.

Operating conditions:

Operating Voltage	380-480V , ± 10%
Displacement Factor	0.97 or better at nominal load
Rated Frequency	50Hz
Efficiency	97 % at nominal load for standard drives
VFD Protection Class	IP21
Panel/Enclosure Protection Class	IP 54
Relative Humidity	5-95% without condensation
Overload capability	110% of nominal current at normal duty for 60s 150% of nominal current at heavy duty for 60s
Operating ambient Temperature	+40 °C
Operating altitude:	0…1,000 m/0…3,281 ftwithout derating 1,000...4,800 m/3,281…15,748 ftwith derating of 1% per 100 m/328 ft
Withstand to harsh environments:	Chemical class 3C3/3C2 conforming to IEC/EN60721-3-3 Mechanical class 3S3/3S2 conforming to IEC/EN60721-3-3 **Electronic cards with protective coating**
Harmonics	➢ Less than 5% (THDi)even at 100% load individual drive ➢ Less than 5% (THDi) at part loads with Active Harmonic Filter, essential clause of Specifications

GENERAL REQUIREMENTS

This specification covers complete variable frequency drives (VFDs) designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD.

i. The VFD shall be tested to UL 508C. The appropriate UL label shall be applied. VFD shallbe manufactured in ISO 9000, 2000 certified facilities.

ii. The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequencyto maintain desired motor magnetization current suitable for the driven load and toeliminate the need for motor derating.

iii. IEEE519, 2014 recommendations shall be used for the basis of calculation of total harmonic distortion (THD) at the point of common coupling (PCC). On request VFD

manufacturer shall provide THD figures for the total connected load. The Contractor shall provide details of supply transformer rating, impedance, short circuit current, short circuitimpedance etc. to allow this calculation to be made.

iv. All VFDs shall contain integral EMC Filters to attenuate Radio Frequency Interference conducted to the AC power line. The VFDs shall comply with the emission and immunity requirements of IEC 61800-3: 2004, Category C2 or C3. VFDs without EMC filters are not acceptable.

v. VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.

vi. A description of the alarm, and the date and time of the alarm shall be recorded. VFD shall be able to store and display fault history/ power consumption in real time management and in graphical format in daily/monthly/yearly consumption.

vii. A real-time clock shall be an integral part of the VFD. The real-time clock shall be able totime and date stamp all faults recorded in the VFD fault log.

viii. The VFD shall provide as standard one embedded Modbus port and one embedded Ethernetport.

ix. When used with a pumping system, the VFD shall be able to detect no-flow situations, drypump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected. The VFD shall be able to display the “Best Efficiency Point” set point for pump based on pump characteristics.

x. The VFD shall have Protection against input transients, loss of AC line phase, output shortcircuit, output ground fault, over voltage, under voltage, VFD over temperature and motorover temperature.

xi. Display of the drive shall be graphical full LCD display to monitor energy graphs, trendsand faults.

xii. Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Levels of password protection shall be provided to guard against unauthorized parameter changes.

xiii. To set up multiple VFDs, it shall be possible to upload all setup parameters to the

VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters toeach VFD.

xiv. The programming terminal /Display shall be able to display a chart relative to energyefficiency and energy management.
Report in KW

Daily, weekly, monthly report

Trend base on variation /time

xv. At least, the following standard Inputs and Outputs shall be provided, to be used in interfacewith the control system :
Analogue Inputs & Outputs:

- 3 x Programmable current input 0(4) - 20mA or 0 – 10V
- 2 x Programmables analogues outputs 0 (4) - 20mA or 0–10V Logic inputs:
- 6 x Programmable Logic Inputs isolated from the mains
- In accordance with IEC 61131-2
- All logic inputs may be used either in sink or sourceRelay Outputs:
- 3x Programmable Digital outputs

xvi. It shall be possible to extend the number of inputs/ outputs of the VFD up to:12 logic inputs, 5 analogue inputs, 2 analogue outputs, 1 logic outputs, 6 relays

xvii. All Chiller and pumps shall be supplied with VFDs and active harmonic filters and shall be completely factory packaged and physically inspected and complied before dispatch. Quality control certificates must indicate that all functionality including VFD and filter is tested in factory and has passed all quality control tests.

xviii. VFD and active harmonic filter must indicate OEM's confirmation on their letter head on maximum TDD <5% at source on all load between 25% to 100%. A compliance letter will be also required for IP54 Panel offering. Supplier need to submit Harmonic analysis report, THDi level spectrum of all rating of VFD model along with 5^{th}&7^{th} harmonics order.

2.13.13.2 VARIABLE FREQUENCY DRIVE FOR AHU

GENERAL REQUIREMENTS

This section provides general requirements for pulse-width modulated (PWM) Adjustable Frequency Drives, herein referred to as AC Drives, for use with NEMA design AC motors, or standard IEC motors.

The AC Drive is a system for controlling the rotational speed of an AC motor and providing on demand the right torque and speed to the pump & fan application.

The drive must be able to manage asynchronous motor.

Drive shall have maintenance and monitoring tools such as fault history, parameters upload/ download, scope and keypad emulation are built-in in the drive and used for trouble shooting. Moreover, additional user-friendly PC software must encompass the configuration management and commissioning functionalities without additional investment.

APPLICABLE STANDARDS

The VSD is qualified to address all the major economic area standards.The AC Drives shall be:

- CE marked, conforming to European Low Voltage (2006/95/EC modified from 73/23/EEC and 93/68/EEC and EMC (2004/108/EC modified from 89/336/EEC) Directives, and Machinery directive N0 98/37/EC modified by 98/79/EC.
- UL marked according to UL 508C
- GOST Marked
- CSA marked according to CSA 22.2 N14-05.
- C-Tick Marked
- The manufacturer of the AC Drive shall be a qualified ISO 14001 facility.
- The materials used in the AC Drive shall be recyclable, non-toxic and flame retardant. The AC Drive shall comply with the European directive RoHS (Restriction of HazardousSubstances) 2002/95/EC.
- The Product Environmental Profile (PEP) analysis must be performed in conformity with standard ISO 14040 “Environmental management: life cycle assessment, principle and framework”.
  Moreover, it shall comply with National and International standards and the recommendations for electrical industrial control devices (IEC, EN, UL, NFC, VDE) listed below :

Standard	***Title***
IEC 60068-2-3 IEC 60068-2-6 IEC 60068-2-27	Environmental testing; Part 2-3: Tests - Test Ca: Damp heat, steady state Part 2-6: Tests - Test Fc: Vibration (sinusoidal) Part 2-27: Tests - Test Ea and guidance: Shock
IEC 60529	Degrees of protection provided by enclosures (IP Code)

IEC 61800-3 IEC 61800-5-1	Adjustable speed Electrical Power Drive Systems; Part 3: EMC requirements and specific test methods Part 5-1: Safety requirements - Electrical, thermal and Energy

SPECIFIC REQUIREMENTS PROTECTION

The following function shall be available to prevent the risks of equipment destruction from component's failures :

- ✓ The AC Drive shall be protected against short circuits, between output phases and to ground.
- ✓ The AC Drive shall have under-voltage power-loss ride through performance.
- ✓ The AC Drive shall integrate a protection against IGBT chips over temperature in additionto the heat sink overheat protection.
- ✓ The output frequency shall be software enabled to fold back when the motor is overloaded.
- ✓ Upon loss of the analog process follower reference signal, the AC Drive shall be programmable to display a fault.
- ✓ Three skip frequency ranges that can be programmed to a bandwidth of 30Hz.
- ✓ VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.

COMMISSIONING

A keypad display interface shall offer the modification of AC Drive adjustments through a Graphical Display on panel. All electrical values, configuration parameters, I/O assignments, faults, local control, and adjustment storage, and diagnostics shall be accessible.

The built-in keypad display interface must have the Run/Stop command buttons for quick local running feature. For security reasons the keypad must not be removable from the drive.

The optional remote display is mandatory and must have the three following press keys:

- LOC/REM to switch the drive command locally or remotely via a graphic Keypad
- RUN to run the drive
- STOP to stop the drive.

A red led will lit on the front panel to indicate the energizing status of the drive DC bus.

The hereafter parameters Speed reference, Motor current, Drive rated current, Drive thermal state,Output power must be displayed on the graphic terminal.

HARMONICS MANAGEMENT

- ✓ To mitigate the over sizing of the transformer and power cables the rectifier bridge technology must guarantee a VSD THDi (Total Harmonic Current Distortion IEC/EN 61000-3-12 standard) below 35% without additional parts such as fixed or swinging chokes, DC Chokes and harmonic filters to avoid voltage drops.
- ✓ The Drive vendor shall be specifying the THDi level spectrum of all rating of VFD model along with 5th& 7th harmonics order.
- ✓ In case VFD alone is not able to provide THDi below 5%, VFDs shall require an external AC line reactor or filters to reach VSD THDi below 5%. VFDs with inbuilt line choke/swinging Choke are not acceptable considering deration of drive because of heat generated by chokes.

CONTROL CONNECTIONS

- ✓ The control power for the digital inputs and outputs shall be 24Vdc. The input logic type (positive logic) or sink (negative logic) is configured by a hardware switch.
- ✓ The internal power supply shall incorporate automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs will be current limited and will not be damaged if shorted.
- ✓ Removable terminal strips shall be used on all logic and analog signal connections in the power converter
- ✓ Two voltage-free relay output contacts will be provided. One of the contacts will indicate AC Drive fault status. The other contact shall indicate a drive run status. These relays shall be configurable for other status indicators.

SERIAL COMMUNICATION

- ✓ The AC drive shall have a dual port communication:
- First Port :Modbus communication.
- Second port : Modbus, METASYS N2, APOGEE FLN, BACnet

OPERATION

Input Voltage & Power Range

Rated Input Voltage and Power range	Three phases power supply: 380V -15% 480V +10% ,3Phase
Rated Input Frequency	50 Hz -5% to 60 Hz + 5%
Protection degree	IP 21 for VFD Unit
Cooling system	Heatsink and Air forced
Harmonics according to IEC/EN 61000-3-12	Harmonics <5% THDi for each VFD at 100% load
Efficiency	≥ 97%

Output Voltage	0 - UN, three-phase
Acceleration/Deceleration Time	Adjustable duration, linear ramp, S shape ramp, with U or customised profile.
Overload capability	110% of the nominal motor torque for 60 seconds

ENVIRONMENTAL RATINGS

Operating ambient Temperature	50 °C without derating
Storage ambient Temperature	-25°C up to 70 °C
Maximum operating altitude	1000 m without derating 1000…3000m: current derating of1% per additional 100 m.
Max. Relative Humidity (IEC 60068-2- 3)	5…95 %, without condensation and dripping water

- ✓ The AC Drive shall be able to give a 100 % output current continuously in the above specified conditions. The derating factor must not have an impact on the lifetime of the AC Drive, the unit's performance, overload capability included, and the reliability of the AC Drive.

- ✓ All VFDs shall contain integral EMC Filters to attenuate Radio Frequency Interference conducted to the AC power line. The VFDs shall comply with the emission and immunity requirements of IEC 61800-5-1, IEC 61800-3, Category C2 or C3. VFDs without EMC filters arenot acceptable.

MAINTENANCE BUILT-IN FUNCTIONALITY

Upon power-up, the AC Drive shall automatically test for valid operation of memory, loss of analog reference input, loss of communication, DC-to-DC power supply, control power and pre-charge circuit. A user friendly PC software shall be provided for commissioning, configuration set-up and troubleshooting tool.

MANUFACTURER

The AC Drive Manufacturer must have a minimum of 40 years experience in world-class drive design and manufacturing. The installed base product quantity must be large enough to be crediblein its capability to be an edge company continuously enhancing its product management process.

LOCAL SUPPORT

The Supplier shall have a permanent representative office with a trained and skilled support staff,in the country where the goods are delivered.

The most critical spare parts like fuses, IGBTs, cooling fans as well as main control- and I/O-boards shall be available on site.

The more rarely used spare parts shall be available in maximum 14 days on site.

2.13.13.3 VARIABLE FREQUENCY DRIVE FOR COOLING TOWER

GENERAL REQUIREMENTS

This section provides general requirements for pulse-width modulated (PWM) Adjustable Frequency Drives, herein referred to as AC Drives, for use with NEMA design AC motors, or standard IEC motors.

The AC Drive is a system for controlling the rotational speed of an AC motor and providing on demand the right torque and speed to the pump & fan application.

The drive must be able to manage asynchronous motor.

Drive shall have maintenance and monitoring tools such as fault history, parameters upload/ download, scope and keypad emulation are built-in in the drive and used for trouble shooting. Moreover, additional user-friendly PC software must encompass the configuration management and commissioning functionalities without additional investment.

APPLICABLE STANDARDS

The VSD is qualified to address all the major economic area standards.The AC Drives shall be:

- CE marked, conforming to European Low Voltage (2006/95/EC modified from 73/23/EEC and 93/68/EEC and EMC (2004/108/EC modified from 89/336/EEC) Directives, and Machinery directive N0 98/37/EC modified by 98/79/EC.
- UL marked according to UL 508C
- GOST Marked
- CSA marked according to CSA 22.2 N14-05.
- C-Tick Marked
- The manufacturer of the AC Drive shall be a qualified ISO 14001 facility.
- The materials used in the AC Drive shall be recyclable, non-toxic and flame retardant. The AC Drive shall comply with the European directive RoHS (Restriction of Hazardous Substances) 2002/95/EC.
- The Product Environmental Profile (PEP) analysis must be performed in conformity with standard ISO 14040 “Environmental management: life cycle

assessment, principle and framework".

Moreover, it shall comply with National and International standards and the recommendations for electrical industrial control devices (IEC, EN, UL, NFC, VDE) listed below

Standard	***Title***
IEC 60068-2-3 IEC 60068-2-6 IEC 60068-2-27	Environmental testing; Part 2-3: Tests - Test Ca: Damp heat, steady state Part 2-6: Tests - Test Fc: Vibration (sinusoidal) Part 2-27: Tests - Test Ea and guidance: Shock
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 61800-3 IEC 61800-5-1	Adjustable speed Electrical Power Drive Systems; Part 3: EMC requirements and specific test methods Part 5-1: Safety requirements - Electrical, thermal and Energy

SPECIFIC REQUIREMENTS PROTECTION

The following function shall be available to prevent the risks of equipment destruction from component's failures :

- ✓ The AC Drive shall be protected against short circuits, between output phases and to ground.
- ✓ The AC Drive shall have under-voltage power-loss ride through performance.
- ✓ The AC Drive shall integrate a protection against IGBT chips over temperature in addition to the heat sink overheat protection.
- ✓ The output frequency shall be software enabled to fold back when the motor is overloaded.
- ✓ Upon loss of the analog process follower reference signal, the AC Drive shall be programmable to display a fault.
- ✓ Three skip frequency ranges that can be programmed to a bandwidth of 30Hz.
- ✓ VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.

COMMISSIONING

A keypad display interface shall offer the modification of AC Drive adjustments through a Graphical Display on panel. All electrical values, configuration parameters, I/O assignments, faults, local control, and adjustment storage, and diagnostics shall be accessible.

The built-in keypad display interface must have the Run/Stop command buttons for quick local running feature. For security reasons the keypad must not be removable from the drive.

The optional remote display is mandatory and must have the three following press keys:

- LOC/REM to switch the drive command locally or remotely via a graphic Keypad
- RUN to run the drive
- STOP to stop the drive.

A red led will lit on the front panel to indicate the energizing status of the drive DC bus.

The hereafter parameters Speed reference, Motor current, Drive rated current, Drive thermal state, Output power must be displayed on the graphic terminal.

HARMONICS MANAGEMENT

- ✓ To mitigate the over sizing of the transformer and power cables the rectifier bridge technology must guarantee a VSD THDI (Total Harmonic Current Distortion IEC/EN 61000-3-12 standard) below 35% without additional parts such as fixed or swinging chokes, DC Chokes and harmonic filters to avoid voltage drops.
- ✓ The Drive vendor shall be specifying the THDI level spectrum of all rating of VFD model along with 5th& 7th harmonics order.
- ✓ In case VFD alone is not able to provide THDi below 5%, VFDs shall require an external AC line reactor or filters to reach VSD THDi below 5%. VFDs with inbuilt line choke/ swinging Choke are not acceptable considering deration of drive because of heat generated by chokes.

CONTROL CONNECTIONS

- ✓ The control power for the digital inputs and outputs shall be 24Vdc. The input logic type (positive logic) or sink (negative logic) is configured by a hardware switch.
- ✓ The internal power supply shall incorporate automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs will be current limited and will not be damaged if shorted.
- ✓ Removable terminal strips shall be used on all logic and analog signal connections in the power converter
- ✓ Two voltage-free relay output contacts will be provided. One of the contacts will indicate AC Drive fault status. The other contact shall indicate a drive run status. These relays shall be configurable for other status indicators.

SERIAL COMMUNICATION

- ✓ The AC drive shall have a dual port communication:
- First Port : Modbus communication.

- Second port : Modbus, METASYS N2, APOGEE FLN, BACnet

OPERATION Input Voltage & Power Range

Rated Input Voltage and Power range	Three phases power supply: 380V -15% 480V +10%, 3 Phase
Rated Input Frequency	50 Hz -5% to 60 Hz + 5%
Protection degree	IP 21 for VFD Unit
Cooling system	Heatsink and Air forced
Harmonics according to IEC/EN 61000-3-12	Harmonics <5% THDi for each VFD at 100% load
Efficiency	≥ 97%
Output Voltage	0 - U_N, three-phase
Acceleration/Deceleration Time	Adjustable duration, linear ramp, S shape ramp, with U or customised profile.
Overload capability	110% of the nominal motor torque for 60 seconds

ENVIRONMENTAL RATINGS

Operating ambient Temperature	50 °C without derating
Storage ambient Temperature	-25°C up to 70 °C
Maximum operating altitude	1000 m without derating 1000…3000m: current derating of 1% per additional 100 m.
Max. Relative Humidity (IEC 60068-2-3)	5…95 %, without condensation and dripping water

- ✓ The AC Drive shall be able to give a 100 % output current continuously in the above specified conditions. The derating factor must not have an impact on the lifetime of the AC Drive, the unit's performance, overload capability included, and the reliability of the AC Drive.
- ✓ All VFDs shall contain integral EMC Filters to attenuate Radio Frequency Interference conducted to the AC power line. The VFDs shall comply with the emission and immunity requirements of IEC 61800-5-1, IEC 61800- 3, Category C2 or C3. VFDs without EMC filters are not acceptable.

MAINTENANCE BUILT-IN FUNCTIONALITY

Upon power-up, the AC Drive shall automatically test for valid operation of memory, loss of analog reference input, loss of communication, DC-to-DC power supply, control power and pre-

charge circuit. A user-friendly PC software shall be provided for commissioning, configuration set-up and troubleshooting tool.

MANUFACTURER

The AC Drive Manufacturer must have a minimum of 40 years' experience in world-class drive design and manufacturing. The installed base product quantity must be large enough to be crediblein its capability to be an edge company continuously enhancing its product management process.

LOCAL SUPPORT

The Supplier shall have a permanent representative office with a trained and skilled support staff,in the country where the goods are delivered.

The most critical spare parts like fuses, IGBTs, cooling fans as well as main control- and I/O-boards shall be available on site.

The more rarely used spare parts shall be available in maximum 14 days on site.

2.13.14 ELCTRONICALLY COMMUTATED MOTOR BASED FAN COIL UNITS

Scope:

Works includes but is not limited to the following:

Energy efficient; low noise (> NC 35 or lesser) version of following fan coil units: Ceiling concealed / Ducted / Wall / ceiling / floor standing decorative type, Cassette Type Fan Coils.

Water temp 7/12 deg C and for hot water 50/45 deg C

Material:

General: Fan coil realised with support structure in galvanised steel. It shall have holes in the rear part of the appliance for wall mounting and shall have condensate drip tray with non corrosive material. For the models without cabinet, the closing panel of the ventilation unit is mounted on the front. The feet (accessory) for the ducted units are made of galvanised steel sheetmetal.

PROTECTIVE CABINET When FCU placed open in the room - Casing colour RAL9003 / Flow grids colour RAL7047 or as per the architecture layout approval. The casing shall be made with galvanised steel sheet metal and painted with polyester powder to guarantee high resistance to rustand corrosion.

The feet (accessory) for the units with casing are made of plastic colour RAL9003.

Fan Unit:

Fan unit: Centrifugal Invertor motor fans with double wing suction blades developed in length to achieve high flow rates at low revs. The motor make shall be as per manufacturer recommendation provided the type of motor shall full fill the tender specifications.

Electric motor protected against overloads with start condenser always inserted, directly coupled to the fans and buffered using elastic mounts. Extractable and inspecting screw in low-noise plasticmaterial. The fan-motor shall handle minimum 8 mm ESP, if required.

Filter Section:

Removable filter made from regenerable materials and which can be washed. Filtration class G4

Coil type:

Fan-coil shall supply with a single three-rows (standard) or four/six-rows (enhanced) coil, with copper tubes and aluminum fins where ever required in BOQ; the manifolds shall fit with female plugs and air vent shall located at the top. The connections shall position on the left side of the coil but shall reversible during installation.

Condensate drip tray:

There shall two condensate drip trays: one for vertical installation and one for horizontal installation. Both basins are thermally insulated and have double drainage to the right and to the left. The unused drain must be sealed as per the site adjustment.

Coil Thickness shall vary or equal to (> 8mm - 9.8mm <)

Control:

The control panel shall be in the fan coil head and may be protected from tampering by locking the cover door with a screw. In units with the T-Touch electronic controller and the App application, by simply placing the smart device on the fan coil it shall possible to set operating modes and weekly hour programming using the APP's graphic interface. It shall also possible to access a wealth of additional information such as the alarms list, the closest Technical Service Centre etc.

Available for Android OS.

In versions where the control panel is an accessory, it can be installed on the fan coil or be wall-mounted. In wall-ceiling mounted versions the control panel (accessory) can only be installed on the wall.

The fan coils shall have option to integrate with BMS if asked in the BOQ.

Manufacturer:

The products or manufacturers listed here in are included for the purpose of establishing minimum quality standards. Products equal in quality or better than those specified will be considered if they are produced by a specialized manufacturer whose units are equal in every respect and have been in similar service for not less than thirty (30) years.

A. Submit coil pressure drop, manufacturer's specifications for fan coil units showing dimensions, capacities, ratings, performance characteristics include sound power level, gages and finishes of materials and installation instructions. Need to submit software selection with all details.
B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, constructions details and field connection details. Shop drawings shall show coordination with all related work sections.
C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to Fan Coil units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

DATA/ INFORMATION:-

The Contractor shall complete the Data Sheet & submit as a part of his technical submittal at appropriate stage.

DATA SHEET B

	GENERAL	
1.1	Manufacturer	
1.2	Type of Unit	
1.3	Over All Dimensions (L x W x H) (mm)	
1.4	Weight (Including Water in circulation) Kg.	
1.5	Approximate Noise Level (DBA)	
1.6	Fan Discharge Position	
2.0	FAN SECTION	
2.1	Air Quantity (CFM)	
2.2	Total Static Pressure (mm of WG)	
2.3	Fan Speed (RPM)	
2.4	Fan Diameter (INCH) and no. Of fans	
2.5	Balancing (Static and / or dynamic)	

2.6	BHP	
2.7	Motor HP, RPM, Make & Type	
3.0	COOLING COIL	
3.1	Coil Fin Material (Aluminum or copper)	
3.2	Tube Diameter (INCH) and material	
3.3	Water through coil (USGPM) and no. of circuits	
3.4	Fin Size (INCH)	
3.5	No of Fins / INCH	
3.6	Water velocity through Coil (FPS)	
3.7	Water Coil Pressure Drop (ft of WG)	
3.8	Outside Coil Surface (SQFT)	
3.9	Face Area (SQFT) of Coil	
3.10	Rows Deep	
3.11	Water Temperature IN & OUT (DEG F)	
3.12	Air In and Out DB& WB Temp (DEG F)	

INLINE & PROPELLER FANS

1. SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of centrifugal and inline fans conforming to these specifications and in accordance with the requirement of drawing and specification.

2. TYPE

Centrifugal and inline fans shall be of type as indicated in drawing and specification

3. INLINE FANS

Inline fan shall incorporate SISW direct driven centrifugal fan with TEFC (IP-44) motor. Thefan assembly shall be enclosed in a sheet metal housing of 22 gauge GSS and with necessary inspection cover with proper gasket assembly. The fan material shall be galvanized sheet steel. Flanges shall be provided on both sides of inline fan to facilitate easy connection. Flexible anti-vibration joints shall be provided to arrest vibration being transferred to other equipments connected to inline fan. Motor shall be single phase/three phase as per duty conditions.

All single-phase fans shall be provided with speed regulators while all three phase fans shallbe provided with opposed blade dampers in GSS construction at fan outlet for air balancing.

4. PROPELLER FANS

Propeller fans shall be direct driven, three or four blade type mounted on a steel mounting plate with orifice ring.

Mounting plate shall be of steel construction, square with streamlined venturi inlet coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge steel sheet 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.

Fan blades shall be constructed of aluminum or glass reinforced polypropylene. Fan hub shallbe of heavy welded steel construction with blades bolted to the hub fan blades and assemblyshall be statically and dynamically balanced

Shaft shall be of steel accurately ground and shall not pass through first critical speed through entire range of specified fan speed.

Motor shall be standard permanent split capacitor of shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for a quiet operation with a maximum speed of 1000 RPM for fans 60 cm dia. or larger and 1440

RPM for fans 45 cm dia. and smaller. Motors for larger fans shall be suitable for 415 ± 6% volts. 50 cycle 3-phase power supply and for smaller fans shall be suitable for 220 ± 6% volts,50 cycles single-phase power supply. Motors shall be suitable for horizontal or vertical service as indicated in drawing and specification. Propeller fans shall be provided with following accessories:

a. Wire guard and bird-screen
b. Gravity louvers at outlet
c. Regulator for controlling fan speed for single-phase fan motor.
d. Single-phase preventors for 3 phase fans.
e. Wiring between regulator and fan motor including termination at both ends.

5. PERFORMANCE DATA

All fans shall be selected for the lowest operating noise level. Capacity rating, power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of installation.

6. TESTING

Capacity of all fans shall be measured by an anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings, power consumption shall be computed from measurements of incoming voltage and incoming current.

2.13.15 VENTILATION FAN SECTIONS

GENERAL

a. Fans shall be of the type, size, arrangement and capacity as indicated in the schedule and/or asshown on the drawings.
b. Unless specified, fan performance rating data shall be tested accordance with AMCA Standard 210-85(Air Moving and Conditioning Association), ANSI/ASHRAE Standard 51-1985 “Laboratory Methods of Testing Fans for Rating”. Sound ratings shall conform to AMCA Standard 300-85, “Reverberant Room Method for Sound Testing of Fans”.
c. A computer printout of fan performance rating corresponding to the AMCA licensed data, with corrected ratings for altitude and temperature, fan operating speed, bearing life, etc. shallbe submitted for approval.
d. All fans shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade after assembly. A computer printout with the vibration spectrum analysis shall be attachedto the fans.
e. Fan motors shall comply in all respects with continuous rating in accordance with IEC34 or equivalent. Motor bearings shall be of ball or roller type, grease or lubricant sealed for life. Fanand drive shall be earthed to prevent accumulation of static charge.
f. Kitchen exhaust fan shall be of Bifurcated Axial or SISW Centrifugal direct or belt driven type. DIDW Centrifugal and Direct Drive Axial Flow Fan where belts or motor are in the airstream are not acceptable.
g. Fan shall be of G.S.S., the Steel sheet shall be JFE Galvazinc (Base metal cold rolled), JIS G3302, SGCC with Z22 (minimum coating weight on both sides @ 220 g/m2) zinc coating& Zero Spangle, skinpassed, chromated and dry.
h. If fan is open to atmosphere, Fans shall be with Pure polyester powder coating for minimumthickness of 60 microns.

AXIAL FLOW FANS (DIRECT DRIVE)

a. Fans shall be licensed to bear the AMCA Seal. The test standard used shall be ANSI/AMCA 210-85, ANSI/ASHRAE Standard 51-1985 “Laboratory Method of Testing Fans for Rating” and AMCA 300 “Reverberant Room Method for Sound Testing of fans”.
b. To achieve the minimum and equal clearance between the blade tips and casing, tube casing shall maintain its roundness by means of using one piece of sheet metal with 90 edge flanging up.
c. Fan motor base support shall be properly secured (locked and sealed) to the fan housing and be of adjustable type to have precise control of motor shaft central position as well as running clearance between blade tips and casing. Motor (KW/HP) shall be able to be changed or upgraded at site without changing fan housing or ducting construction.
d. Fans supplied shall be complete with factory fabricated mounting bracket (ceiling or foot mounted) and suction/ discharge matching flanges as accessories.
e. All hubs shall be cast Aluminum alloy (Grade LM2) unless for Smoke Extractor Fans where high temperature (250C/2Hrs) air is expected then Aluminum alloy or steel fan impeller blades are required. Otherwise, impeller blade material with

Polypropylene (PP), Glass-reinforced Polypropylene (PPG) and Glass-reinforced Polyamid (PAG), to provide self-balancing, anti- static, anti-sparking characteristic is preferable.

f. Running clearance between blade tips and casing shall not exceed 1% of the impeller diameter, and 2% for smoke spill high temperature fan where mechanical expansion coefficient is different from normal ambient temperature. Fan manufacturer shall provide the fan assembled with the dame clearance between blade tips and casing of the tested prototype. Note that the air performance and pressure loss are greatly affected by this clearance.
g. Impellers shall be secured to the drive shaft by a key and keyway. Axial location shall be provided by a collar or shaller on the drive shaft together with a retaining washer and screw fitted into a tapped hole at the end of the shaft and locked in position. Blades shall be secured in place to the angle setting by setscrews, locking nuts or setting pins.
h. Fan motor shall be totally enclosed and external terminal box of at least IP55 shall be provided.
i. Fan RPM shall be as per DBR / requirememt.
j. All fans after assembly shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 – G2.5 quality grade. A computer printout with vibration spectrum analysis shall be attached to the fans.
k. Fan shall be of G.S.S., the Steel sheet shall be JFE Galvazinc (Base metal cold rolled), JIS G3302, SGCC with Z22 (minimum coating weight on both sides @ 220 g/m2) zinc coating& Zero Spangle, skinpassed, chromated and dry.

VANE AXIAL FLOW FANS (DIRECT DRIVE)

a. Fan shall be licensed to bear AMCA seal.
   To achieve the minimum and equal clearance between the blade tips and casing, tube casing shall maintain its roundness by means of using one piece of sheet metal with 90 edges flangingup with Fixed Guide Vanes.
b. Fan Casing shall be provided with Special Designed Integral **Straightening Vanes** toreduced turbulence provide high performance & low noise level.
c. Fan motor base support shall be properly secured (locked and sealed) to the fan housing and be of adjustable type to have precise control of motor shaft central position as well as running clearance between blade tips and casing. Motor (KW/HP) shall be able to be changed or upgraded at site without changing fan housing or ducting construction.
d. Fans supplied shall be complete with factory fabricated mounting bracket (ceiling or foot/discharge matching flanges as accessories.
e. All hubs shall be cast Aluminum alloy (Grade LM2) unless for Smoke Extractor Fans wherehigh temperature (250C/2Hrs) air is expected then Aluminum alloy or steel fan impeller blades are required. Otherwise impeller blade material with Polypropylene (PP), Glass-reinforced Polypropylene (PPG) and Glass-reinforced Polyamide (PAG), to provide self-balancing, anti- static, anti-sparking characteristic is preferable.
f. Impellers shall be secured to the drive shaft by a key and keyway. Axial location

shall be provided by a collar or shaller on the drive shaft together with a retaining washer and screw fitted into a tapped hole at the end of the shaft and locked in position. Blades shall be secured in place to the angle setting by setscrews, locking nuts or setting pins.

g. Fans shall not exceed 1500 RPM.
h. All fans after assembly shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 G2.5 quality grade. A computer printout with vibration spectrum analysis shall be attachedto the fans.
   The Fan shall be AMCA Certified for Air Performance.
i. Fan shall be of G.S.S., the Steel sheet shall be JFE Galvazinc (Base metal cold rolled), JIS G3302, SGCC with Z22 (minimum coating weight on both sides @ 220 g/m2) zinc coating& Zero Spangle, skinpassed, chromated and dry.

CENTRIFUGAL FANS

a. Fans, Aerofoil, forward or backward curved, SISW or DIDW, shall be licensed to bear the AMCA Air and Sound Certified Ratings Seal. The test standard used shall be ANSI/AMCA 210-85, ANSI/ASHRAE Standard 51-1985 “Laboratory Method of Testing Fans for Rating” and AMCA 300 “Reverberant Room Method for Sound Testing of fans”.
b. All fans shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade after assembly. A computer printout with vibration spectrum analysis shall be attached to the fans.
c. Fan shall be of G.S.S., the Steel sheet shall be JFE Galvazinc (Base metal cold rolled), JIS G3302, SGCC with Z22 (minimum coating weight on both sides @ 220 g/m2) zinc coating & Zero Spangle, skinpassed, chromated and dry.
d. Fans housing shall be of an appropriate thickness to prevent vibration and drumming. The fan scroll shall be attached to the side plate by means of continuous lock seam or intermittent spot welding. The wheel and inlet cone shall be aerodynamically designed and constructed to provide maximum performance and efficiency as published by the manufacturer.
e. Fans must be physically capable of operating safely at every point of rating at or below the “minimum performance” limit for that class as defined in AMCA standard 99-2408-69 “Performance Class of Operating Limits for Centrifugal Fans”.
f. Shafts sizes shall be carefully calculated and designed such that the maximum operating speed (RPM) shall not exceed 75% of the first critical speed. For any application that is not a standard product from catalogue of the fan manufacturer detailed calculation of critical speed characteristic shall be submitted for approval.
g. Shafts shall be made of carbon steel (C45) machined and polished to tolerance of standard ISO 286-2 - grade g6. Protective coat of anti-rusting shall be applied to all bare surfaces of the shafts at the factory.

h. Bearings shall be of self-alignment (concentric) type with adaptor sleeve bearing. Bearings of eccentric locking collar with grub screw type are not acceptable. Bearing shall be maintenance free with permanently lubricated sealed ball bearing type. Bearing life shall be at least 75,000 hours based on basic rating life, L10 of ISO 281 standard. Calculation sheet of Bearing Life shall be submitted for approval.
i. Motor installed shall be of a minimum 130% of the fan power absorbed (Brake horsepower) and shall have sufficient torque available for starting and continuous operation.

j. Belts and pulleys shall be sized for a minimum 150% of the installed motor horsepower. The belt speed shall not exceed 30m/s. The pulley shall be of Taper Lock SPZ, SPA, SPB or SPC type. Conventional type of pulley is not acceptable. Both fan and motor pulley shall be balanced to the quality grade G.2.5.
k. Fan outlet velocity shall not exceed 10% of the main duct air velocity designed (0.1" per 100 ft or 1 Pascal per meter duct length). Pressure Loss is as referred to in SMACNA Standard, unless otherwise specified.
l. Computer printout on fan performance rating corresponding to the AMCA licensed data, with corrected rating for altitude and temperature, fan operating speed, bearing life, etc. shall be submitted for approval.
m. For Air washer Application, fans shall have to coat of pure polyester powder coating. Fans shall have Inspection door & Drain plug.

2.13.16 **AUTOMATIC CONTROLS AND INSTRUMENTS**

PRODUCTS

i. 2 WAY MODULATING/ PRESSURE INDEPENDENT/ BALANCING and FLOWCONTROL VALVE.

The Self balancing flow control valves that are pressure independent, 2-way, modulating to accept Input signals from the control system.

Each Air Handling Unit / Fan Coil Unit shall be provided with a 2Way Pressure Independent Balancing and Control Valve integrated in a single Body. The valve shall be a **Globe Type**. **Rolling Diaphragm based delta p controller shall ensure 100% valve authority .**

Each air-handling unit/ fan coil unit shall be actuated by a space thermostat. Space conditions shall be maintained by continuous proportional modulation of the chilled/hot water through the coil .

Control - Valve shall be equipped with electronic modulating gear type (not thermal/wax) actuator which can accept either "4(0)-20 mA / 2(0)-10V DC signals. Operating voltage for actuator shall be 24V AC.

Minimum Pressure Drop across the valve must not exceed 30 kPa in bigger Sizes. All Valveactuators shall be microprocessor based with self-calibrating feature. Valve Actuator combination shall be able to give logarithmic control. Actuator shall be able to work against pump head or maximum closing pressure Manual Override Flow Balancing shall only be done in Valve, not in actuator Balancing – Each Valve shall have a stepless adjustable maximum flowlimitation as per the designed flow rate of coils. The balancing shall be done only in the valve not in the actuator so that in case of actuator failure the balancing is not lost and easily accessible. For Test ports valve shall have Needle measuring nipple.

Two way or Three-way motorized valve for each fan coil unit shall be provided in chilled water lines at each fan coil unit as shown drawing and specification. The valve shall be

actuated by space thermostat. Constant space conditions shall be maintained by allowing all of chilled water to either pass through the coil or bypass the coil and mix with the chilled water return. Thevalve shall revert to fully bypass position when fan is shut off.

Valve shall be similar to Honeywell two-position diverting valves 15 cm (1/2 inch) diameter with flare connection. Valve shall be selected for water flow rate of 5-6 USGPM. Pressure dropacross the valve shall not exceed 2 psi. Valve shall have the facility to replace motor & actuator without removing the valve body.

ii. Flow switches shall be provided in the condensing water line (outlet) and chiller water line (outlet) only near the chilling machine. The control supply of chilling units shall be interlocked with these flow switches.
iii. Thermostats shall be electrical mode, fixed differential type with sensing element located in the return air stream.
iv. Proportional control thermostats for air conditioning application for actuating the two ways or three-way modulating valve at each air-handling units, as shown on drawings and included in drawing and specification. Range shall be 56–84-degree F, differential shall be 3 degree F.
v. SNAP acting fixed differential thermostat for FCU shall be with temperature range of 13-29 degree C differential 37 deg C with ON/OFF, HI/LOW fan switch, normal-cool setting switchingoff must break fan circuit.

INSTRUMENTS

i. Thermometer: Thermometers shall be dial type 100 mm dia or V form industrial type. Body shall be aluminum alloy, anodized gold colored surface. The casing shall be adjustable sideways for reading from the front. The glass capillary shall be triangular in shape with blue mercury filledin glass for better visibility. Scale of reading shall be of the range 0 deg C to 60 deg C & +32 deg F to 150 deg F. Graduation of scale shall be 1 deg in both readings. Ranges of scales shall be 30-90 degrees F (0-50 deg C) for all conditioning applications of cooling only.
Thermometer shall be suitable for 15mm connection. Thermometer for chilled water shall be with long stem so that thermometer is removable without damaging the insulation ms socket to be welded / inserted using hote cut grooved method on pipes shall be provided with thermometer.Thermometer shall be installed of chilled water supply and return at each air handling unit, supplyand return of each chiller, condenser.

ii. Pressure gauge: shall be installed on suction header and at discharge side of each pump in the chilled water supply and return at each air handling unit, at inlet and outlet of each chiller. Suction side gauge at pump suction header shall be compound gauge with 150 MM dia, range 75 cm vacuum to 10 kg pressure. Discharge side gauge at pumps and at all other locations shall be 150mmrange 0-10 kg per sq cm (0-150 PSI) Pressure.

iii. Thermostats: Thermostats shall be electric fixed differential type as indicated below, with sensing element located in the return air stream. All thermostats shall be

supplied with the standard mounting boxes as recommended by the manufacturer. The profile, mounting arrangement and exact location of the thermostat shall be such as to suit the site.

I) Proportional control thermostats shall be provided for actuating the three way modulating valve at each air handling unit. Thermostat shall provide manual switching (heat-off-cool-in heating-cooling system).

II) Snap-acting fixed differential type thermostat for actuating the three-way diverting valve at each fan coil unit.

Thermostat shall have temperature adjustments WARM-NORMAL-COOL settings and fan switch. Switching off must break fan circuit.

III) Snap-acting fixed differential heating thermostat for electric winter heating and reheat applications for putting on/off power supply to electric heating or reheat coils in air handling units.

IV) Safety thermostat shall be provided for electric winter heating and reheat application for cutting off power supply to strip heaters in case air flow across strip heater is not established.

V) Air-stat shall be provided within air handling unit containing electric heating or reheat coils to prevent heaters from energizing unless the air flow is established.

iv. Humidistats: Humidistat shall be provided with air handling unit for areas, which require humidity control. One humidistat shall activate the reheat coils in case the space humidity rises beyond the preset limit. Another humidistat shall energize the humidifier when the humidity falls below the preset limit. These humidistats shall also de-energize these devices when the desired humidity is reached.

Humidistats shall be snap-acting type having humidifier/dehumidifier control from 20-80 percent relative humidity, with differential of 5 percent. Humidistat shall have nylon element withthree bobbins, and removable knob to prevent tempering of set point.

v. AUTOMATIC BALANCING VALVES for Chiller/condenser line: Size : 100-1000 mmsize

AUTOMATIC BALANCING VALVES WAFER type Valve shall consist of a dynamic, flow limiting device.

VALVE housing shall be constructed of ductile iron ASTM A536, Class 60-40-18; rated at no less than 3400 kPa static pressure at +175°C; shall have single or multiple, parallelinstalled stainless steel cartridge assemblies (Flow regulation unit assembly shall be manufactured of stainless steel and stainless-steel spring.), to provide rated flow rate.

- Valve shall be permanently marked to show direction of flow.
- Dual pressure/ temperature test plugs for verifying accuracy of flow performance shall be provided for all valve sizes.
- Flow regulation unit shall be available in four different kPa operational ranges; minimum range shall be capable of being activated by minimum 10kPaD; and shall be capable of controllingflow within +/-5% of rated flow.
- Identification tag shall be available for all valves; tag can be indelibly marked with model number, flow rate.

2.13.17 SHEET METAL WORKS AND ACCESSORIES - (MANUAL FABRICATION)

Duct work shall mean all ducts, casings, dampers, access doors, joints, stiffeners, hangers & all accessories.

DUCT MATERIALS

The ducts shall be fabricated from galvanized steel sheets class VIII - Light coating of Zinc conforming to ISS: 277-1962 (REVISED) and with a galvanizing thickness of nominal 120 gm. per SQM surface area.

i. Only new, fresh, clean (unsoiled) and bright GI/Aluminum sheets shall be used. The THE EMPLOYER/EMPLOYER reserve the right to summarily reject the sheets not meeting these requirements. Fabrication of ducts shall be through Lock forming machines.

ii. All duct work, sheet metal fabrication unless otherwise directed, shall strictly meet requirements, as described in IS:655-1963 with Amendment-I (1971 Edition)

Longer size of Duct	**Sheet Thickness GI (MM)**	**Type of Joints**	**Bracing**
Up to 750	0.63	GI Flange	
751-1000	0.80	25x25x3 mm angle iron frame with 8 mm Dia nuts & bolts	25X25X3 MM @ 1M
1001-1500	0.80	40x40x5 mm angle iron frame with 8 mm Dia nuts & bolts	40x40x5 MM @1M
1501-2250	1.00	50x50x5 mm angle iron frame with 10 mm Dia nuts & bolts at 125 mm center	40x40x3 mm @ 1.2m to bebraced diagonally.
2251 & above	1.25	50x50x6 mm angle iron frame with 10 mm Dia nuts & bolts at 125 mm center	40x40x3 mm @ 1.6m diagonally braced

iii. Ducts larger than 450 mm shall be cross broken, duct sections up to 1200 mm length may be used with bracing angles omitted.

iv. Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 Deg. Angle from the axis of the main duct unless otherwise approved by the Employer's Representative.

v. All ducts shall be supported from the ceiling/slab by means of M.S. rods of 10 MM Dia with

M.S. angle at the bottom of size 40 mm x 40 mm x 6 mm for sizes up to 1500 mm at 3 m intervals. Above size 1500 mm upto 2250, support shall be provided with 10 mm dia. MS rod and MS angle size 50 mm x 50 mm at bottom at 2.5 m intervals. Above size 2250 mm support shall be provided with 12 mm dia MS rod and MS angle size 50 mm x 50 mm at bottom

INSTALLATION

i. All ducts shall be fabricated and installed in workman like manner, generally conforming to relevant BIS codes. Round exposed ducts shall be die formed for achieving perfect circle configuration.

   a. Ducts so identified on the drawing shall be acoustically lined and thermally insulated as described in the section 'Insulation' and as indicated in drawing and specification. Duct dimensions shown in drawings are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in drawing and specification.
   b. Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made airtight.
   c. All exposed ducts upto 60 cm width within conditioned spaces shall have slip joints. The internal ends of the slip joints shall be in the direction of airflow. Ducts and accessories within ceiling spaces visible from air-conditioned areas shall be provided with two coats of matt black finish paint.
   d. Change in dimensions and shape of ducts shall be gradual. Air turns shall be installed in all vanes arranged to permit the air to make the turn without appreciable turbulence.
   e. Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees of ample size to keep the ducts true to shape and to prevent buckling, vibration or breaking.
   f. All sheets metal connections, partitions and plenums required to confine the flow of air to and through the filters and fans shall be constructed of 18 Gauge GSS thoroughly stiffened with 25mm x 25mm x 3mm angle iron braces and fitted with all necessary inspection doors as required to give access to all parts of the apparatus. Doors shall be not less than 45cm X 45cm in size.
   g. Plenums shall be panel type and assembled at site. Fixing of MS angle iron flanges of duct pieces shall be with rivet heads inside i.e. Towards G.S. sheet and riveting shall be done from outside.
   h. Rubber gasket 3 mm thick shall be used between duct flanges and between duct and duct supports instead of felt in all ducting installation for complete sealing.

ii. During the construction, the Contractor shall temporarily close duct openings with sheet metal covers to prevent debris-entering ducts and to maintain opening straight and square, as per direction of Employer's Representative.

a. Great care shall be taken to ensure that the ductwork does not extend outside and beyond height limits as noted on the drawings.
b. All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be tight and shall be made in the direction of airflow.
c. The ducts shall be reinforced where necessary, and must be secured in place so as to avoid vibration of the duct on its support.
d. All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration. All ducts shall be fabricated and installed in accordance with modern design practice. The sheet metal gauges and fabrication procedures as given in I.S. specifications shall be adhered to and shall be considered as an integral part of these specifications.
e. The ductwork shall be varied in shape and position to fit actual conditions at building. All changes shall be in accordance with accepted duct design and subject to the approval of the Employer's Representative. The Contractor shall verify all measurements at building and shall notify the Employer's Representative of any difficulty in carrying out his work before fabrication.
f. Sponge rubber or approved equal gaskets shall be installed between all connections of sheet metal ducts to walls. Sheet metal connections shall be made to walls and floors by means of galvanized steel angles anchored to the building structure with anchor bolts and with the sheet bolted to the angles. Sheet metal connections shall be as shown in the drawings or as directed by Employer's Representative.
g. All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angel/channel under ducts. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods and angles/ channels shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/ anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats.
h. Where ducts pass through brick or masonry openings, it shall be provided with 25 mm thick TF quality thermo Cole around the duct prior to sealing of the opening.
i. All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 100 mm long but not more than 200 mm, securely bonded and bolted on both sides. Sleeve

shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.

j. Flanges and supports are to be black, mild steel and are to be primer coated on all surfaces before erection and painted with aluminum thereafter. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.
k. The ductwork shall be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling Contractors.

DAMPERS

At the junction of each branch duct with main duct and split of main duct, volume control dampers must be provided. Dampers shall be rigid in construction to the passage of air.

The volume dampers shall be of an approved type, lever operated and complete with suitable levellinks & quadrants, locking devices, which will permit the dampers to be adjusted and locked in any position.

The dampers shall be of opposed blade or louver type. The damper blade shall not be less than 1.25 mm (18) gauge and shall not be over 225 mm wide. Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Damper framesshall be constructed of 16-gauge steel

After completion of the ductwork, dampers are to be adjusted and set to deliver the required amount of air as specified in the drawings.

ACCESS PANEL

A hinged and gasket access panel shall be provided on ductwork before each control device that may be located inside the ductwork. Doors shall be provided with neoprene rubber gaskets. Angle joints shall be provided with neoprene rubber gaskets for leak tightness of the joints. Access door/panels shall be provided: - Near each smoke sensor Any other place specifically mentioned in the drawing or if asked by THE EMPLOYER/ EMPLOYER during execution stage.

MISCELLANEOUS

a. Sponge rubber gaskets also to be provided behind the flange of all grills.
b. Each shoot from the duct, leading to a grille, shall be provided with an air deflector to divertthe air into the grille through the shoot.
c. Inspection doors measuring at least 450 mm x 450 mm are to be provided in each system atan appropriate location, as directed by Employer's Representative.
d. Diverting vanes must be provided at the bends exceeding 600 mm and at branches connected into the main duct without a neck.

e. Proper hangers and supports shall be provided to hold the duct rigidly, to keep them straight and to avoid vibrations. Additional supports are to be provided where required forrigidity or as directed by Employer's Representative.
f. All duct supports, flanges, hangers and damper boxes etc. Shall be given 2 coats of red oxide paint before installation and one coat of aluminum paint after the erection, at no extracost.
g. All angle iron flanges are to be welded electrically and holes to be drilled.
h. All the angle iron flanges are to be connected to the GSS ducts by rivets at 100 mm centers.

2.13.18 GRILLS / DIFFUSERS

SUPPLY AND RETURN AIR DIFFUSERS

Supply and return air diffusers shall be made of extruded aluminum section. The diffusers shall be powder coated in finish. Supply air diffusers shall be provided with screw operated opposed bladevolume control devices of extruded aluminum in black anodized finish. The diffusers shall be suitable for concealed fixing arrangement and as approved by Employer's Representative/EMPLOYER.

The diffusers shall be provided with removable central core.

All diffusers shall be selected as per selection curves and in consultation with EMPLOYER. All diffusers shall have soft continuous rubber/foam gasket between the periphery of the diffusers and the surface on which it has to be mounted.

a. LINEAR GRILLS:

Linear continuous supply or return air grills shall be extruded aluminum construction with fixed horizontal bars at 15 0 inclination with flanges on both sides. The thickness of fixed bar louvers shall be 5mm in front and the flange shall be 20mm wide with round edges. The grille shall be suitable for concealed fixing and horizontal bars of the grille shall be mechanically crimped from the back to hold them.

Volume control device of extruded aluminum construction in black anodized finish shall be provided in S.A. duct collars.

b. DOUBLE ADJUSTABLE LOUVERED SUPPLY/ RETURN AIR GRILLS WITH HORIZONTAL /VERTICAL OR VERTICAL/ HORIZONTAL LOUVER ARRANGEMENT:

The grille shall be adjustable as each louver shall be pivoted to provide pattern with 00 to plusor minus 150 ARC upto 300 deflection down towards. The louvers shall hold deflection settings under all conditions of velocity and pressure. The rear louver of the register shall be in black shade.Volume control device of extruded aluminum construction with black anodized finish shall be provided in S.A. grills.

c. EXHAUST AIR REGISTER:

Exhaust air register shall be made of extruded aluminum with fixed horizontal louvers at 40 degree angle setting on a 20 mm louvers pitch. The register shall have 20 mm wide flange with round edges all around. The register shall be suitable for front screw fixing.

Volume control device of extruded aluminum construction with black anodized finish shall be provided.

d. MULTI SLOT CEILING DIFFUSERS:

Multi slot ceiling diffuser shall be made of extruded aluminum with various slot width and air pattern deflectors. Deflectors in each slot provide an adjustable air pattern of 180 degree full. A special plenum shall be provided for each supply air diffuser. The linear diffuser shall have alignment strips to give straight look while installation.

Hit & miss type volume control damper of extruded aluminum construction with mill finish shall be with multi-slot supply air diffuser.

e. LINEAR CEILING MOUNTED DIFFUSERS:

Linear ceiling mounted air terminals shall be made of extruded aluminum surface mounted one way or two way pattern. The linear terminal shall have alignment strips to give straight look while installation. Volume control device of extruded aluminum construction in mill finish shall be provided in S.A. diffuser.

f. FRESH AIR INTAKE LOUVERS:

Fresh air intake louvers 50 mm deep (minimum) wherever required as per shop drawing will be made of extruded aluminum construction duly anodized or powder coated. Bird/insect screen will be provided with the intake louvers. The blades are inclined at 450 on a 40 mm blade pitch to minimize water ingress. The lowest blade of the assembly shall extend out slightly to facilitate disposal of rainwater without falling in door/wall on which it is mounted.

Wherever specified, the intake louvers shall be provided with factory fitted all aluminum construction volume control dampers in black anodized finish.

g. LAMINAR FLOW DIFFUSERS

i. Introduction

Diffusers are available for flush mounting in the ceiling. Suitable angle frames are also provided for the modular panel construction. The units are available in three standard sizes for top entry complete with opposed blade dampers

ii. Description

LFD laminar flow diffusers are constructed from 18 swgAluminiumsheet,perforated face with approx 50% perforation. The perforated front face is openable hinge type complete with key operated dampers from front.

iii. Sizes

Available in standard sizes of 600 x 600 mm, 900 x 600 mm & 1200 x 600 mm or as per requirements.

iv. Features

a. Suitable for modular panel assemblies.
b. Top entry with opposed blade dampers.
c. Pivoting type face plate for damper operation from front.
d. Easy maintenance and cleaning

v. Finishesd Standard

a. Epoxy Polyester Powder Coated off white/pure white
b. Natural anodised.

MOTORIZED COMBINED SMOKE & FIRE DAMPERS – SPRING RETURN

All supply and return air ducts at AHU room crossings and at all floor crossings shall be provided with Motor operated Fire & smoke damper of at least 90 minutes rating. These shall be of multileaf type and provided with Spring Return electrical actuator having its own thermal trip for ambient air temperature outside the duct and air temperature inside the duct. Actuator shall have Form fit type of mounting, metal enclosure and guaranteed long life span.The dampers shall meet the requirements of NFPA90A, 92A and 92B. Dampers shall have a fire rating of 1.5 Hrs. in accordance with latest edition of UL555 and shall be classified as Leakage

Class 1 smoke damper in accordance with latest edition of UL555S. Each fire/smoke damper shall be AMCA licensed and bear the AMCA seal for air Performance. Actuators used shall be UL listed. Each damper shall be supplied with factory mounted sleeve of galvanized steel of thickness as per SMACNA and of minimum 400mm long or as specified in drawing and specification depending up on the wall thickness. The damper shall be fitted in to sleeve either using welding or self-tapping screws. All welded joints shall be finished using heat resistance steel paint, UL listed and approved Silicon sealant shall be applied at all corners as well as at joints between damper frame and sleeve.

Damper Frame shall be a roll formed structural hat channel, reinforced at corners, formed from a single piece of 1.5mm galvanized steel. Damper blades shall be aerofoil shaped (equivalent to 2.0mm thickness strength) roll formed using 1.0mm thick single piece of galvanized sheet. Bearings shall be of stainless steel fitted in an extruded hole in the damper frame. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked in to the blade edge (adhesive type seals are not acceptable). Side Jam seals of stainless steel and Top and bottom

seals of galvanized steel shall be provided. All galvanized steel used shall be with minimum 275 gm/ Sq.m Zinc coating. Bigger size Dampers shall be supplied in multiple modules of sizes not exceeding in dimensions of certified module, jack shafted together. Multiple actuators shall be provided for large dampers with higher torque requirements as prescribed in UL.

The electric actuator shall be energized either upon receiving a signal from smoke detector installed in AHU room supply air duct/ return air duct. Electric Actuator of suitable Torque and as approved by UL shall be factory mounted and tested. The actuator shall be suitable for 230V AC supply. In addition actuator shall have elevated temperature rating of 350 deg. F. Electric Actuator shall have been energized hold open tested for a period of at least one year with no spring return failure. Each fire/smoke damper shall be equipped with a heat actuated release device which shall allow controlled closure of damper rather than instantaneous to prevent accident (Electrical fusible link). The damper shall be equipped with a device to indicate OPEN and CLOSE position of Damper blades through a link mounted on the damper blade.

Each damper shall be provided with its own control panel, mounted on the wall and suitable for 230 VAC supply. This control panel shall be suitable for spring return actuator and shall have at least the following features:

- Potential free contacts for AHU fan ON/ OFF and remote alarm indication.
- Accept signal from external smoke / fire detection system for tripping the electrical actuator.
- Test and reset facility.

  Indicating lights/ contacts to indicate the following status:

- Power Supply On
- Alarm
- Damper open and close position.

Actuators shall be mounted on the sleeve by the damper supplier in his shop and shall furnish test certificate for satisfactory operation of each Motor Operated Damper in conjunction with its control panel. Control panel shall be wall mounted type. It shall be HVAC Contractor's responsibility to co-ordinate with the Fire Alarm System Contractor for correctly hooking up the Motor Operated Damper to Fire Detection/ Fire Management System. All necessary materials for hooking up shall be supplied and installed by HVAC Contractor under close co-ordination with the fire protection system Contractor.

HVAC Contractor shall demonstrate the testing of all Dampers and its control panel after necessary hook up with the fire protection/ fire management system is carried out by energizing all the smoke detectors with the help of smoke. HVAC Contractor shall provide Fire retardant cables wherever required for satisfactory operation and control of the Damper.

HVAC Contractor shall strictly follow the instructions of the Damper Supplier or avail his services at site before carrying out testing and installation at site.

Fire/smoke damper shall be provided with factory fitted sleeves; however, access doors shall be provided in the ducts within AHU room in accordance with the manufacturer's recommendations.

The Contractor shall also furnish to the Owner, the necessary additional spare actuators and temperature sensor (a minimum of 5% of the total number installed) at the time of commissioningof the installation.

PAINTING

All grilles and diffusers shall be powder coated in color as approved by EMPLOYER before installation.

All ducts immediately behind the grilles/diffusers etc. are to be given two coats of black paintin Matt finish.

TESTING

After completion, all duct system shall be tested for air leakage.

The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the final balance of air quantity through each outlet shall be submitted to the Employer's Representative for approval. Measured air quantities at fan discharge and at various outlets shall be identical to or less than 5% in excess of those specified and quoted. Branch duct adjustments shall be permanently marked after air balancing is completed so that these can be restored to their correct position if disturbed at any time.

2.13.19 SHEET METAL WORKS – (FACTORY FABRICATED)

GENERAL

i. The work under this part shall consist of furnishing labour materials, equipment and appliances as specified necessary and required to install all sheet metal and otherallied work to make the air conditioning supply, ventilating, and exhaust system ready for operation as per drawings.
ii. Except as otherwise specified all duct work and related items shall be in accordance with these specifications.
iii. Ductwork shall mean all ducts, casings, dampers, access doors, joints, stiffeners and hangers.

DUCT MATERIALS

i. The ducts shall be fabricated from galvanized steel sheets class VIII conforming to ISS:277- 1962 (revised) or aluminium sheets conforming to ISS:737-1955 (wherever aluminium ducts are specified).
ii. All duct work, sheet metal thickness and fabrication unless otherwise directed, shall strictly meet requirements, as described in IS:655-1963 with amendment-I (1971 edition)
iii. GOVERNING STANDARDS: - Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards ("HVAC Duct Construction Standards-Metal and FlexibleSecond Edition-1995" SMACNA)

RAW MATERIAL

i. Ducting
   a. All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I. row materialfurnished with accompanying Mill test Certificates.
   b. Galvanizing shall be of 120gms/sq.m. (total coating on both sides).
   c. In addition, if deemed necessary, samples of raw material, selected at random by THE EMPLOYER/ EMPLOYER's site representative shall be subject to approval and tested for thickness and zinc coatingat Contractor's expense.
   d. The G.I. raw material shall be used in coil-form (instead of sheets) so as to limit the longitudinal joints at the edges only irrespective of cross section dimensions.

ii. Duct Connectors and Accessories

All transverse duct connectors (flanges/cleats) and accessories/related hardware are such as support system shall be zinc-coated (galvanized)/ FABRICATION STANDARDS

- All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces to provide the requisite quality of ducts and speedof supply.
- Coil lines to ensure location of longitudinal seams at comes/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along anyface side of the duct.
- All ducts, transformation pieces and fittings to be made on CNC profile cutlers for required accuracy of dimensions, location and dimensions of notches at the folding lines.
- All edges to be machine treated using lock formers, flanges and roller for fuming up edges.
- Sealant dispensing equipment for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified.

SELECTION OF G.I. GAUGE AND TRANSVERSE CONNECTORS

Duct Construction shall be in compliance with 1" (250 Pa) w.g. static norms as perSMACNA. All transverse connectors shall be the Rolamate 4-bolt slip-on flange system or Techno Fabriduct imported makes of similar 4-bolt systems with built-in sealant if any to avoid any leakage additional sealant to be used. The specific class of transverse connector and duct gauge for a given duct dimensions will be 1"(250 Pa) pressure class. Non-toxic, AC-applications grade P.E. or PVC Casketing is required between all mating flanged joints. Gasket sizes shall conform to flange manufacturer's specification.

DUCT CONSTRUCTION

The fabricated duct dimensions shall be as per approved drawings and all connecting sections are dimensionally matched to avoid any gaps.

DIMENSIONAL TOLERANCES:

a. All fabricated dimensions will be within +/- 1.0 mm of specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be +/- 1.0 mm per meter.
b. Each and every duct pieces shall be identified by color coded sticker which shows specificpart numbers, job name, drawing number, duct sizes and gauge.
c. Ducts shall be straight and smooth on the inside Longitudinal seams shall be airtight and at comers only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, toensure air tightness.
d. Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the tum without appreciable turbulence.
e. Plenums shall be shop/factory fabricated panel type and assembled at site.
f. Factory Fabricated ducts shall have the thickness of the sheet shall be as follows.

S. No.	Size of Duct	Sheet Thickness	Fastner Size	Type of Joints		Bracing with Gltie rods of following sizes	Support Angle
1	Upto 750 mm	0.63 mm	3/8"	Fabricated out of G.I. sheet of 24 gauge at every 1.2 m internal.	The flanges shall be made out of the same duct sheet and all the four corner shall be fitted for fitting the bolt	Cross tie rods to be fitted of suitable dia GI rod for each piece of duct	25x25x3 mm
2	751 mm to 1000 mm	0.80 mm	3/8"	E-24 type flange, shall be fabricated out of 24 G sheet at every 1.2 m internal.			25x25x3 mm

3	1001 mm to 1500 mm	0.80 mm	5/8”	E-22 type flange shall be fabricated out of 22 G sheet at every 1.2 m internal.	The flanges shall be made out of the same duct sheet and all the four corner shall be fitted for fitting the bolt	Cross tie rods to be fitted of suitable dia GI rod for each piece ofduct	40x40x5 mm
4	1501 mm to 2250 mm	1.00 mm	5/8”	J-16 type flange, shall be fabricated out of 16G sheet at every1.2minternal.			40x40x6 mm angle
5	2251 mm and above	1.25 mm	5/8”	J-16 type flange, shall be fabricated out of 16G sheet at every 1.2 m internal.			50x50x6 mm with MS rods of 12 mm dia.

g. The gauges, joints and bracings for sheet metal duct work shall further conform to the provisions as shown on the drawings.

h. Ducts larger than 600 MM shall be cross broken, duct sections upto 1200 MM length may be used with bracing angles omitted.

i. Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the Employer’s Representative.

j. All ducts shall be supported from the ceiling/slab by means of M.S. Rods of 10 MM (3/8") DIA with M.S. Angle at the bottom. The rods shall be anchored to R.C. Slab using metallic expansion fasteners.

INSTALLATIONS

i. During the construction, the Contractor shall temporarily close duct openings with sheet metalcovers to prevent debris entering ducts and to maintain opening straight and square, as per direction of Employer’s Representative.

ii. Great care shall be taken to ensure that the duct work does not extend outside and beyond height limits as noted on the drawings.

iii. All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be air tight and shall be made in the direction of air flow.

iv. The ducts shall be re-inforced with structured members where necessary, and must be securedin place so as to avoid vibration of the duct on its support.

v. All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration.

a. The duct work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Employer’s Representative. The Contractor shall verify all measurements at site and shall notify the Employer’s Representative of any difficulty in carryingout his work before fabrication.

vi. Sponge rubber or approved equal gaskets of 6 MM maximum thickness shall be installed between duct flanges as well as between all connections of sheet metal

ducts to walls, floor columns, heater casings and filter casings. Sheet metal connections shall be made to walls and floors by means of wooden member anchored to the building structure with anchor bolts and with the sheet screwed to them.

vii. Flanges bracings and supports are to be Rolamate or Techno Fabriduct. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.

viii. Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Employer's Representative.

ix. Joints requiring bolting or riveting may be fixed by Hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Self tapping screws must not be used. All jointing material must have a finish such as cadmium plating or Galvanized as appropriate.

x. Fire retarding flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by Employer's Representative. On all circular spigots the flexible materials are to be screwed or clip band with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.

xi. The flexible joints are to be not less than 75 MM and not more than 250 MM between faces.

xii. The duct work shall be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling Contractors.

xiii. Duct passing through brick or masonary, wooden frame work shall be provided within the opening. Crossing duct shall have heavy flanges, collars on each side of wooden frame to make the duct leak proof.

DOCUMENTATION TO MEASUREMENTS

For each drawing, all supply of ductwork must be accompanied by computer-generated detailed bill of material indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct areas by gauge and duct size range as applicable. Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge wise.

All duct pieces to have a part number, which shall correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement, verification and approvals.

TESTING

After duct installation, a part of duct section (approximately 5% of total ductwork) may be selected at random and tested for leakage. The procedure for leak testing shall be followed as per SMACNA- "HVAC Air Duct Leakage Test Manual: (First Edition).

2.13.20 INSULATION:

i. PRODUCTS MATERIALS

GENERAL

- All insulation works shall be carried out by one firm specializing in insulation work.
- Provide insulation and covers in strict accordance with authorities governing combustibility and fireproofing of materials and in accordance with manufacturer's recommendations.
- Provide non-combustible insulation, jackets and finishes having a Flame Spread/Smoke Developed rating meeting authority requirements.

The materials shall comply with following standards:

- BS 476: Part 4 – Non Combustible
- BS 476: Part 5 – Not easily Ignitable (Class P)
- BS 476: Part 6 – Fire propagation Index (I<12)
- BS 476: Part 7 - Surface spread of flame (Class 1)
- The material shall comply toClass'O' fire rating as per BS 476 part 6&7.
- The product shall be able to work effectively at ambient temperature range of -100ºC to150 ºC

Thermal Insulation Materials (Ducts):

- Insulation material shall be Closed Cell Elastomeric Nitrile Butadiene Rubber.
- Insulation material shall have anti-microbial product protection. The antimicrobial product protection shall be an integral part of insulation that is built-in during the manufacturing process and the product protection shall not allow the microbes to function, grow and reproduce.
- Resistance towards microbiological growth on insulation surface shall confirm to following standards: Fungi Resistance – ASTM G21 where the fungal growth on the surface is NIL after 28 days of incubation at 28 – 30° C and Bacterial resistance – ASTM E 2180 where the reduction of bacterial growth is minimum 99.9% after 24 hours of incubation at 34 – 38° C.
- Thermal conductivity of Elastomeric Nitrile rubber shall not exceed 0.035 W/m°K at an average temperature of 20°C in accordance to EN12667
- 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.
- Water vapour permeability shall not exceed 1.74 x 10-14 Kg/m.s.Pa, i.e. Moisture Diffusion Resistance Factor or 'μ' value shall be minimum 10,000 according to EN 12086

- Density of Material shall be between 40 to 60 Kg/m3.
- Mechanical Protection shall be given to exposed insulated ducts

Note: Insulation shall meet ECBC and IGBC criteria even if the ECBC / IGBC criteria ismore stringent than above mentioned.

Duct Acoustic Lining:

- Material shall be engineered Nitrile Rubber open cell foam.
- The Random Incidence Sound Absorption Coefficients (RISACs) across the octave band frequencies; tested as per ISO 354, and Noise Reduction Coefficients (NRCs) for the Acoustic Insulation shall be minimum
- The material shall be fibre free.
- The density of the acoustic insulation shall be minimum 140 Kg/m3
- The insulation shall have Built-in Anti-Microbial Product Protection, and shall pass Fungi Resistance as per ASTM G 21 and Bacterial Resistance as per ASTM E 2180.
- The insulation shall be non-eroding & shall pass Air ErosionResistance
- Test in accordance to ASTM Standard C 1071-05 (section 12.7).
- The material shall have a thermal conductivity not exceeding 0.047 W/m.K @ 20 ° C
- The material shall withstand maximum surface temperature of +850C and Minimum surface temperature of -200C
- The material shall confirm to Class 1 rating for surface spread of Flame in accordance to BS 476 Part 7 & UL 94 (HBF, HF 1 & HF 2) in accordance to UL 94,1996.
- Thickness shall be 10mm for Duct Acoustic Lining

Closed Cell Cross Linked Polyethylene Insulation (Equipment Insulation):

a. Closed Cell Chemically Cross Linked Polyethylene thermal insulation sheet of nominal density of the material shall be 33 kg/m3, having a thermal conductivity of 0.032 W/m ok at 23 oC, mean temperature. The material shall conform to BS 476 Part 7 Class 1 category. Water Vapour Resistance factor, □, of bare material shall be > 11000 and with Al foil > 14000.

Tube: Aluminium foil faced insulation tube, an FR Closed Cell Chemically Cross Linked Polyethylene thermal insulating pre-formed tubing material. The material conforms to BS 476 Part 7, Class 1 category. Water Vapour Resistance factor, □, of bare material is >11000 and with Al foil > 14000. Insulation tube could be supplied in the required ID to match with the type of pipe –

whether MS or Copper in required thickness in single or multilayer, suitable for the location and conditions prevalent with a vapour barrier as aluminium foil on the outermost side.

Pipe Insulation:

a. All chilled water pipe, hot water pipe, condensate drain pipe and condenser water pipe running in air-conditioned space shall be insulated/ pre-insulated as specified in Design Basis Report.
b. The insulation shall be factory faced on one side with aluminium foil faced on the outside, reinforced with kraft paper to the insulation.
c. This insulation shall be factory fabricated, and shall be of preformed section type. In case of pre insulated pipe, manufacture shall be only by personnel specialising in the production of pre-insulated piping systems, and the system shall be reviewed by the Consultants prior to installation.
d. The casing of galvanised iron of the spiral formed locked seam type shall be provided for all pre-insulated pipes.
e. The insulation as specified in the schedule of quantity, specially formulated to ensure a satisfactory performance in both manufacture and operation.

For pipe diameter ranging from 6mm to 125mm and various thicknesses with limiting outer diameter insulation sheet shall be used. For larger range of pipe diameters, insulationsheet shall be rolled to build up the required diameter & thickness.

The insulation shall be fire retardant to BS 476 Part 6 or as per the relevant fire BIS codes.

f. The insulation shall be with expanded polyurethene foam (PUF) of minimum density 36kg/cum covered with 26 G GI cladding complete with supports, flanges and fitings as specified. These criteria shall be substantiated with independent test certificates that shall be included with the tenders on request.
g. Refrigerant piping shall be insulated with closed cell elastomeric thermal insulation having 'K' value of 0.032 -0.030 w/mk at 20 Deg C. All chilled I Hot water and Drain piping up to 25 mm diameter shall be insulated with closed cell cross linked polythylene/ closed cell elastmeric insulation of required thickness as detailed in drawing and specification Eccentricity of the service pipe shall not be greater than 15% of specified insulation thickness.
h. Supports shall be sized to ensure adequate support to the casing, without crushing the insulation and shall be generally to the manufacturers' recommendations or as specified elsewhere.
i. The finish shall be as for pipe work exposed to view, as detailed elsewhere in this Specification to approval.
j. The Installer shall be responsible for ensuring that he obtains complete installation recommendations from the pre insulated pipe manufacturer, and that these are followed throughoutthe installation.

INSULATION (CHILLER):

Following procedure shall be followed for chiller insulation if required to be executed at site:

- Chiller surface shall first be cleaned with wire brush.
- Fix self-adhesive insulation fasteners (pins) of appropriate length on chiller body at regular interval of 250 mm at either side or max. 150mm from the end.
- Apply generous layers of cold setting Pidilite SR 998 adhesive.
- Insulation shall then be fixed in two layers, staggering the joints between the strips and sealing them with3mm thick 50 mm wide polyethylene tap.
- Insulation shall then be covered with O.63mm; 19mm mesh wire netting which shall be fixed to the insulation tighten with GI lace wire along the length.
- The final finish shall be 12mm sand cement plaster which shall be applied in two layers of 6mrn each and travelled to a smooth round finish.
- After the insulation is fixed on the head as specified, it shall then be covered with aproperly shaped jacket ofO.80mm G.I. sheet.

INSULATION (OTHERS)

The expansion tank and chilled water pumps shall be insulated as mentioned above and finished with plaster excepting that the insulation of 20 mm shall be fixed in a double layer with staggeredjoints.

ii. Execution

DUCT INSULATION (INDOOR)

External thermal insulation shall be provided as follow:

- Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying outinsulation work.
- Measurement of surface dimensions shall be taken properly to cut sheets to size with sufficient allowance in dimension.
- Material shall be fitted under compression and no stretching of material shall be permitted.
- A thin film of adhesive (refer Insulation Protection & Adhesive) shall be applied on the metal surface and then on the back of the insulating material sheet.
- When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond. Also care shall be taken to prevent the trapping of air bubbles between metal sheets and insulating material sheet.
- All duct flanges shall be covered properly with a 150mm wide strip of aluminium tape after gaining uniform height by applying multiples layer of 75mm wide strip of insulation sheet from the both side of flanges.
- All longitudinal and transverse joints shall be sealed with aluminium tapes of 50mm (wide) x 3mm (thick).

PIPING INSULATION

- Before applying insulation, all pipes shall be brushed and cleaned. All Pipe surfaces shallbe free from dirt, dust, mortar, grease, oil, etc. Thermal insulation shall be applied as follows or as specified in drawings or schedule of quantity:
- Insulating material in tube form shall be sleeved on the pipes.
- Two coats of rubber based adhesive as per OEM standard shall be applied on cleaned pipe surface.
- Wherever preformed section shall be used it shall be cut out in correct dimension. All longitudinal and transverse joints shall be sealed with of 50mm (wide) x 3mm thick) aluminium tape. The insulation shall be continuous over the entire run of piping, fittings and valves. Multiple layer of Insulation sheet wherever applicable shall be applied to stagger all longitudinal & transversal joints.
- All valves, fittings, joints, strainers, etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same asabove. Valves bonnet, yokes and spindles shall be insulated in such a manner as not tocause damage to insulation when the valve is used or serviced.

PIPING INSULATION (Under Ground):PIPE

The pipe shall be MS ERW as specified in the Piping Section.

INSULATION

MS Pipe dia. (mm)	**PUF Thickness (mm)**	**Thickness of HDPE Cladding (mm)**
20 mm	29	2.5
25 mm	36	2.5
32 mm	31	2.5
40 mm	36	2.5
50 mm	37	3.0
65 mm	39	3.0
80 mm	43	3.0
100 mm	40	3.2
125mm	39	3.5
150 mm	53	4.4
200 mm	63	5.0
250 mm	57	6.3
300 mm	58	7.0
350 mm	64	7.8
400 mm	68	8.8

450mm	77	9.8
500mm	50	11.1
550mm	65	11.1
600mm	83	12.5
650mm	58	12.5
700mm	82	13.0
750mm	104	15.0
800mm	79	15.0

The pipe insulation shall be polyurethane foam with 36 kg/cu m minimum density, 90% minimum closed cell content, minimum compressive strength of 40 psi and initial thermal conductivity of 0.0154 Btu/hr.ft.^{0}F. The insulation shall completely fill the annular space between the service pipeand jacket and shall be bonded to both, the service pipe & jacket.The insulation (PUF) shall be provided to the minimum thickness with cladding of minimum thickness as specified below:

UNDER GROUND PIPING & INSULATION EXECUTION:

Underground systems shall be buried in a trench of not less than 600 mm deeper than the top of the pipe & not less than 450mm wider than the combined OD of all piping systems. A minimum thickness of 600mm of compacted backfill over the top of the pipe is desirable.

Trench bottom shall have a minimum of 150mm of sand, pea gravel or specified backfill material, consolidated to suit operating weight & to act as a cushion for the piping.

Buried piping:

The outer protective insulation jacket shall be seamless, extruded, black, uv resistant, high-densitypolyethylene **(HDPE).** The minimum thickness of the **HDPE** jacket and PUF shall be as follows:

However, the exact thickness could vary marginally for underground piping based on the exact sizes of **HDPE** pipes available as per the chart given below:

FITINGS

Fitting can be fabricated at site over the carrier pipe and correct quantity of PUF shall be poured manually.

FIELD JOINTS INSULATION:

Field joints insulation shall consist of **PUF** poured manually in a site-fabricated.

Installation of Insulation with Cladding

- The insulated ducts shall be covered with wrapping of two layers of polythene vapour barrier of 500 G of virgin type of white colour with overlapping of longitudinal and transverse joints. Cover this with PVC strapping for keeping insulation in position.
- Finish the surface with 24 G aluminium sheets of approved make fixed with the hand operated grooving M/C and anodised steel screw to get smooth finish surface.
- Do not cover equipment nameplates with insulation.
- Coordinate related work with other Divisions.
- Pump, valves, fittings and accessories in the chilled water circuit shall also be proper insulated by using either the same material as pre-insulated pipe or high density fibreglass. Galvanised external jacket with paint finish shall also be provided.

Acoustic Lining Ductwork

Insulation material for Duct Acoustic Lining shall be open cell antimicrobial nitrile rubber with self adhesive. The thermal conductivity of the material for air-conditioning application shall not exceed 0.047 W/m.K at 20 deg C. Density of the same shall be within 140- 180 Kg/m3. Thickness of the material shall be as specified for individual application as per schedule of quantity.

Ducts shall be provided with acoustic lining for a distance of minimum 5 meters as follows:The inside surface for the ducts shall be covered with nitrile rubber with self adhesive, and provided with 22 gauge GI Channels 25 x 25 mm screwed back to back and fixed on the inside ofduct, spaced not more than 60 cm center to form a frame work of 60 x 60 cms square. Cut panels60 x 60 cms of resin bonded fiber glass 25 mm thick shall be fitted in the squares.

Plenum Box

The plenum boxes shall generally be designed to meet the requirements as specified in the Noise and Vibration Control section of this Specification.

The boxes shall be so designed as to provide an efficient, quiet and maintenance free air distribution system.

Installation of Acoustic lining

The duct surface shall be cleaned and required surface preparation shall be done for applying black paint.

Fix the G.I channel 25 x 50 x 50 x 50 x 25 for 50 mm thick and 25 x25 x 25 x25 x 25 for 25 mm thick lining with 1.25mm thick sheet at 600 mm intervals longitudinally. Then fix cross G.I channel with a brass/ SS Screws.

Fill each rectangle with 50/25 mm resin bonded glass wool wrap tissue paper. Then cover with24 SWG (0.56 mm) perforated Aluminium sheet having 3 mm perforations.

Acoustic Lining of Mechanical Rooms (AHU Rooms)

Glass Wool Acoustic Board

Density: 70 to 80 Kg/cu.m

Thickness: 25 mm

Lamination: One Side FSK & Other side Black Glass Cloth

Size: 1200mm x 600mm or 3M x 1.20 M

Please refer Annexure B for the datasheet of the product

Tender Specification:

Acoustic Board shall be applied on AHU walls and ceiling to provide superior acoustic absorption.

The insulation shall conform to non-combustibility, Class-P (not easily ignitable), Class 1 (surface spread of flame NIL), and Class 'O' rating as per BS 476 standards.

Installation guideline:

The surface shall be cleaned and friction fixed in 610mm X 610 mm frame of 25X25X18 mm made out of 22 G thick GI sheet U shaped channel or else it can install on the wall with screwbit.

The Acoustic board shall be placed in such a way that black glass cloth is visiblefrom inside the AHU room. Complete as required and as per specifications.

QUALITY CHECKS ON DUCTING

S. No.	DESCRIPTION	YES - OK NO - X	REMARKS
1	Whether material adheres to Fabrication Standards asspecified (Look form Quality Sheets)		
2	Valid for construction Drawings. at site.		

3	Cross breaking, bracings/reinforcements are as perstandard.		
4	Air tightness of transverse / Longitudinal Joints ensured.		
5	Grease and heat resistant sealant for kitchen exhaustduct.		
6	Neoprene gaskets for pharmaceutical and clean roomprojects used		
7	Check following aspects of duct supporting system		
7.1	Hanger spacing		
7.2	Anchor bolts size and quality		
7.3	Primer painting of supports		
7.4	Check allowable load on trapeze angle for bigger ducts		
8	Check whether Contractor has provided		
8.1	Vanes in elbows		
8.2	Clinched collar at take Offs		
8.3	Splitters		
9	Check transitions & offsets slopes & fabrication.		
10	Whether the installed ducting is as per layout approved,check locations, headroom etc.		
11	Whether grilles/ diffusers are as per approved shade.		
12	Check the method of installation for Grilles / Diffusers		
13	Repair / paint damaged surfaces.		
14	Check the coordination of following activities as per thegiven sequence:-		
14.1	Main Ducts Cut for taking collars		
14.2	Match / Fabricate collar taking false ceiling frameworkfor diffuser into account		
14.3	Fix grilles / diffuser framework in false ceiling		
14.4	Install the collar		
14.5	Install diffuser		

S. No.	DESCRIPTION	YES - OK NO - X	REMARKS
15	All elbows/ turning points and branches to be properlysupported		
16	Access door is provided at serviceable position for fanand fire damper		
17	Air balancing for room is studied		
18	Air replacement is considered for air exhausted fromroom.		
19	PVC or stainless steel material is used for corrosivefume exhaust system.		
20	Anti vermin netting installed for louvers removable andserviceable.		
21	Water or gas vent outlet is not installed near air intakelouver.		
22	Kitchen exhaust is not short circuited to outdoor airintake louver.		
23	Kitchen room pressure is slightly below the surroundingarea.		
24	Sound level of fan is studied.		
25	Face velocity for louvers / grills / diffusers is studied.		
26	Air distribution of the room is studied.		
27	Cross break all flat surfaces to prevent vibrations orbuckling due to air flow.		
28	Sides of ducts having collar for grills shall not be crossbroken to facilitate alignment of grills.		
29	All bends and collars shall have vanes.		
30	If duct passes through fire chamber increase sheetthickness.		
31	Kitchen exhaust ducts to be tapered at bottom for oil /grease collection.		
32	Avoid flanged joints in kitchen exhaust duct above false ceiling.		
33	When aluminum ducts are used with steel angles, steelto be painted with Zinc chromate paint		
34	Provide check nuts with duct hangers		
35	Ducts below 250 mm shall not be more than 1 m longto facilitate proper joining.		

S. No.	DESCRIPTION	YES - OK NO - X	REMARKS
36	Plenums shall have flanged and bolted ends for rigidity and easy maintenance.		
37	Avoid 'U' bends in ducts		
38	Provide long radius bends and offsets.		
39	No collars to be taken from top.		
40	Install duct spool pieces near equipment for easyremoval.		

2.13.21 PIPING AND FITTINGS

2.13.21.1 WATER PIPING

MATERIAL

Water piping fittings and valves shall be of the following makes or approved equal make and shall conform to IS standards as indicated below.

Pipes

- UPTO150MM :- MS, Class C (Heavy Class) as per IS 1239 (Part I & II) 1990/1992
- 200MM & ABOVE:- Welded Black Steel Pipe Class 2 (6.35 MM Thickness). As per IS 3589(LATEST)

Grooved Couplings & Fittings shall be used to join pipes from 20 NB &Above. No Welding is allowed.

Pipe/Grooved: Carbon Steel / MS- Roll grooved-ends as appropriate to pipe material, wall thickness, pressures, size and method of joining. The Grooving Machine used shall be of the samemanufacturer as Grooved Couplings & Fittings. Groove Measuring Tape shall be used to check the Groove in the pipe.

Standard Mechanical Couplings

Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. (Gaskets used for potable water applications shall be UL classified in accordance with ANSI/NSF-61 for potable water service.) Mechanical Coupling bolts shall be zinc plated (ASTM B633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A- 183, minimum tensile strength 110,000 psi (758450 kPa). Grooved Couplings requiring Torque to tighten as a part of their installation shall not be allowed till 12".

Rigid Type 20 NB and above: 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.

a. 2" (DN50) through 8" (DN200): Installation ready rigid coupling for direct stab installation without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from 30 deg F (-34 deg C) to +250 deg F (+120 deg C)
b. 10" (DN250) through 12" (DN300): Standard rigid coupling - Gasket shall be Grade "E" EPDM compound with green color code designed for operating temperatures from -30 deg F (-34 deg C)to +230 deg F (+110 deg C)

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, for each connector, shall be placed in close proximity to the vibration source.

a. 2" (DN50) through 8" (DN0200): Installation ready flexible coupling for direct stab installation without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C) -
b. 10" (DN250) through 12" (DN300): Gasket shall be Grade "E" EPDM compound with green color code designed for operating temperatures from 30 deg F (-34 deg C) to +230 deg F (+110 deg C)
c. Flange Adapters: For use with grooved end pipe and fittings, flat faced, for mating to ANSI Class 125/ 150 flanges/ PN 10/ PN 16
d. Grooved couplings shall meet the requirements of ASTM F-1476.
e. Gasket: Synthetic rubber conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D- 2000.
   Grooved AGS Mechanical Couplings - 14 inch (DN350) & above: Couplings shall consist oftwo ASTM A-536 ductile iron housing segments, a wide elastomer pressure responsive gasket, and zinc electroplated carbon steel track head bolts and nuts conforming to the physical and chemical requirements of ASTM A-449 and the physical requirements of ASTM A-183.
f. Coupling housings designed with the wedge-shaped AGS key profile to engage the mating pipe(s)/component(s) wedge-shaped AGS grooves. Housings include lead-in chamfer to accommodate a wider range of initial pipe positions. Housings shall be coated with orange enamel

Grooved End Fittings: Standard fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall (9,53 mm wall), or fabricated from Std. Wt. Carbon Steel pipe conforming to ASTM A53, Type F, E or S, Grade B. Fittings provided with an alkyd enamel finish. Zinc electroplated fittings and couplings conform to ASTM B633.

AGS Fittings shall be supplied with factory AGS grooved ends. Fittings shall be manufactured of ductile iron conforming to ASTM A-536, forged carbon steel conforming to ASTM A-234, or factory fabricated from carbon steel pipe conforming to ASTM A-53. Fittings shall be manufactured to the dimensional standards ASME B16.9. Orange enamel coated - for use with Grooved AGS Product

Hole-Cut Branch Outlets: Bolted Branch Outlet: Branch reductions on 2"(DN50) through 8"(DN200) header piping. Bolted 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 Installation Ready Couplings shall be installed directly in the pipe without disassembling the Gasket.

Grooved end product manufacturer to be ISO-9001 certified.

GATE & GLOBE VALVES

Make: As approved shall be heavy duty non rising spindles as per IS 780, 778 and flanges as per is 1536 and factory tested for 10Kg/ sq cm test pressure.

BALANCING VALVES

The balancing valves control and shut off valves with built in pressure drop and flow measuring facility shall be provided in the water outlet pipes of condensers and chillers, AHUs or wherever shown in tender drawings. The valve shall have Oblique(Y-Type) Design for lower pressure drop and low Cavitations for Longer Valve Life;

i. 15mm to 50mm Size: Cast Bronze (IS 318 GR. LTB2) Screwed ends
ii. 65mm and above: Cast Iron (IS 210) with flanged ends

Balancing Disc Shall be of High Tensile Brass (BS2874 CZ114) / Cast Carbon Steel (ASTM A216 GR. WCB) with nickel Coating precision machined for Equal Percentage Flow Characteristics & Wide Rangeability. Stem shall be in Dezincification Resistant Brass (BS2874 CZ114). Valve shall be Gland Less design with double EPDM O-Ring Stem Seals for life time maintenance free Sealing. Handle shall be infinitely adjustable for easy and precise presetting with Concealed Memory feature for temper proof Operation. The Valve shall be supplied with Pressure &

Temperature test plugs as standard. Paint shall be 200+ micron thick Fusion Bonded Epoxy (Lead free) coating for much higher Corrosion & Erosion resistance.

To enable accurate and practical operation, measurement of flow and differential pressure shall bemade with a computerized balancing instrument which shall enable the operator to read the flow directly without the use of diagrams or tables. In addition to measuring flow rate, differential pressure and temperature, computerized balancing instrument shall have a computer programs toprovide the following functions:-

To balance the HVAC installation and calculate the necessary valve settings, based on system measurements.

To store the results of balancing.

To log measured values from a valve (differential pressure, flow rate or temperature)To printout saved data in computerized measurement protocol (CMP) consisting of:-

- Name and size of Balancing Valve (BV)
- Presetting position of BV
- AP at BV
- Flow at BV
- Design Flow

Flanges shall be of approved make. The supply of flanges shall form part of piping (not separatelyidentified in Schedule of Quantities) and shall also include supply of bolts, washers, nuts and suitable rubber insertion gaskets (minimum 3 mm thick).

BUTTERFLY VALVES

Butterfly valve shall be resilient seated, wafer type Semi Lugged design with pressure ratingof PN 16. The valve shall have integral extended neck to accommodate min. 2" (50mm) of insulation. The body shall be Cast Iron (IS 210) with Epoxy coating (min. 200 microns) for adequate corrosion resistance. Disc shall be Black Epoxy coated Ductile Iron (ASTM A536). Valve Seat shall be Black Nitrile **vulcanized on a hard back up ring suitable for field replacement**. Stem shall be Stainless Steel Gr.410 (ASTM A276). Heavy Duty Square Grooved Disc/Stem Connection without any mechanical fastening. Shaft shall be supported with Self Lubricated Bearings to minimize torques and impact of line pressures. Butterfly valves shall come with Self lubricated Sliding bearings. The valve shall be universal design for insertion between BS4504 PN10/16, ASME B16.5 #150 & BS10 Table D/E flanges. Mounting Flange as per ISO 5211. Valves shall be supplied with flow control lever with notches. Valves of size 250mm & above will be Heavy Duty Worm Gear Operated and to be supplied with factory machined companion flanges and fasteners. Paint shall be 200+ micron thick Fusion Bonded Epoxy (Lead free) coating for much higher Corrosion & Erosion resistance.

MOTORIZED BUTTERFLY VALVES

The butterfly valves shall be as per same specifications as of Butterfly valves with pressurerating of PN 16.

Electric Actuator shall be On/Off Type with Protection class - IP68 & Power Supply of 230V AC as standard; Inbuilt Double Limit Switches, Over-hot & Overload Protection Features. Actuator Body shall be made of Die Casting Aluminum Alloy & internals made of Antirust & Anti – Corrosion Stainless Steel.

BALL VALVES

Ball Valve shall be resilient seated, Two Way On-Off type, Screwed Ends with pressure rating of PN 20. The body shall be **Forged Brass** (IS 6912) for adequate corrosion resistance. Ball shall be mirror Polished Chrome Plated Stainless Steel (ASTM A351). Valve Seat shall be EPDM + Pure PTFE (BS6564) suitable for Adequate Sealing. Stem shall be Stainless Steel (ASTM A276). Stem seals shall be EPDM. Heavy Duty Rectangle Grooved Ball/Stem connection without any mechanical fastening. End connection shall be suit one of the BS21BSP/BSPT, ASME B1.20 NPT& ISO228 Pipe Threads.

NON RETURN VALVES

Non return valves shall be dual plate check valve provided as shown on the Drawings, and identified in Schedule of Quantities conforming to relevant Codes and in accordance with the following Specifications.

Size	**Construction**	**Ends**
50mm and above	Body cast iron with 200+ micron thick Fusion Bonded Epoxy (Lead free) coating	Wafer

Disc shall be Black Epoxy coated Ductile Iron (ASTM A536). Valve Seat shall be Black Nitrile vulcanized on body suitable for Bubble Tight Sealing. Hinge Pin & Spring shall be Stainless Steel Gr.304 (ASTM A276). Valve Design shall be with true bore area relevant to the valve size. The valve shall be universal design for insertion between BS4504 PN10/16, ASME B16.5 #150 & BS10 Table D/E flanges.

STRAINERS

i. Strainers shall be 'Y' type or Pot type Strainers as shown on drawings and as per requirements. 'Y' Strainer shall be fabricated out of MS 'C' class pipe two sizes higher than that of Strainer pipe size. Flanges as per B.S. 10 shall be provided at inlet and outlet connectors. The body shall be pressure tested at 10 kg/cm2 and shall be hot dip galvanized. Permanent magnet shall be provided in the body of the Strainer to arrest MS particles. Filter element shall be of non-magnetic 20 gauge SS sheet with 3 mm perforation. Strainers shall be provided at in let of each Air Handling Unit and Pump as shown in drawings and as per requirements.

Pot Strainers body shall be fabricated out of MS plate IS 226. Thickness of sheet shall be as per size of the strainer chamfered pipes with flanges shall be provided at inlet/ outlet connections of the strainer. The tangential entry of water shall create a centrifugal action and due to velocity shall separate sediments and deposit on the inner surface of Filter Element and at bottom of the Strainer. Butterfly valves shall be provided at inlet/outlet connections as shown in drawing and as per requirements. The 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 of Pot Strainer shall be of non-magnetic 18 gauge SS sheet properly reinforced to avoid damage of the element. A cone with sufficiently to flush out foreign particles. This arrangement shall avoid frequent opening of Pot Strainer for cleaning of filter element. Gage connection shall be provided at inlet and outlet connection. A set of MS flanges with tongue and groove arrangement and neoprene rubber gasket shall be provided on the top cover and Pot Strainer flange with sufficient bolts and nuts to make the joint watertight. Bearing loaded top cover lifting and swinging arrangement shall be provided. The Pot strainer body shall be properly de-rusted and epoxy coated from inside and outside. Manufacturers Test Certificate shall be provided with each Pot Strainer.

Size of various Pot Strainer, Filter Element and Thickness of MS sheet shall be as detailed below:-

Size (mm)	Pot Dia. (mm)	Pot HT (mm)	Element Dia. (mm)	Element HT(mm)	MS Plate Thickness (mm)
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	8
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

The Y-Strainer & Pot Strainer confirming to SSPL 107 & SSPL 106 shall have cast iron body and factory tested at works at 16 Kg/sq.cm pressure. The screen shall be made out

of 3 mm perforated stainless steel sheet. It shall be easily removable when required to be cleaned. Isolating butterfly valves at either end of the pot strainer shall be provided.

Each pot strainer shall be provided with a Test Certificate.

ii. All chilled water piping and fittings shall be pressure tested, painted and then insulated as described under the section "Insulation".

AUTO AIR VENT VALVES

- Air vent valves shall be provided at all higher points in piping system for venting and of following sizes:-
  Up to 100 mm dia pipes: 25 mm dia.
- Air vent valves shall be Gun metal and tested up to pressure of Class I pressure rating.
  FITTINGS

The dimensions of the fittings shall conform to IS 1239/69 Part II (as per latest amendment) unless otherwise specified in specification.

All bends in sizes up to and including 150 mm dia shall be readymade of heavy-duty, wrought steel of appropriate class.

All fittings such as branches, reducers etc. in all sizes shall be fabricated from pipes of same dia and thickness and length at least twice the dia of pipe.

The branches may be welded straight to main line.

Blank ends are to be formed with flanged joints and 1 mm thick blank insertion of rubber gasket between flange pair for 150 mm and over in case where a future extension is to be made otherwise blank end discs of 6 mm thickness are to be welded on with additional cross stiffeners.

2.13.21.2 PIPING INSTALLATION

- All piping work shall be carried out in workman like manner causing minimum disturbance to the existing services.
- Piping shall be of steel, primer coated with rust preventive paint and finished with approved shade. Pipe supports shall not exceed the following spacing: -

MAXIMUM SPACING OF PIPE SUPPORTS

Pipe Size (MM)	Spacing (Mtr.)	Rod Size
25	2	10 mm
30 to 75	2.5	10 mm
100 and above	3.0	12.5 mm

Pipe hangers shall be fixed on walls and ceiling by means of metallic Raw bolts or approved shear fasteners.

- Piping shall be properly supported on, or suspended from, stands, clamps, and hangers as specified and as required. The Contractor shall adequately design all the brackets, saddle, anchors, clamps and hangers and be responsible for their structural sufficiency.
- Vertical risers shall be parallel to walls and columns. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe and with a 10 mm thick rubber pad or any resilient material. Where pipes pass through the terrace floor, suitable flashing shall be provided to prevent water leakage. Risers shall also have a duck foot elbow or steel support welded to the pipe at the lowest point. On risers drain valves shall be provided at heels.
- Pipe sleeve of 50 mm larger than the pipe diameter shall be provided wherever pipes pass through walls and the annular space filled with felt and finished with retaining rings. In case of aninsulated pipe the diameter shall be inclusive of insulation.
- Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. Metal sheet shall be provided between the insulation and clamp, saddle or roller extending at least 150 mm on both sides of clamp, saddle or roller.

i. PRESSURE GAUGES AND THERMOMETERS

- One pressure gauge each shall be provided to measure pressure at the inlet and outlet of each cooling coil, shall be not less than 100 mm Dia and shall be complete with shut off (globe) valve. Care shall be taken to protect pressure gauge during pressure testing, range shall not exceed 50% above normal measurement.
- Thermometer shall be stem type and shall be provided at inlet and outlet of each cooling coil.

2.13.21.3 TESTING

a. All water piping shall be tested to hydrostatic test pressure of at least one and a half times the maximum operating pressure but not less than 10 kg/sq cm 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 EMPLOYER Employer's Representative .
b. Pipes repaired subsequent to above pressure shall be retested in same manner.
c. Piping may be tested in section and such sections shall be securely capped.
d. The Contractor shall ensure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipments in the system concerned. If proper circulation is not achieved due to air bound connections, the 'Contractor' shall rectify the defective connections. He shall bear all the expenses for carrying out above rectifications involving tearing up and refinishing of floor walls etc. as required.
e. The Contractor shall give sufficient notice to all other agencies at site, of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by Employer's Representative at site.

f. The Contractor shall provide temporary pipe connections to initially by-pass condenser/chiller and circulate water through condenser/ chilled water pipe lines for minimum 8 hours. Water shall be drained out from the lowest point. The temporary lines shall be removed and blanked with dead flanges. Pot strainers and Y strainers shall be cleaned and fresh water filled in the circuits.

g. After the piping has been installed, tested and run for at least three days of eight hours each, all un-insulated exposed piping in plant room shall be given two finish coats, 3 mills each of approved colour, conforming to relevant BIS Codes. The direction of flow of fluid in the pipes shall be visibly marked with identifying arrows. For painting of insulated and clad pipes refer to insulation section.

h. After testing, all systems shall be chemically cleaned. After cleaning, the pipe work shall be rinsed multiples times until the system is neutral. The Contractor shall make a report conforming the above to Employer's Representative for records.

i. The Contractor shall provide all materials tools equipments, services and labour required to perform the test and to remove water resulting from cleaning and testing.

2.13.21.4 BALANCING

a. After completion of the installation, all water systems shall be adjusted and balanced to deliver water quantities as specified.

b. Instruments required for the water balancing (computerized balancing instrument) shall be accurately calibrated in an approved manner before taking any measurements. Calibrated orifices and portable flow meters shall be used to balance the water flow. Orifices used for testing and balancing shall be installed with straight length up stream and down stream as recommended by the manufactures and shall be left permanently installed in the system.

c. Automatic control valve and three way valves shall be set for full flow conditions during balance by procedure. Water circuit shall be adjustable by balancing cocks provided for balancing. These shall be permanently marked after balancing is completed so that they can be restored to their correct positions of disturbed.

2.13.21.5 PAINTING

In case of pipes to be insulated after thorough anti grease and rust removal treatment, clean the pipe and then apply two coats of epoxy primer before applying in insulation treatment as specified elsewhere. All uninsulated pipes after de rusting will be provided with two coats of epoxy primer followed by epoxy paint of approved shade.

2.13.21.6 FIRE BREAKS INSULATION

Firebreaks shall be provided in all ducts for internal lining/external thermal insulation after a run of 10 m center to center. There shall be a discontinuity of the insulating material in the form of MS angle of a minimum of 50 mm x 50 mm x 3 mm size. At the interface of the MS angle and insulating material, proper care of tucking in of the insulating material shall be taken so as to prevent erosion.

2.13.22 INSULATION PROTECTION & ADHESIVE Recommended Adhesive

- High Bond Strength adhesive for installing all flexible insulation materials. Adhesive shall be used for bonding the seams securely together. All butt & longitudinal joints, fittings and coverings must be closed with adhesive
- The adhesive shall be synthetic in nature, free from benzene and shall be complying to the Green Building Norms. Certificate of compliance shall be supplied by Adhesive manufacturer only. Incase the adhesive is supplied by a dealer/ third party manufactured, certificate from the manufacturer only will be accepted.
- The adhesive shall have excellent bonding to porous and non-porous surfaces and shall nothave any pungent odours.
- The adhesive has to be applied with the help of brush only.
- Suggested product AC Duct King Echo Fresh/ equivalent

Technical Details

Solvent Based Rubber contact adhesive

Temperature Range: -20°C to +96°C

Form: Liquid

Material: Chloroprene Rubber based synthetic adhesive

Minimum Drying Time (airing time): 3-4 Minutes

Setting Time: 24 hours

Viscosity @ 30°C: 1000 - 2500 cps

Specific Gravity: 0.75 - 0.90 **Flash Point:**> -20°C

Coverage: 5-6 square meters per litre per coat

Tack Retention Time: 20 minutes

VOC : Less than 700 gms / litre

<u>"Protective Covering for Duct and Pipe Insulation in Internal and External Areas".</u>

- **Internal Duct Insulation Protection:**

All longitudinal and transverse joints shall be sealed as per manufacturer recommendations. The adhesive shall be strictly as recommended in the above section.

All insulated internal ducts shall be coated with two protective coats each of 500 micron (0.5 mm) WFT Fire Retardant coating conforming to UL 723 Class A and ASTM 4804 and having Anti Fungal and Anti Bacterial properties conforming ASTM D 5590, sandwiched with 7 Mil Class E Glass Cloth with relevant colors.

Manufacturer shall submit test certificate of conformity for above all parameter issued by internationally recognized Independent Laboratory shall be submitted along with type test report.

- **Internal Piping Insulation Protection**

All internal insulated pipes shall be coated with two protective coats each of 500 micron (0.5 mm) WFT Fire Retardant coating conforming to UL 723 Class A and ASTM 4804 and having Anti Fungal and Anti-Bacterial properties conforming ASTM D 5590, sandwiched with 7 Mil Class E Glass Cloth with relevant colors.

Manufacturer shall submit test certificate of conformity for above all parameter issued by internationally recognized Independent Laboratory shall be submitted along with type test report.

- **External Duct Insulation Protection:**

All longitudinal and transverse joints shall be sealed as per coating manufacturer recommendations. The adhesive shall be strictly as recommended in the above section.

All insulated external ducts shall be coated with external grade coating with each of 500 micron (0.5 mm) WFT, Weathering Resistant coating conforming ASTM 6695 and having excellent Rain Water Resistance, high level water permeability resistance and must be Anti Fungal and Anti Mold (both properties), conforming to relevant internationally acclaimed standards such as ASTM D 6904, ASTM D 2842, ASTM D 5590 and ASTM D 5589. The coating has to conform to ASTM E 96 for water vapor permeability. Coatings conforming to with Fire resistant properties such ASTM 4804 and ASTM E 84 shall be preferred.

The Two coats shall be sandwiched between 10 Mil Class E Fibre Glass Cloth.

Coating Manufacturer shall submit test certificate of conformity for above all parameter issued by internationally recognized Independent Laboratory shall be submitted along with type test report.

- **Piping Insulation Protection**

All longitudinal and transverse joints shall be sealed as per coating manufacturer recommendations. The adhesive shall be strictly as recommended in the above section.

All insulated external chilled water and refrigerant pipes shall be coated with external gradecoating with each of 500 micron (0.5 mm) WFT, weathering Resistant coating conforming ASTM 6695 and having excellent Rain Water Resistance, high level water permeability resistance and must be Anti Fungal and Anti Mold (both properties), conforming to relevant internationally acclaimed standards such as ASTM D 6904, ASTM D 2842, ASTM D 5590 and ASTM D 5589. The coating has to conform to ASTM E 96 for water vapor permeability. Coatings conforming towith Fire resistant properties such ASTM 4804 and ASTM E 84 shall be

preferred. The Two coatsshall be sandwitched between 10 Mil Class E Fibre Glass Cloth. Glass Cloth Tape of 10 Mil ClassE can also be used.

Coating Manufacturer shall submit test certificate of conformity for above all parameter issued by internationally recognized Independent Laboratory shall be submitted along with type test report.

2.13.23 DUCT SUPPORTING SYSTEM

Wire Hangers shall be used to suspend all static HVAC Air Distribution services.

Wire Hangers shall consist of a pre-formed wire rope sling with a range of end fixings to fit various substrates and service fixings, these include a ferruled loop, permanently fixed threaded M6 (or M8, M10,M12) stud/eyebolt, permanently fixed nipple end with toggle, at one end or hook or eyelet, cladding hook, barrel, wedge anchor, eyebolt anchor or any other end fixture type or sizeas per manufacturers recommendation and design. The end fixings and the wire must be of the same manufacturer with several options available. The system shall be secured and tensioned with a Hanger self-locking grip (double channel wedge type lock) at the other end. Once the grip is locked for safety purpose unlocking shall only be done by using a separate setting key and shall not be an integral part of the self-locking grip. Only wire and/or supports supplied and/or approved, shall be used with the system.

a. Wire Hangers shall have been independently tested by Lloyds Register. APAVE, TUV, CSA, Chiltern International fire, ADCAS, Intertek, ECA, and SMACNA, approved by CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire ropeshall be manufactured to BSEN 12385: 2002

b. Wire Hangers shall be independently tested by reputed third party testing organization to sustain safe working load for 120min at elevated temperature of 175 deg. C or above.

c. The Contractor shall select the correct specification of wire hanger to use for supporting each particular service from table 1 below. Each size is designated with a maximum safe workingload limit (which incorporates a 5:1 safety factor).

The correct specification of wire hanger required shall be determined using the following formula or as per manufacturer’s recommendation, whichever is stringent.

Weight per meter of object suspended (kg) X distance between suspension points (m) = weight loading per Hanger suspension point (kg).

Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the recommendations give in the manufacturer's handbook.

The Contractor shall select the correct length of wire rope required to support the service. The Contractor shall select the correct length of wire rope required to support the service. No in–line joints shall be made in the rope.

The standard range of Hanger Kits shall contain galvanized high tensile steel wire rope or stainless steel wire rope as per the application, the minimum specification is as above and shall be manufactured to BS 302 (1987), BSEN12385. Comply with manufacturer's load ratings and recommended installation procedures. Note the testing is done to the minimum breaking load of the wire thus giving a minimum safety factor of 5: 1.

HVAC Supports – Wire Rope Hanger Supports are suitable for: Rectangular duct, Spiral Duct, Oval Duct, Fabric Duct, Desertification fans, Air Conditioning Units, Plenum Boxes, Radiant Panels, Heaters, Fan Coil Units, Diffusers and Chilled Beams. Hangers shall also be fully threadedrods of 8mm dia. Galvanized mild steel for duct sizes up to 1500 mm and of 10mm dia for ducts up to 2250mm size, and 12 mm dia for larger sizes.

a. Standard Ducting Supports:

Ducting over furred ceiling shall be supported from the slab above or from beams after obtaining approval of Construction manager/consultant. In no case shall any duct be supported from false ceiling Hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other Contractor's work in the building.

b. Special Supports:

Refer to manufacturer's recommendations on Catenary supports, special care shall be taken with tensioning of the wire and angles at which the installation of services are made**.** Stainless Steel Supports shall be available for food, chemical and High Corrosion areas near coastlines.

Refer to manufacturers catalogue and installation guide for further technical information.Comply with manufacturer's load ratings and recommended installation procedures.

Notes: All supports are considered at 2400 mm interval and may vary as per the design but shall not be greater than 2400mm.

Desertification fans, Air Conditioning Units, Plenum Boxes, Radiant Panels, Heaters, Fan Coil Units, Diffusers, Cassette units and Chilled Beams.

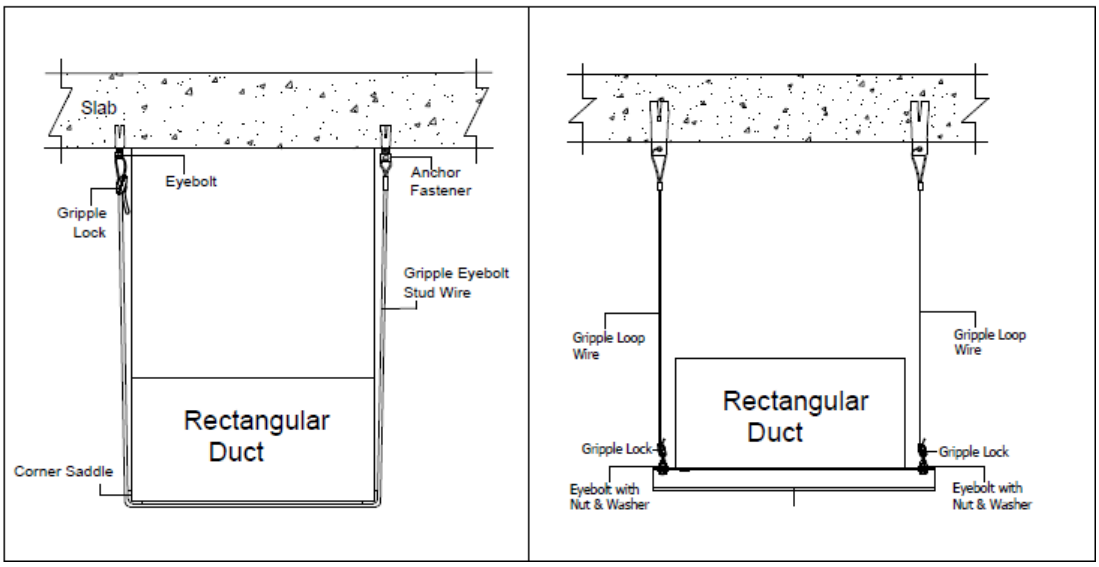
All units shall be adequately secured and supported in an approved manner using wire hanger suspension Y fit solution as per manufacturers' recommendation with prior approval.

Rigid Supports:

Rigid supports if required in conjunction with wire hangers, as per manufacturer recommendation, shall be of steel, adjustable for height and Zinc chromate primer coated and finish coated black, Galvanized Strut support system of required strength and profile can also be used. Where supportsand clamps are of dissimilar materials, a gasket shall be provided in between.

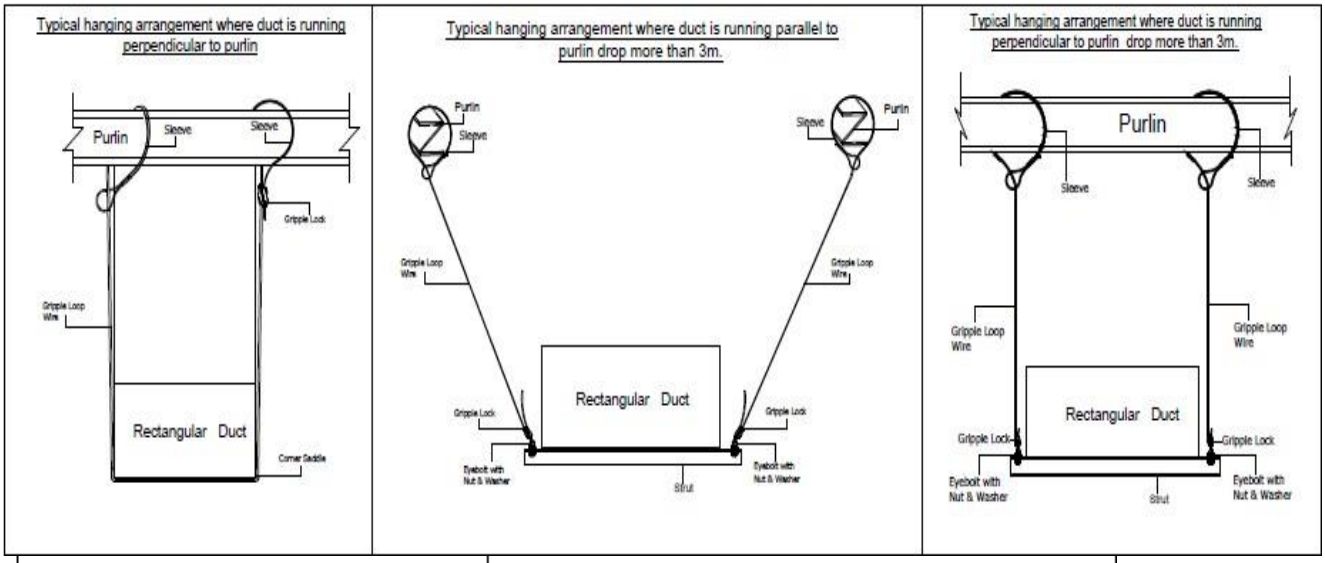
c. Typical Arrangement for Duct Supports from RCC slab

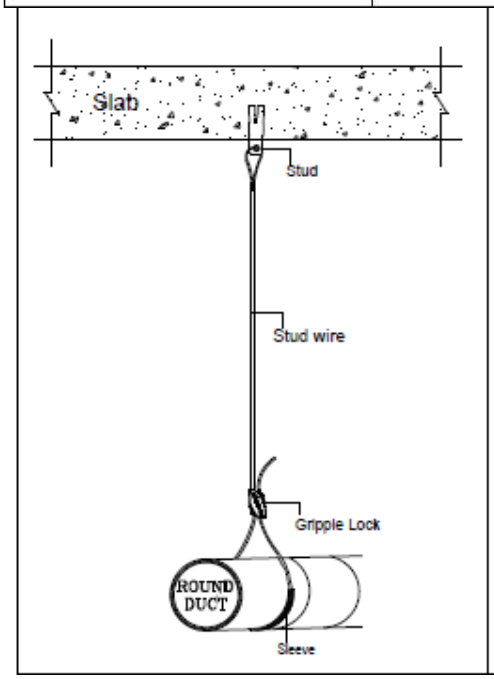
Typical Arrangement Rectangular Duct for Slab Area

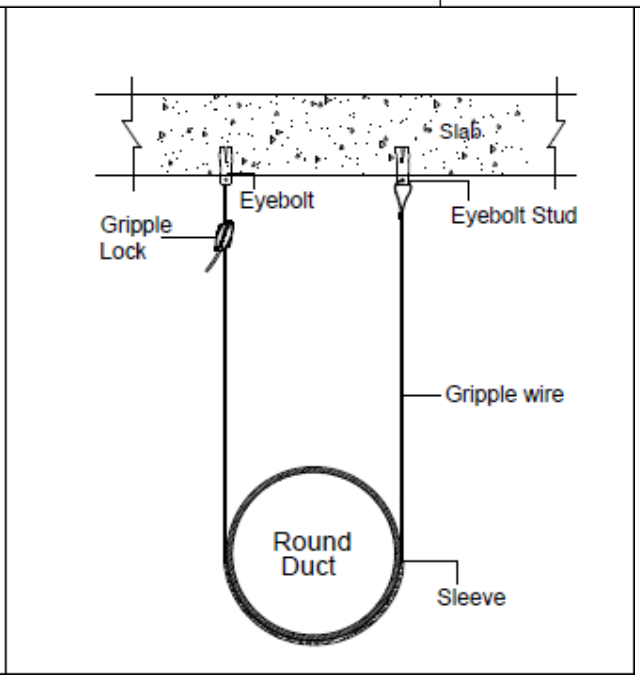


d. Typical Arrangement for Duct Supports from PEB

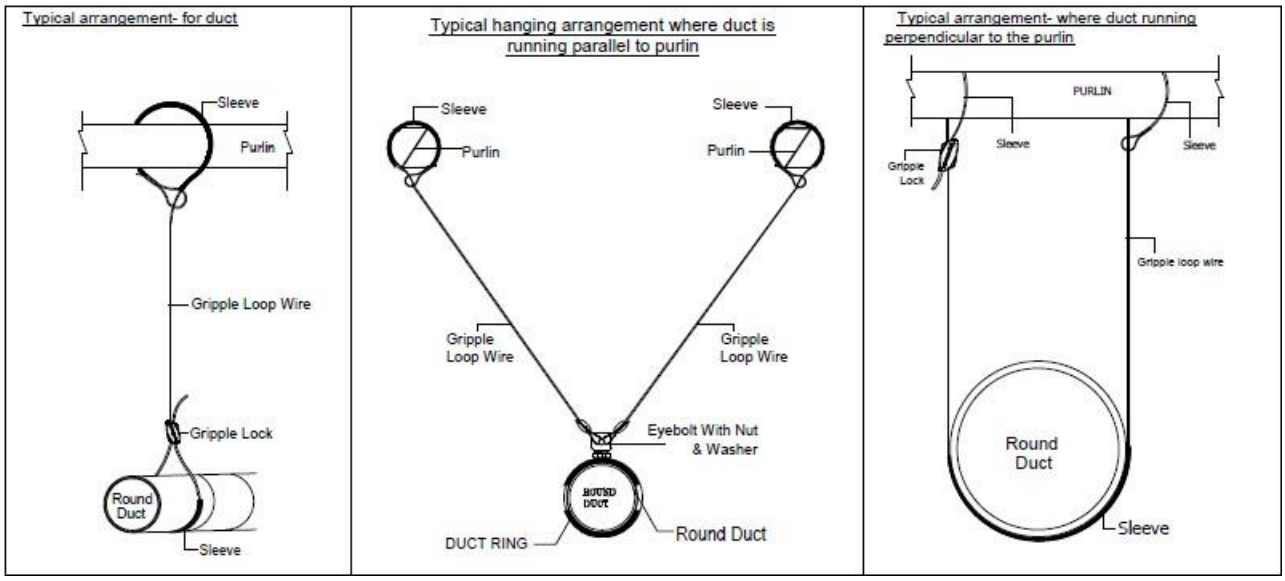
Typical Arrangement Rectangular Duct for Structure Area



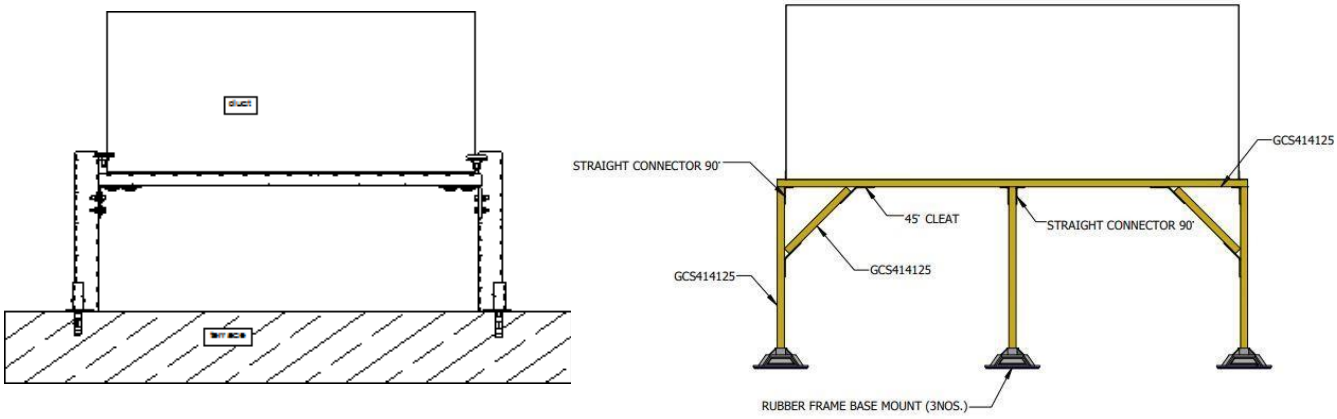




Typical Arrangement Round duct for Structure Area



e. Typical Arrangement for Duct Support on terrace:



Note: Foot based supports shall be used for terrace/floor application to avoid anchorage/drilling on terrace/floor.

2.13.24 COIL MOUNTED UV-C IRRADIATION SPECIFICATIONS

i. UVGI system shall be designed for effective disinfection and provide a UV dose of greaterthan 1,000 µJ/cm2 in a single pass to achieve kill rate at least 99% (log 2) of virus/bacteria susceptible to this dose.
ii. In addition, the UVGI system shall be designed to provide effective destruction and prevention of growth of bacteria, virus, mold, fungi and microbiological species and to provide a minimum intensity of not less than 500 µw/cm² on AHU coil and shall envelope the entire surfacearea of the cooling coil.
iii. The computer simulation provided by the manufacturer will state the UV dose imparted tothe airstream and the irradiation profile on the AHU coil.
iv. The UV-C shall be of 254 nm wavelength and no ozone shall be produced as a by-product.
v. The power source shall be available in 230V AC 50 Hz. and be able to operate reliably inindoor environments ranging from 4°C to 40°C temperature, with relative humidity up to 100%.
vi. The lamps shall be of High Output type (800 mA each). These lamps shall be specially designed to be used in low temperature applications and shall provide a rated average life of 16,000hours.
vii. The UV-C lamp shall be internally coated to reduce solarisation and of such intensity as toprovide minimum performance as listed below.
viii. The fixtures shall be non-corrosive hardware so that the fixture does not vibrate or loosen. Safety interlock switches are to be installed on all access doors where UV intensity may be present.
ix. Length of each lamp used in the germicidal system shall be adequately long to cover the AHU width.
x. The reflector shall be built from an high UV reflective aluminium material capable of withstanding air velocities of up to 2000 ft/min without excessive noise, wobble, or vibration.
xi. The vendor shall supply the test certificate for each unit showing conformance to the technical specifications.
xii. The MOC of each lamp shall be High Purity Fused Quartz.
xiii. The ballasts must be integrated onto the module in a sealed aluminum enclosure to protect against moisture and humidity present in the AHU or duct and be certified for installation inside the duct along with the emitter.
xiv. The device submitted shall be classified by UL (Underwriters Laboratories) as an Air Duct Mounted Accessory (ABQK) and meet the UL Standards 1995 (Heating and Cooling Equipment) and 2043 (Fire Test for Heat and Visible Smoke Release). The appropriate UL mark along with manufacturers UL file number shall be permanently marked on the exterior of the product.
xv. Vendor Shall submit a report comprising of a swab test on the coil every 6 months (from the date of commissioning) during the DNP from a NABL accredited laboratory to ensure performance.
xvi. As it is a critical system hence it shall be supplied and installed by either OEM directly or by authorised system integrator only. In case of authorised system

integrator no case specific authorisation letter shall be acceptable.

2.13.25 FAN COIL UNIT KIT

Connection and regulation kit for HVAC fan coil units in heating and cooling systems. Complete with: pressure independent control valve, three-way shut-off valves, integrated by-pass, Venturi device with pressure test ports (only for dedicated versions), filtering cartridge and pre-formed shell insulation made of PPE.

Sizes DN 15, DN 20 and DN 25. Main connections on system side 1/2" F (from 1/2" to 1"); terminal unit side 3/4" M (from 3/4" to 11/4"). Connections centre distance: 80 mm. Pressure test port connections 1/4" F (ISO 228-1) with cap (only for dedicated versions). Connection for code 145014 and 6565 series thermo-electric actuators. M30 p.1,5.

Flow rate adjustment range of the group with Venturi device: 0,02–0,10 m3/h (code 149..0 H10); 0,10–0,20 m3/h (code 149..0 H20); 0,20–0,40 m3/h (code 149..0 H40); 0,40–0,80 m3/h (code 149..0 H80); 0,80–1,20 m3/h (code 149..0 1H2); 1,20–1,80 m3/h (code 149..0 1H8); 1,80–3,00 m3/h (code 149..0 3H0).

Flow rate adjustment range of the group without Venturi device: 0,02–0,20 m3/h (code 149..0 H20); 0,08–0,40 m3/h (code 149..0 H40); 0,08–0,80 m3/h (code 149..0 H80); 0,12–1,20 m3/h (code 149..0 1H2); 0,18–1,80 m3/h (code 149..0 1H8); 0,3–3,00 m3/h (code 149..0 3H0).

Linear or equipotential flow rate adjustment characteristic, which can be set up by actuator depending on the characteristics of the terminal unit.Maximum working pressure 25 bar. Maximum differential pressure with actuator code 145014 (and 656. series) installed: 5 bar. Nominal operation Δp range 25–400 kPa. Working temperature range -10−120°C. Ambient temperature range 0−50°C. Strainer mesh size 800 µm. Medium: water and glycol solutions; maximum percentage of glycol 50%. Dezincification resistant alloy body and adjustment headwork; stainless steel strainer mesh; EPDM diaphragm, obturator and seals.

All included valves, actuator (ON & OFF / Modulating type), pressure independent control valve, three-way shut-off valves, integrated by-pass, Venturi device with pressure test ports (only for dedicated versions), filtering cartridge and pre-formed shell insulation made of PPE shall of from single manufacturer, NO locally assembled unit is acceptable.

Technical specificationsMaterials:

Body: dezincification resistant alloyEN 12165 CW602N

Strainer mesh: AISI 304

Shut-off valves knobs: PA6G30PICV

Headwork: dezincification resistant alloyEN 12164 CW602N

Control stem and piston: stainless steelEN 10088-3 (AISI 303)

Obturator seat: -0,02–0,4/0,08–0,8/0,12–1,2 m3/h: PTFE

-0,18–1,8/0,30–3,00 m3/h: stainless steel EN 10088-3 (AISI 303)

Obturator: EPDM

Pressure regulator membrane: EPDM

Springs: stainless steel EN 10270-3 (AISI 302)Seals: EPDM

Seals: non-asbestos fibre

Pre-adjustment indicator: PA6G30Knob: PA6

Connections

System side 1/2” F (DN 15) - 3/4” F (DN 20) - 1” F (DN 25)

Terminal unit side: 3/4” M (DN 15) - 1” M (DN 20) - 1 1/4” M (DN 25)

Performance

Medium: water, glycol solutions Maximum percentage of glycol: 50%Max. working pressure: 25 bar

Max. differential pressure with actuator

code 145014 and 656. series thermo-electric actuators: 5 barWorking temperature range: -10–120°C

Ambient temperature range: 0–50°C Nominal Dp control range: 25–400 kPa Flow rate regulation range: 0,02–3,00 m3/h (see hydraulic characteristics)

Max. flow rate, with 656. series thermo-electric actuator fitted, reduced by: 0,02–0,4/0,08–0,8/0,12–1,2 m3/h: 20% 0,18–1,8/0,30–3,00 m3/h: 25%

Strainer mesh size: 800 µm

Insulation

Material: PPE

Density: 30 Kg/m3

Thermal conductivity: 0,037 W/(m·K) at 10°CReaction to fire (UL94): class HBF

Image of Fan Coil Unit (for refrence only):

2.13.26 TESTING, ADJUSTING AND BALANCING

The HVAC Contractor shall have a dedicated experienced, specialized, approved, testing and commissioning (T&C) team/ agency responsible for coordination with other trades, preparation of T&C plan method statement & T&C procedures, organizing & scheduling the T&C activities along with the progress of works, supervision any re-testing, coordination with third parties for commissioning & certification, organizing & performing testing for satisfaction of all Statutory Bodies, T&C record documentation & handover

General

a. Testing, adjusting and balancing of heating, ventilating and air-conditioning systems at site.
b. Testing, adjusting and balancing of HVAC Hydronic system at site.
c. Testing, adjusting and balancing of exhaust system at site.
   Comply with current editions of all applicable practices, codes, methods of standards preparedby technical societies and Assoc. ciations including:

   ASHRAE: 2007 HVAC Application or latest version.

   SMACNA : Manual for the Balancing and Adjustment of air distribution system.

d. HVAC Contractor shall submit a Test, adjust, balance procedure/method statements/chartsfor approval to The Employer.

Performance

a. Verify design conformity.
b. Establish fluid flow rates, volumes and operating pressures.
c. Take electrical power readings for each motor.
d. Establish operating sound and vibration levels.
e. Adjust and balance to design parameters.

f. Record and report results as per the formats specified.

Definitions

a. Test: To determine quantitative performance of equipment.
b. Adjust : To regulate for specified fluid flow rates and air patterns at terminal equipment (e.g. reduce fan speed, throttling etc.)
c. Balance : To proportion within distribution system (submains, Branches and terminals) in accordance with design quantities.

Testing, Adjusting and Balancing (TAB) Procedures

The following procedures shall be directly followed in TAB of the total system. Before commencement of each one of the TAB procedure explained hereunder, the AC Contractor shall intimate the The Employer about his readiness to conduct the TAB procedures in the format given in thesespecifications.

Description of System and Requirements

Adjust and balance the following system to provide most energy efficient operation compatible with selected operating conditions.

a. All supply, return and outside air systems.
b. All exhaust air systems.
c. All chilled water systems.
d. All cooling tower (condenser) water systems.
e. Emergency purge systems.

Air Systems

I. Air Handlers Performance

The TAB procedure shall establish the right selection and performance of the AHUs with the following results :

a. Air-IN DB and WB temperature.
b. Air-OUT DB and WB temperature.
c. Dew point air leaving.
d. Sensible heat flow.
e. Latent heat flow.
f. Sensible heat factor.
g. Fan air volume.
h. Fan air outlet velocity.
i. Fan static pressure.
j. Fan power consumption.
k. Fan speed.

II. Air distribution

Both supply and return air distribution for each AHU and for areas served by the AHU shall be determined and adjusted as necessary to provide design air quantities. It shall cover balancing of air through main and branch ducts.

III. The Preparatory Work

To conduct the above test, following preparatory works are required to be carried out including the availability of approved for construction shop drawings and submittals:

a. All outside air intake, return air and exhaust air dampers are in proper position.
b. All system volume dampers and fire dampers are in full open position.
c. All access doors are installed & are air tight.
d. Grilles are installed & dampers are fully open.
e. Provision and accessibility of usage of TAB instruments for traverse measurements are available.
f. All windows, doors are in position.
g. Duct system is of proper construction and is equipped with turning vanes and joints are sealed.
h. Test holes and plugs for ducting.

Hydronic System Balancing

I. The Hydronic system shall involve the checking and balancing of all water pumps, piping network (main & branches), the heat exchange equipment like cooling and heating coils, condensers and chillers and cooling towers in order to provide design water flows.

- The essential preparation work, must be done by the HVAC Contractor prior to actual testing,adjusting and balancing of HVAC system and ensure following:
- Availability of co-ordinated drawings and approved submittals and system sketch with designwater flows specified thereon.
- Hydronic system is free of leaks, is hydrostatically tested and is thoroughly cleaned, flushedand refilled.
- Hydronic system is vented.

II. The HVAC Contractor shall confirm completion of the basic procedures and prepare check lists for readiness of system balance.

a. Check pumps operation for proper rotation and motor current drawn etc.
b. Confirm that provisions for TAB measurements (Temperature, pressure and flow measurements) have been made.
c. Open all shut-off valves and automatic control valves to provide full flow through coils. Set all balancing valves in the preset position, if these values are known. If not, shut all riser balancing valves except the one intended to be balanced first.

Balancing work for both Chilled Water System and Condenser Water System shall be carried out in a professional manner and test reports in the specified format shall be prepared and presentedto the The Employer / Consultant for endorsement.

Readiness for Commencement of TAB

Before starting of any of the tests, the readiness to do so shall be recorded as per the prescribed check list.

TAB Instruments

I. Air Measuring Instruments

a. For measuring DB and WB temperature, RH and dew point, microprocessor based TSI USA make VelociCalcPlus Meter, Model 8386, or equivalent shall be used. This instrument shall be capable of calculating the sensible, latent total heat flows, sensible heat factor and give printouts at site and have data logging/downloading facility.
b. For measuring Air velocity, DB temperature and Air volume, TSI USA make VelociCalc meter model 8386/ 8345 or equivalent shall be used. It shall be able to provide instant print out of recorded Air volume readings.
c. Pitot tube.
d. Electronic Rotary Vane Anemometer TSI make or equivalent.
e. Accubalance Flow Measuring Hood TSI make or equivalent.

[All above instruments shall have a valid certification from a reputed testing institution.]

II. Hydronic Measuring Instruments

For measurement of water flow across balancing valves, instruments as provided by the manufacturer of the valves specific to the type of valves shall be need. This shall include but not be limited to differential pressure manometers. Temperature shall be measured using electric thermometers from thermowells provided at strategic location by the HVAC Contractor. The water balancing shall be carried out being computer simulation program provided / certified by the balancing valve manufacturer.

III. Rotation Measuring Instrument

a. Electronic DigitalTachometer.

IV. Temperature & RH Measuring Instrument

a. TSI VelociCalc model 8386 / VelociCalc model 8345 or equivalent.

V. Electrical Measuring Devices

a. Clamp on Volt ammeter.
b. Continuity Meter.

VI. Vibration and Noise Levels

Vibration and alignment field measurements shall be taken for each circulating water pump, water chilling unit, air handling unit and fan driven by a motor over 10 HP. Readings shall include shaft alignment, equipment vibration, bearing housing vibration, and other test as directed by theEMPLOYER'S REPRESENTATIVE.

Sound level readings shall be taken at ten (10) locations in the building as selected by the Contractor/ The Employer. The readings shall be taken on an Octave Band analyzer in a manner acceptableto him. The AC Contractor shall submit test equipment data and reporting forms for review. In order to reduce the ambient noise level, the readings shall be taken at night. All test shall be performed in the presence of The Employer/ Consultant or his authorized representative.

2.13.27 SYSTEM READY TO BALANCE CHECK LIST (NOT LIMITED TO FOLLOWING)

Description	**Ready**		**Date**
	Yes	**No**	**Corrected**
1. HVAC Units (AHU)			
a) General Louvers installed			
Manual dampers open & locked			
Automatic dampers set properly			
Housing Construction leakage			
Access doors-leakage			
Condensate drain piping and pan			
Free from dirt and debris Nameplate data			
b) Filters			

Type and size

Number

Clean

Frame-Leakage

c) Coils (Hydronic)

Size and rows

Fin spacing and condition

Obstructions and / or debris

Airflow and direction Piping leakage

Correct piping Connections and flow

Valves open or set

Air vents or steam traps

Provision made of TAB Measurements

d) FansRotation

Wheel clearance and balance

Bearing and motor lubrication

Drive alignment

Belt tension

Drive set screws tight

Belt guard in place

Flexible duct connector alignment

Starters and disconnect switches

Electrical service & connections.

Nameplate data

e) Vibration Isolation Springs & Compression

Base Level & Free

2. Duct System

a) General

Manual dampers open & locked

Access doors closed and tight

Fire dampers open and accessible

Terminal units open and set

Registers and diffusers open and set

Turning vanes in square elbows

Provisions made for TAB measurements.

Systems installed as per plans.

Ductwork sealed as required

b) Architectural Windows installed andclosed.
Doors closed as required.

Ceiling plenums installed and sealed.

Access doors closed and tight

Air shafts and openings as required

3. Pumps
a) Motors.Rotation Lubrication Alignment
Set screws tight

Guards in place

Tank level and controls. Starters

and disconnect switches Electrical

service & connections.

Nameplate data.

b) Piping
Correct flow

Correct connections

Leakage

Valves open or set

Strainer clean

Air vented

Flexible connectors

Provisions made for TAB measurements

c) Bases
Vibration isolation.
Grouting

Leveling

4. Hydronic Equipment

a) Heat Exchangers/HW coil

Correct flow and connections

Valves open or set

Air vents or steam traps

Leakage

Provisions made for TAB measurements

Nameplate data.

5. Refrigeration Equipment

Crankcase heaters energized

Operating controls and devices.

Safety controls and devices.

Valves open

Piping connections and flow

Flexible connectors

Oil level and lubrication

Alignmentand drives.

Guards in place.

Vibration isolation.

Starters, contactors and disconnect switches.

Electrical connectors.

Nameplate data.

6. Hydronic Piping systems.

Leak tested.

Fluid levels and

make-up Relief or safety valves.

Compression tanks and air vents.

Steam traps and connections.

Strainers clean valves open or set

Provisions made for TAB measurements.

Systems installed as per plans.

7. Controls System
Data centers.

Outdoor return air reset

Economizer

Static pressure

Room controls.

8. Other Checks.
Other trades or personnel notified of TAB work requirements.

Preliminary data complete

2.13.28 INSTRUMENT CALIBRATION REPORT

PROJECT _____

S/N INSTRUMENT/ APPLICATION DATES OF CALIBRATIONSERIAL NO.
USE TEST DATE

1.

2.

3.

REMARKS

TEST DATE_____READINGS BY _____

CHILLER TEST REPORT

PROJECT_____UNIT_____

LOCATION_____

MANUF._____MODEL_____SERIAL NO. _____ CAPACITY _____REFRIG_____STARTER___HEATER SIZE _____

Description **Design** **Actual**

a) COMPRESSOR
Make/ Model Serial No.

Type (Reciprocating, Centrifugal, Screw, Scroll)

Piping Material Suction Pr / Tem.

Discharge Pr/Temp

Refrigerant

Oil Pump TypeOil Pressure

Oil Failure Switch Pressure

Unload Arrangement

Unload Set Points

Drive

Compressor Speed

Oil Level

Oil Temperature

L P Setting

H P Setting

Anti Freeze Setting

Purge Unit Type

Purge Operation Checked

b) COMPRESSOR MOTOR

Make / Model

Type

Voltage

Motor Rated Current

Motor F L Current

c) MOTOR STARTER

Make / Model

Type

Voltage

Amps

O/L Release Range

d) EVAPORATOR

Make / Model

No. of Passes

Ref : Level

Ref : Pressure / Temperature

Ent. Water Temp/Pressure

Leaving Water Temp/Pressure

Temperature Difference

Pressure Difference

Water Quantity

Relief Valve Setting

IKW / Ton

REMARKS

TEST DATE_____READINGS BY_____COOLING

TOWER TEST REPORT

PROJECT_____SYSTEM_____

LOCATION_____

MANUF._____MODEL_____SERIAL NO._____

NOM. CAPACITY_____WATER TREAT._____

Description	**Design**	**Actual**
a) TOWER / MOTOR		
Make / Model		
Type		
Tons		
No. of Fan Motors		
Motor HP / RPM		
Motor / Drive Motor Speed		
Motor Rated Current		
Motor FL Current		
O/L Release Setting		
CT Range		
CT Approach		
b) TOWER / FAN		
No. of Fans		
Type/ Drive of Fan		
Fan Dia		
Fan Speed		
Air Inlet Temperature		
Air Outlet Temperature		
Fan Air Quantity Water		
Bleed GPM		
c) TOWER / AIR DATA		
Fan CFM		
Outlet S.P.		
Avg. Ent. W.B.		

Avg. Lvg. W.B.

Ambient W.B.

Fan RPM Voltage

Amps

d) TOWER / WATER DATA
Ent//Lvg./Water Pressure
Ent//Lvg./Water Temperature
Water Temperature – T

GPM

Bleed GPMVoltage

Amps

REMARKS

TEST DATE_____READINGS BY_____

PUMP TEST REPORT

PROJECT_____

DATA	**PUMP NO.**	**PUMP NO.**	**PUMP NO.**	**PUMP NO.**	**PUMP NO**.
Location					
Service					
Manufacturer					
Model Number					
Serial Number					
GPM/Head					
Req. NPSH					
Pump RPM					
Impeller Dia.					
Motor Mfr. / Frame					
Motor HP/RPM					

Volts/Phase/Hertz

F.L Amps

Seaeal Type Pump Off-Press.

Valve Shut Diff.

Act.Impeller Dia.

ValveOpen diff.

Valve Open GPM Final

Dischg.Press.

Final Suction Press.

Final Ap

Final GPM

Voltage

Amperage

REMARKS

TEST DATE_____READINGS BY_____

AIR HANDLING EQUIPMENT TEST REPORT

PROJECT_____

SYSTEM/UNIT_____**LOCATION**_____

Description	**Data**

a) UNIT
Make/Model No.
Type/Size

Serial Number

Arr./Class

Discharge

Pullydia/Bore

No. Belts/make/size

No.Filters/type.size (Pre.)

No.Filters/type/size (secondary)

b) MOTOR
Make / Frame

H.P / RPM

Volts/Phase/cycles F.L amps.

PullyDia/Bore Pully /Distance.

Total Cfm

Total S.P

Fan RPM

Motor Volts. T

Outside air Cfm

Return air Cfm

Discharge S.P

Cooling Coil S.P

Filters S.P

REMARKS

TEST DATE_____READINGS BY_____

COOLING/ HEATING TEST REPORT (AHU)

PROJECT_____

COIL DATA System Number Location Coil Type No. Rows Fins/In Manufacturer Model Number Face Area, Sq.Ft.	**COIL NO.**		**COIL NO.**	
TEST DATA	**DESIGN/ ACTUAL**	**DESIGN/ ACTUAL**	**DESIGN/ ACTUAL**	**DESIGN/ ACTUAL**
Air Qty. CFM Air Vel.FPMPress.Drop In. Out.Air DB/WB Ret. Air DB/WB Ent.Air DB/WB Lvg.Air DB/WB Air AT Waer flow. GPM Press.Drop.PSI Ent.Water Temp Lvg .Water Temp Water AT Exp.Valve/RefrigRefrig.Suction Pr. Refrig.Suct.Temp Inlet Steam press.				

REMARKS

TEST DATE_____**READINGS BY**_____

FAN COIL TEST REPORT

PROJECT_____

DATE_____**LOCATION**_____

MANUFACTURER_____

AREA SERVED GRILLE ROOM	FCU MAKE	CAPACITY TR	TEMPERATURE DEG. F
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

REMARKS

TEST DATE_____**READINGS BY**_____

FAN TEST REPORT

PROJECT_____

FAN DATA	**FAN NO.**	**FAN NO.**	**FAN NO.**
Location			
Service Manufacturer			
Model No.			
Serial No.			
Type / Class			
Motor Make / Style			
Motor H.P/RPM/ Frame			
Volts/Phase/Cycles F.L			
Amps.			
Motor pully Dia./Bore			
Fan pully Dia./Bore No.			
Belts/ Make/Size Pully			
Distance.			
CFM			
FAN RPM			
S.P IN/OUT			
TOTAL S.P			
Voltage			
Amperage			

REMARKS

TEST DATE_____**READINGS BY**_____

RECTANGULAR DUCT TRAVERSE REPORT

PROJECT_____SYSTEM_____

LOCATION / ZONE_____ACTUAL AIR TEMP._____DUCT S.P_____

DUCT		**REQUIRED**		**ACTUAL**	
SIZE	**SQ.FT.**	**FPM**	**CFM**	**FPM**	**CFM**

POSITION	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1											
2											
3											
VEL1OCITY											
SUBTOTALS											

REMARKS

TEST DATE_____READINGS BY_____

GRILLES AND DIFFUSERS TEST REPORT

PROJECT_____**SYSTEM** _____

OUTLET_____**MANUFACTURER**__

TEST APPARATUS_____

S/N	AREA SERVED	OUT LET NO./TYPE/SIZE	DESIGN CFM/VEL	PRLIMINARY VEL/CFM	FINAL VEL/CFM
1.					
2.					

.

REMARKS

TEST DATE_____**READINGS BY**_____

PAINTING WORK

Application : The original colour of all equipments like water chilling machines, airhandling units etc. which if get damaged during transportation or during installation shall be painted in original shade with the two coat of paint to give a final finish.

All chilled water pipes shall be painted as per standard code of practice and arrows shall be markedto indicate direction of flow of water.

Colour Scheme For The Equipments/ Materials

Description	**Standard Colour & Reference**	**Lettering Colouring**
Exposed Duct Work (other than plant room)	As per E-I-C Directions	As per E-I-CDirections
Air Conditioning Duct Work (Plant Rooms)	BSS 111 Pale Blue	Black
Ventilation Duct Duct Work (Plant Rooms)	BSS 111 Pale Blue	Black
Conditioner Casings Air Handling Units, Filter Plenums	BSS 111 Pale Blue	Black
Electrical (Conduit Ducts and Motors)	BSS 557 Light Orange	Black
Chilled Water Pipe	Jade Green	Black
Drains	Black	White
Vents	White	Black
Fans	BSS 111 Pale Blue	Black
Valves and Pipe Line Fittings	White with black handles	Black
Beltquards	Black and yellow diagonal stripes (45 25mm wide)	
Switchboards- exterior – interior	BS 366 Light Beige	White
Machine Bases, Inertia Bases andPlinths	Charcoal	Grey
Chilling M/C	As Per Manufacturer's Standard	
Pump-sets	Battle ship grey	
Condenser water pipes	Light green	Black
Electrical panels/sub-panel/ remote control console	Light grey powder coated RAL 7032 as per DIN	
Supports for ducts		Silver

IDENTIFICATION OF SERVICES

General

This section comprises of identification of services for each piece of equipment

Valve Labels and Charts

Each valve shall be provided with a label indicating the service being controlled, together with a reference number corresponding with that shown on the Valve Charts and " as fitted" drawings. The labels shall be made from 3 ply (black / white/ black) Traffolyte material showing white letters and figures on a black background. Labels to be tied to each valve with chromium plated linked chain. The labels shall be suitable for minimum 40 characters with font size of 24 minimum. Labelling scheme of each equipment to be submitted for approval from The Employer / Consultant.

A wall mounted, glass covered plan to the endorsement of the The Employer/ Consultant 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. All AC equipments shall be provided with permanent mounted identification labels and unique tagging numbers. The shop drawings shall also include these tagging numbers for easy identification on site. It shall be co-ordinated with BMS also to ensure consistent equipment tagging among drawings, BMS display and siteinstallation.

Identification of Services

Pipe work and duct work shall be identified by colour bands 150 mm. wide or colour triangles of at least 150 mm. / side. The bands of triangles shall be applied at termination points, junctions, entries and exits of plant rooms, walls, in ceiling spaces, ducts and control points to readily identify the service, but spacing shall not exceed 4.0 metres.

Pipe Work Services

For pipe work services and its insulation the colours of the bands shall comply with BS.1710: 1971.Basic colours for pipe line identification:

Pipe Line Contents	BS. 4800 Colour Reference	Colour
Water	12 D 45	Green
Steam	10 A 03	Grey
Oils	06 C 39	Brown

Gas	08 C 35	Yellow / Brown
Pipe Line Contents	BS. 4800 Colour Reference	Colour
Air	20 E 51	Blue
Drainage	00 E 53	Black
Electrical	06 E 51	Orange

Colour code indicator bands shall be applied as colour bands over the basic identification colour in the various combinations as listed below :-

Pipe Line Contents	**Colour Bands to BS. 4800**
Water Services :	
Cooling	00 E 55
Fresh / 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 Line Contents	**Colour Bands to BS. 4800**
Central Heating Services :	
Below 100 Deg. C	18 E 55/04 D 45/18 E 53
Above 100 Deg. C	04 D 45/18 E 53 /04 D 45
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
Hydraulic Power	04 C 33
Sea / River Untreated	Basic Colour only
Fire Extinguishing	04 E 53
Steam Services :	Basic Colour only
Air : Compressed	Basic Colour only
Vacuum	White
Town Gas : Manufactured	14 E 53
Natural	10 E 53
Oils :	
Diesel	00 E 55
Lubricating	14 E 53
Hydraulic Power	04 C 53
Transformer	04 D 45

Drainage and other fluids :	Basic Colour only
Electrical Services :	Basic Colour only

In addition to the colour bands specified above all pipe work shall be legibly marked with black or white letters to indicate the type of service and the direction of flow, identified as follows:-

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 letters F and R added to indicate flow and return respectively as well as directional arrows.

Duct Work Services :

For Duct work services and its insulation the colours of the triangles shall comply with BS.1710 : 1971. The size of the symbol will depend on the size of the duct and the viewing distance but the minimum size shall not be less than 150 mm. length per side. One apex of the triangle shall point in the direction of airflow.

Services	**Colour**	**BS.4800 Colour Reference**
Conditioned Air	Red and Blue	04 E 53 / 18 E 53
Ward Air	Yellow	10 E 53
Outdoor air	Green	14 E 53
Exhaust / Extract / Recirculated Air	Grey	AA 0 09
Foul Air	Brown	06 C 39
Dual Duct System Hot Supply Air	Red	04 E 53
Cold Supply Air	Blue	18 E 53

In addition to the colour triangles specified above all duct work shall be legibly marked with black or white letters to indicate the type of service, identified as follows:-

Supply Air	S

Return Air	R
Outdoor Air	O
Exhaust Air	E
Smoke Extract Duct	M
Spill Air	A

The colour banding and triangles shall be manufactured from self adhesive cellulose tape, laminated with a layer of transparent ethyl cellulose tape.

NOISE & VIBRATION CONTROL

Standards

The testing of all noise control equipment and the methods used in measuring the noise rating of air conditioning plant and equipment shall be in accordance with the relevant sections of the following British Standards, unless otherwise stated:

BS 4718: 1971	Methods of Test of Silencers for Air Distribution Systems
BS 2750:	Laboratory and Field Measurement of Airborne Sound
Parts 1-9:1980	Insulation of Various Building Elements
	Recommendations for Field Laboratory Measurement of Airborne and Impact Sound Transmission in Buildings
BS 3638: 1987	Methods of Measurement of Sound Adsorption in a Reverberation Room
BS 4773:	Acoustic Testing.
Part 2: 1976	
BS 4856:	Acoustic performance without additional ducting of forced
Part 2: 1976	fan convection equipment.
Part 5: 1976	Acoustic performance with additional ducting of forced fan convection equipment
BS 4857:	Acoustic Testing and Rating of High Pressure Terminal
Par 2:1978 (1983)	Reheat Units.
BS 4954:	Acoustic Testing and Rating of Induction Units.
Par 2:1978 (1987)	
BS 5643:	1984 Glossary of Refrigeration, Heating, Ventilating and Air Conditioning Terms

General

The air conditioning Contractor must take all necessary precautions to have minimum noise generation and its transmission generated by moving plant and equipment to achieve acceptable limits for occupied areas. In addition to the noise level criteria particular attention must be given to the following details at time of ordering plant and equipment and their installation :-

- All moving plant / equipment shall be statically and dynamically balanced at manufacturersworks and certificates issued.

- The isolation of moving plant, machinery and apparatus including lines equipment from thebuilding structure.
- Where duct work and pipe work services pass through walls, floors and ceilings, or wherever supported shall be surrounded with a resilient acoustic absorbing material to prevent contact with the structure and minimize the outbreak of noise from plant rooms.
- The reduction of noise breakout from plant rooms and the selection of externally mounted equipment and plant to meet ambient noise level requirements of the Specifications.
- Electrical conduits and connections to all moving plant and equipment shall be carried out in flexible conduit and cables to prevent the transmission of vibration to the structure and nullify the provisions of anti-vibration mountings.
- All duct connections to fans shall incorporate flexible connections, except in cases where these are fitted integral within air handling units.
- 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.
- Where practicable, attenuators shall be built into walls and floors to prevent the flanking of noise the duct work systems and their penetrations sealed in the manner previously described. Where this is not feasible, the exposed surface of the duct work between the attenuators and the wall subjected to noise infiltration shall be acoustically clad as specified.
- Ambient noise from cooling tower also shall be assessed to determine the suitable attenuators that can reduce the noise so as not affecting the adjoining public area.

Sound Attenuators

Attenuators shall be provided in ducts in accordance with acceptable noise level criteria. Attenuators shall be constructed from high quality pre-galvanised steel sheet casings with lock formed joints along the casing length. Angle iron cross jointing flanges shall be fitted to silencer casings, drilled as required and finished with red oxide primer paint. Acoustic splitters shall be formed by chancel section pre-galvanised sheet steel framework retaining acoustic fill of a densityto attain the required performance. Splitters shall have round Nos., ends to give smooth entry andexit conditions to minimise air pressure drops. The acoustic fill shall be protected from the air flow by 22 swg minimum perforated galvanized sheet steel. All attenuators shall be selected against a maximum allowable air pressure drop of 100 Pa. It will be the responsibility of the AC Contractor at the time of placing orders for fan equipment to obtain from the manufacturers, certified sound power levels to enable the selected duct silencers to be checked against the original design information, prior to orders being placed.

Anti-vibration Mountings.

All items of rotating and reciprocating plant and equipment shall be isolated from the structure by the use of anti-vibration pads or mounts with provision of machine levelling arrangement made up of (mixedcellular polyurethane), air handling units fixed on a frame shall be isolated by anti-

vibration mountings made up of (mixedcellular polyurethane), shall incorporate machine levelling arrangement and eliminating need of grouting. Fan discharge air connections shall be fitted with approved flexible connections. Axial flow fans shall be mounted on steel legs as diaphragm plates supported on anti-vibration mounts made up of (mixedcellular polyurethane) or suspended using spring loaded hangers to suite the application. Centrifugal pumps shall be mounted on inertia bases consisting of reinforced concrete sub-base, anti-vibration mountings made up of (mixedcellular polyurethane) and concrete filled steel upper plinth. The AC Contractor shall be responsible for providing the steel upper plinth and mountings. Pipe work connections to circulating pumps, chillers, cooler coils and other heat exchanger equipment shall be made with flexible connections as per piping Specifications. The construction of the anti-vibration mountings shall generally comply with the following: - anti-vibration mountings made up of (mixedcellular polyurethane), shall incorporate machine levelling arrangement and eliminate need of grouting, as the principle isolation elements, The manufacturers shall provide anti-vibration mountings made up of (mixedcellular polyurethane), shall incorporate machine levelling arrangement and eliminate need of grouting on chillers/Cooling Towers/Pumps/Air handling units/ TFA/Airwasher/Scrubber/Fansetc. subject to approval.

Inertia Bases For Pumps

The inertia base shall be an all welded mild steel channel frame the minimum depth of which shallbe 1/12 of the longest span between isolator but not less than 150 mm. filled with concrete the density of which shall be 2300 kg/m3.

The inertia base shall be sufficiently large to provide support for all parts of the equipment, including any component, which overhands the equipment base, such as suction, and discharge elbows on centrifugal pumps.

The frame shall include pre-located equipment anchor bolts fixed into position and housed in a steel sleeve allowing minor bolt location adjustment.

Isolator support brackets shall be welded into the corners of the base and suitably reenforced for the load of the equipment and base.

Additional reinforcing roads shall be provided at 200 mm. centres to ensure the concrete and frameis adequately stiffened against distortion.

Reference Design Standard

Following standard & guidelines shall be adopted while designing the HVAC System.

i) National Building Code of India (NBC 20016) with latest revision.
ii) Energy Conservation Building Code (ECBC 2007) or latest
iii) ASHRAE latest Hand Books.
a) Fundamentals
b) HVAC Systems and Equipment

c) HVAC Applications
d) Refrigeration
e) HVAC Design Guidelines for Health Care Facilities ASHRAE Standard 170.
iv) Duct construction standards as per relevant latest BIS codes & SMACNA standards.
v) Air filters as per ASHRAE 52.1-1992 or latest and 52.2-2007 or latest
vi) Indoor Air quality as per ASHRAE 62.1-2010 or latest
vii) Motors, Cabling, Wiring and accessories as per latest BIScodes.
viii) National Electric Codes (NEC) latest version ix) ANSI / ASHRAE / IESNA standard 90.1-2009 or latest: Energy standard for building except low rise residential buildings.
ix) ASHRAE standard 55: Thermal Comfort.

BIS Code & Guidelines

Followings are the few list of Bureau of Indian Standards Codes forguidelines.

IS : 277 - 1992	Galvanized steel sheet (Plain & Corrugated) wire for fencing.
IS : 554 - 1985 (Reaffirmed 1996)	Dimensions for pipe threads where pressure tight joints are required on the threads.
IS : 655 - 1963 (Reaffirmed 1991)	Metal air ducts.
IS : 659 – 1964 (Reaffirmed 1991)	Air conditioning (Safety Code)
IS : 660 – 1963 (Reaffirmed 1991)	Mechanical Refrigeration (Safety Code)
IS : 694 - 1990 (Reaffirmed 1994)	PVC insulated (HD) electric Cables for working voltage unto and including 1100 volts.
IS : 732 - 1989	Code of practice for electrical wiring.
IS : 780 - 1984	Sluice valves for water works purposes.
IS : 822-1970 (Reaffirmed 1991)	Code of procedure for inspection of welds.
IS : 1239 (Part - I) - 1990	Mild steel tube
IS : 1239 (Part - II) - 1992	Mild steel Tubulars and other wrought steel pipe fittings.
IS : 1255 - 1983	Code of Practice for installation and maintenance of Power Cables unto and including 33 KV rating (Second Revision)

IS : 1554 - 1988 (Part – I)	PVC insulated (Heavy Duty) electric cables for working voltages unto and including 1100 volts.
IS : 1897 – 1983 (Reaffirmed 1991)	Copper bus bar / strip for electrical purposes
IS : 2379 - 1990	Colour code for the identification of Pipelines.
IS : 2551 - 1982	Danger notice plate
IS : 3043 - 1987	Code of practice for earthing.
IS : 3103 – 1975 (Reaffirmed 1999)	Code of practice for Industrial Ventilation.
IS : 3837 – 1976 (Reaffirmed 1990)	Accessories for rigid steel conduit for electrical wiring.
IS : 4736 – 1986 (Reaffirmed 1998)	Hot-dip zinc coatings on steel tubes.
IS : 4894 - 1987	Centrifugal Fan.
IS : 5133 - 1969 (Part-I)	Boxes for the enclosure of electrical (Reaffirmed 1990) accessories.
IS : 5216 - 1982	Guide for safety procedure and practices (Part-I) (Reaffirmed 1990) in electrical work.
IS : 5312 (Part-I) - 1984	Swing - check type reflux non (Reaffirmed 1990) return valves for water works
IS : 5424 – 1989 (Reaffirmed 1994)	Rubber mats for electrical purposes.
IS : 5578 & 11353-1985	Marking and identification of conductors
IS : 6392 – 1971 (Reaffirmed 1988)	Steel pipe flanges.
IS : 8623 - 1993	Low voltage switchgear and control gear assemblies (Requirement for type / partly type tested assemblies)
IS : 8623 - 1993	Bus Bar trunking system (Part - II)
IS : 8828 - 1996	Circuit Breakers for over current protection for house hold and similar installation.
IS : 9537 – 1981 (Part II)	Rigid Steel Conduits for electrical wiring
IS : 10810 - 1988	Methods of test for cables.
IS : 13947-1993 (Part-I)	General rules for low voltage switch gears and control gears.
IS : 13947-1993 (Part-II)	Circuit Breakers IEC 947 - 2
IS : 13947 - 1993 (Part-III)	Switches, disconnectors and fuse for low voltage switch gear and control gear.

IS : 13947 - 1993 (Part-IV)	Low voltage switch gear and control gear for contactors and motor starters
IS : 13947 – 1993 (Part-V)	Control Circuit Devices.
BS : EN:779 – 1993	Filters
IEC	Relevant Sections.
ASTM A-536	Ductile Iron Castings

SAFETY CODES

SCOPE

The scope of this sub-section is the minimum safety requirements to be observed during manufacture and erection of the HVAC system as specified herein in addition to the safety normsgenerally followed:-

I.S. STANDARDS

The safety code for mechanical refrigeration IS: 660 and safety code for air conditioning IS:659 shall be observed.

SAFETY REQUIREMENTS

Some of the important safety requirements are as under but not limited to the same:-

a) There shall be maintained in a readily accessible place, first aid appliances including adequatesupply of sterilized dressings and cotton wool.
b) The injured person shall be taken to a public hospital without loss of time.
c) Suitable and strong scaffolds shall be provided for workmen for all works that cannot be safely done from ground. No portable single ladder shall be over 8 meters in length. The width between side rails shall not be less than 30 cm (clear) and the distance between two adjacent rings shall not be more than 30 cms, when a ladder is used, an extra mazdoor shall be engaged for holding the ladder.
d) The excavated material shall not be placed within 1.5 meters of the edge of the trench or half of the depth of trenches whichever is more. All trenches and excavations shall be provided with necessary fencing and lighting.
e) Every opening in the floor of a building or in a working platform to be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be one meter.
f) No. Floor, roof or other part of the structure shall be so overloaded with debris or material as to render it unsafe.
g) Workers employed on mixing and handling materials such as asphalt, cement mortar or concrete & lime mortar shall be provided with protective footwear and rubber hand gloves.
h) Those engaged in welding works shall be provided with protective eye shields and

glove.

i) No paint containing lead or lead products to be used except in the form of paste or readymade paint.

j) Suitable facemasks shall be supplied for use of workers when the paint is applied in the form of spray or surface having lead paint dry rubbed and scraped.

k) Overalls shall be supplied by the Contractor to the painter and adequate facilities shall be provided to enable the working painter to wash during cessation of the work.

l) The ropes used in hoisting or lowering material or as a means of suspension, shall be of adequate quality and adequate strength and free from defects.

m) All site personnel shall wear safety helmets whenever they are in the construction/ erection areas.

AA. TECHNICAL SCHEDULE OF EQUIPMENT

The capacity/ratings of various equipments in this contract are for guidance purpose only. The Contractor shall check in details the design/selection of equipments. EPC Contractor shall be finally responsible for maintaining the desired inside conditions and shall not deprive him of the responsibility if selection of equipments is not thoroughly checked. in case of shortfall the a/c Contractor shall replace/ modify equipments for achieving desired parameters without any extra cost to EMPLOYER.

1.0	WATER PIPES		
	i. Material	MS	
	ii. Class	'C'	
	iii. Wall Thickness		
	25 MM TO 40 MM	4	
	50 MM TO 65 MM	4.5	
	75 MM	4.8	
	100 MM TO 150 MM	5.4	
	200 MM TO 610 MM	6.35	
2.0	GSS DUCTING		
	i. Class of Galvanizing	VIII (120 GM/SQM)	
	ii. Code of Fabrication	IS - 655 (LATEST)	
	iii. Material of Hangers	MS	
	iv. Quality of Sheet	LFQ	
3.0	INSULATION		
	A) DUCTS		
	i. Material	Closedn Cell Elastomeric Nitrile Butadiene Rubber	

	ii. Density	between 40 to 60 Kg/m3	
	B) ACCOUSTIC LINING		
	i. Material	Nitrile Rubber open cellfoam	
	ii. Density	minimum 140 Kg/m^3	
	C) PIPE INSULATION		
	i. Material	factory insulated with expanded polyurethene foam (PUF)	
	ii. Density	24 KG/CU.M (minimum)	

BB. TEST READINGS

CHILLER TEST REPORT

PROJECT_____

UNIT_____

LOCATION_____

MANUFACTURER_____

MODEL_____SERIAL NO._____

CAPACITY_____REFRIGERANT_____ STARTER _____HEATER SIZE_____

COMPRESSOR	**DESIGN**	**ACTUAL**	**MOTOR STARTER**	**DESIGN**	**ACTUAL**
Make/Model			Make/Model		
Serial No.			Type		
Type(Reciprocating /Centrifugal/ Screw / Scroll)					
Piping Material			Amps		
Suction Pr/Tem			O/L Release Range		
Discharge Pr/Temp					

Refrigerant			EVAPORATOR	DESIGN	ACTUAL
Oil Pump Type			Make/Model		
Oil Pressure			No. of Passes		
Oil Failure Switch Pressure			Ref. Level		
Unload Arrangement			Ref: Pressure/ Temperature		
Unload Set Points			Ent. Water Temp/ Pressure		
Drive			Leaving Water Temp/ Pressure		
Compressor Speed			Temperature Difference		
Oil Level			Pressure Difference		
Oil Temperature			Water Quantity GPM		
L P Setting			Relief Valve Setting		
H P Setting			IKW / Ton		
Anti Freeze Setting					
Purge Unit Type					
Purge Operation Checked					
Make/Model			Make/Model		
Type			No. of Passes		
Voltage			Ref: Pressure/ Temperature		
Motor Rated Current			Ent. Water Temp/Pressure		
COMPRESSORMOTOR	DESIGN	ACTUAL	CONDENSER	DESIGN	ACTUAL
			No. of Fans		

Motor FL Current			Fan Material		
			Fan Diameter		
REMARKS					
TEST DATE _____					
READING BY _____					
Note : Please Furnish test report for all chillers separately.					

PUMP TEST REPORT

PROJECT				
DATA	PUMP NO	PUMP NO	PUMP NO	PUMP NO
Location				
Service				
Manufacturer				
Model Number				
Serial Number				
GPM/Head				
Req. NPSH				
Pump RPM				
Impeller Mfr./Frame				
Motor Mfr./Frame				
Motor HP/RPM				
Volts/Phase/Hertz				
F.L Amps				
Seal Type				
Pump Off-Press				
Valve Shut Diff				
Actual Impeller Dia				
Valve Open differential				
Valve Open GPM				
Final Dischg.Pressure				
Final Suction Pressure				
Final p				
Final GPM				
Voltage				
Amperage				

REMARKS

TEST DATE_____ **READINGS BY**_____

Note : Please Furnish test report for all CHW pumps.

AIR HANDLING EQUIPMENTS TEST REPORT

PROJECT _____SYSTEM / UNIT

LOCATION

UNIT	**DATA**	**MOTOR**	**DATA**
Make/Motor No.		Make / Frame	
Type/Size		H.P / RPM	
Serial Number		Volts/Phase/Cycles	
Arr./Class		F.Lamps.	
Discharge		Pulley Dia/Bore	
Pulley dia/ Bore		Pulley/ Distance	
No. Belts/make/Size			
No.Filters/type.Size (Pre.)			
No.Filters/type.Size (secondary)			

TEST DATA	DESIGN	ACTUAL	TEST DATA	DESIGN	ACTUAL
Total Cfm			Discharge S.P		
Total S.P					
Fan RPM			Cooling Coil S.P		
Motor Volts			Filters S.P		
Out air Cfm					
Return air Cfm					
REMARKS.					
TEST DATE _____					

READINGS BY _____

Note : Please Furnish above report for all AHU.

RECTANGULAR DUCT TRAVERSE REPORT

PROJECT_____SYSTEM_____

LOCATION/ZONE___ACTUAL_____AIR TEMP._____DUCTS.P____

DUCT SIZE_____ SQ.FT._____	REQUIRED FPM_____ CFM ___	ACTUAL FPM_____ CFM_____

1						
2						
3						
4						
5						
6						
7						
VELOCITY SUBTOTALS						

GRILLES AND DIFFUSERS TEST REPORT

PROJECT_____

SYSTEM _____

OUTLET MANUFACTURER _____

TEST APPARATUS _____

REA		OUT LET			DESIGN		INITIAL		FINAL	
SERVED	NO	TYP	SIZE	VEL	CFM	VEL	CFM	VEL	CFM	VEL

REMARKS.

TEST DATE_____**READINGS BY**_____

Note : Please Furnish above report for all grills/diffusers with S.No. marked on respective drawings

MODES OF MEASUREMENTS

THE QUOTED PRICE OF THE VARIOUS ITEMS SHALL INCLUDE THE FOLLOWING:

- All equipments, machinery, apparatus and materials required as well as the cost of any tests which the EMPLOYER may request in addition to the tests generally required to prove quality and performance of the equipments.
- All the labour required supplying and installing the complete installation in accordance withthe specifications.
- Use of any tools, equipments, machinery, lifting tackle, scaffolding, ladders etc. Required bythe Contractor to carry out his work.
- All the necessary measures to prevent the transmission of vibration.
- The necessary material to isolate equipments foundations from the building structure, wherever necessary.Storage and insurance of all equipments apparatus and materials.
- The Contractor's quoted price shall include all equipments, apparatus, material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipments, apparatus, material and labour usual and necessary to make in question on its own (and within the system as a whole) complete even though not specifically shown, described or otherwise referred to.

TRAINING OF THE EMPLOYER'S PERSONNEL

- The Vendor/Contractor shall train the THE EMPLOYER Purchaser's engineering personnel in the shops, where the equipments will be manufactured and or in their collaborator's woks and where possible, in any other plant where equipments manufactured by the
- Vendor/Contractor or his collaborator is under installation or test to enable those personnel to become familiar with the equipments being furnished by the Vendor/Contractor, either at his works or at his Sub-Vendor's/Sub-Contractor's works or at site.
- The period of training shall be adequate and mutually agreed upon by the THE EMPLOYER and the Vendor/Contractor.
- The training shall be so oriented as to make the THE EMPLOYER's personnel proficient in operating the equipments.
- The THE EMPLOYER's personnel shall also be trained for routine maintenance work and lubrication, overhauling, adjustments, testing and replacement procedures to be adopted for the equipments offered.
- The Vendor/Contractor shall train the THE EMPLOYER/EMPLOYER's personnel in carrying out minor repairs, if need arises, during the operation of the equipments.
- The charges for training the THE EMPLOYER/EMPLOYER's personnel, if any, be included in the quoted price for supply of erection, testing and commissioning.

SYSTEM TESTING ADJUSTMENT AND BALANCING

i. SCOPE

a) Testing, adjusting and balancing of heating, ventilating and air-conditioning systems at site.
b) Testing, adjusting and balancing of HVAC Hydronic system at site.
c) Testing, adjusting and balancing of exhaust system at site.

Comply with current editions of all applicable practices, codes, methods of standards prepared bytechnical societies and associations including:

ASHRAE: 1999 HVAC Application

SMACNA: Manual for the Balancing and Adjustment for air distribution System

ii. PERFORMANCE

a) Verify design conformity.
b) Establish fluid flow rates, volumes and operating pressures.
c) Take electrical power readings for each motor.
d) Establish operating sound and vibration levels.
e) Adjust and balance to design parameters
f) Record and report results as per formats specified.

iii. DEFINITIONS

Test: To determine quantitative performance of equipments.

Adjust: To regulate for specified fluid flow rates and air patterns at terminal Equipments (e.g.reduce fan speed, throttling etc.)

Balance: To proportion within distribution system (sub mains, branches and Terminals) in accordance with design quantities.

iv. TESTING, ADJUSTING AND BALANCING (TAB) PROCEDURES

The following procedures shall be directly following in TAB of the total system.

Before commencement of each one of the TAB procedure explained hereunder, the Contractor shall intimate the Employer's Representative about his ready to conduct the TAB procedures in the formatgiven in these specifications.

v. DESCRIPTION OF SYSTEM AND REQUIREMENT

Adjust and balance the following system to provide most energy efficient operation compatible with selected operating conditions.

- All supply, return and outside air systems.
- All exhaust air systems
- All chilled water systems.
- All cooling tower (condenser) water systems.
- Emergency purge systems

vi. AIR SYSTEMS

a) Air Handlers Performance

The TAB procedure shall establish the right selection and performance of the AHUs with the following results.

- Inlet air Dry and Wet bulb temperatures.
- Outlet air Dry and Wet bulb temperatures.
- Air leaving dew point temperature
- Sensible heat Pickup
- Latent heat Pickup
- Sensible hat factor

b) Air distribution

Both supply and return air distribution for each AHU and for areas served by the AHU shall be determined and adjusted as necessary to provide design air quantities. It shall cover balancing of air through main and branch ducts utilizing telescoping probes of Electronic Rotating Vane Anemometers and Accubalance for grilles and diffusers.

c) The Preparatory work

To conduct the above test, following preparatory works are required to be carried out including the availability of approved for construction shop drawings and submittals.

All outside air intake return air and exhaust air dampers are in proper position. All system volume dampers and fire dampers are in full open position.

All access doors are installed & are airtight. Grilles are installed & dampers are fully open.

Provision and accessibility of usage of TAB instruments for transverse measurements are available.

All windows, doors are in position.

Duct system is of proper construction and is equipped with turning vanes and joints are sealed.

vii. HYDRONIC SYSTEM BALANCING

The Hydronic system shall involve the checking and balancing of all water pumps. Piping network (main & branches), the heat exchange equipments like cooling and heating coils, condensers andchillers and cooling towers in order to provide design water flows.

The essential preparation work, must be done by the HVAC Contractor prior to actual testing, adjusting and balancing of HVAC system and ensure following:

a. Availability of co-ordinate drawings and approved submittals and system sketch with designwater flows specified thereon.
b. Hydronic system is free of leaks, is hydrostatically tested and is thoroughly cleaned, flushedand refilled.
c. Hydronic system is vented.
d. The Contractor shall confirm completion of the basic procedures and prepare checklists for readiness of system balance.

e. Check pumps operation for proper rotation and motor current drawn etc.
f. Confirmthat provisions for TAB measurements (Temperature, pressure and flow measurements) have been made.
g. Open all shut-off valves and automatic control valves to provide full flow through coils. Set all balancing valves in the preset position, if these values are known. If not, shut all riser balancingvalves except the one intended to be balanced first.
h. Balancing work for both Chilled Water System and Condenser Water System shall be carriedout in a professional manner and test reports in the specified format shall be prepared and presented to the EMPLOYER / Employer's Representative for approval.

viii. READINESS FOR COMMENCEMENT OF TAB

Prior to commencement of any test, the readiness to do so shall be recorded as per the prescribedchecklist.

ix. TAB INSTRUMENTS

i. Air measuring Instruments

For measuring DB and WB temperature, RH and dew point, microprocessor, suitableinstrument shall be used. This instrument shall be capable of calculating the sensible, latent total heat flows, sensible heat factor and give printouts at site and have data logging/downloading facility.

For measuring Air velocity, DB temperature and Air volume, suitable instrument shall be used. It shall be able to provide instant print out of recorded Air Volume readings.

Pitot tube.

Electronic Rotary Vane Anemometer.

Accubalance Flow Measuring Hood.

ii. Hydronic Measuring Instruments

For measurement of water flow differential pressure and temperature, The instrument shall have a built-in-microcomputer capable of giving readings for pressure differential flow rate and temperature.

iii. Rotation Measuring InstrumentElectronic Digital Tachometer
iv. Temperature& RH Measuring Instrument
v. Electrical Measuring Devices
- Clamp on Volt ammeter
- Continuity Meter

vi. Vibration and Noise Levels

Vibration and alignment field measurements shall be taken for each circulating water pump, waterchilling unit, air handling unit and fan driven by a motor over 10 HP. Readings shall include shaft alignment, equipments vibration, bearing housing vibration, and other test as directed by the Employer's Representative.

Sound level readings shall be taken at ten (10) locations in the building as selected by the Employer's Representative. The readings shall be taken on an Octave Band Analyzer in a manner acceptable to him. The Contractor shall submit test equipments data and reporting forms for review. In order toreduce the ambient noise level the readings shall be taken at night. All tests shall be performed in the presence of EMPLOYER / Employer's Representative.

LIST OF BUREAUS OF INDIAN STANDARD CODES

IS 1239 (Part– I) 1979	Mild Steel Tube
IS 1239 (Part – I) 1982	Mild Steel Tubular and Other Wrought Steel PipeFittings
IS 4736 – 1986 (Reaffirmed)	Hot Dip Zinc Coatings of Steel Tubes
IS 823-1964	Code of Procedure For Manual Metal Arc Welding of Mild Steel
IS 780-1984	Service Valves For Water Works Purpose
IS 778-1980	Copper Alloy Gate, Globe and Check Valves For Water Works Purpose
IS 1536-1976	Flanges Configuration
IS 5312 (Part –I) 1984	Swing Check Type Reflux Non Return Valves ForWater Works
IS 2379-1963	Color Code For Identification of Pipelines
IS 554-1975	Dimension For Pipe Thread Where Pressure TightJoints Are Required On Threads
IS 655-1963 (Reaffirmed 1991)	Metal Air Ducts
IS 277-1992	Galvanized Steel Sheet For Fencing
IS 4064 Part II-1978	Specific Requirements For Direct Switches of Individual Motors
IS 3854-1969	Switches For Domestic & Similar Purpose
IS 732 (Part III-1902)	Inspection and Testing of Installation
IS 659 – 1964 (Reaffirmed 1991)	Air Conditioning Safety Code
IS 660 – 1963 (Reaffirmed 1991)	Mechanical Refrigeration (Safety Code)
IS 4894 – 1991	Test Code For Centrifugal Fan
IS 3103 –1975 (Reaffirmed 1994)	Code of Practice For Industrial Ventilation

IS 7240 – 1981	Application & Finishing of Thermal Insulation Material
IS 325	Specifications For Three Phase Induction Motor
IS 3142 – 1993	V Grooved Pulley
BS-EN-779 – 1993	Particulate Air Filters For General Ventilation
IS 702 – 1988	Industrial Bitumen
IS 8183 – 1993	Bonded Mineral Wool
IS 2494 – 1993	V Belts For Industrial Purposes
IS 2062 – 1992	General Purpose Steel
ASHRAE Hand Books	American society of heating, refrigeration and air conditioning books - Applications 1999 - Fundamentals 1997 - System and equipments 1996 - Indoor air quality 62 – 1999

2.13.29 SPECIFICATIONS FOR ELECTRICAL WORKS

General:

All Electrical works including but not limited to motors, switchgears, power & control/signal cables, earthing, terminations etc. required for various items shall generally be as per specificationsgiven in electrical specifications.

All electric motors shall be suitable for 3 phase, 50 cycles 415 volts a.c. supply.

Control Panel:

- These panels shall be floor/wall mounted, sheet steel clad, modular construction, cubicle design, compartmentalised. These panels shall comprise of incoming & outgoing feeders (circuit breakers, fuse switch units/switch fuse units, contactor starters with overload relays, single phasing preventor etc.
- The panels shall be provided wherever necessary with necessary interlocks designed to prevent incorrect operation and to ensure safety of operating personnel and equipment.
- All feeders are to be operated from the front and they shall be interlocked suitably. Padlocking arrangement and interlock defeating device shall also be provided. Each module shall have separate door and partition plate. The feeder incomer switches shall be interlocking with the doorso that the door can only by opened when switch is in `off' position. The doors and covers shall beprovided with thick gaskets to make it dust tight. All the door covers shall be provided with synthetic rubber gaskets to make it dust tight. Feeder name tags shall be provided.

Contactor Starters:

i. Star Delta Starter

The star delta starter shall be air break automatic contactor starter provided with main contactor, star contactor, delta contactor, timer and automatic change over from start to delta, bimetallic over load relay, operating coil, start/stop push button, single phasing preventor, auxiliary make and break contacts, indicating lamps etc. The contactor shall quick make, quick break, double break consisting of robust silver contacts. The coil voltage shall be 415 volts ac at 50 hz. The starter shall be provided with trip indication light and overload reset push button for overload relay.

ii. DOL Contactor Starter

The contactor shall be air break type coil operate, dol Contractor starter, provides with cables entries, ambient temperature compensated bimetallic over load relay, single phasing preventor, solenoid coil, start and stop push buttons, 8 auxiliary make and break contacts, indicating lamps etc. The contactors shall be quick make quick make and quick break, double break type consistingof robust silver contacts. The coil voltage shall be 440 volts at 50 c/s. The starter shall be provide with trip indication light and over load reset bush button for overload relay.

Squirrel Cage Induction Motors:

- The motor shall be of well tried out and design and of reputed make. The motors provided on the equipment shall conform to IS:325 in general. The motors shall be squirrel cage indication motors rates for operation at 415 volts, 3 phase, 50 hza.c. supply. The motor for various equipments shall have the following enclosure level.
  a) Cooling tower & exhaust blower - IP:55(tefc)
  b) Compressor and A.H.U. motor-IP:55(TEFC).
  c) Pumps IP:55(TEFC/SPDP).

- The horse power and speed of the motor shall match that of driven equipment and the motor shall be suitable for star delta starting or direct on line starting with class `3' insulation. The motors of 10 HP and above shall be suitable for star delta starting and below 10 H.P suitable for DOL starting. The compressor motor shall be provided with automatic star delta starter

  The console shall contain on/off push bottons and indication lamps for all the items as required. Indicating light for strip heaters, if any shall be provided on the switch board, in the respective unit room.

  The requirements given for the main panel are for one unit only. The actual number of switches and lights shall correspond to the number of units being installed. All controls and alarms shall besuitable for 230 volts on the panel.

  The alarms shall be with reset buttons.

  All controls circuits shall be functionally tested.

  The red indicating lamps shall switch on only in case of fault. Thus, the red light shall come on in case of tripping of starter on overload or single phasing.

  A common alarm shall be connected to all red indicating lamps through individual relays.Lamp testing arrangements shall be provided in console.

  All the airconditioningequipments shall be interlocked in sequence for safe and trouble freeoperations of the plant. Following shall be the sequence of operation.

- Airhandling units
- Chilled / condenser water pumps
- Water chilling units.

During switch off operations the sequence shall be reverse.

- For winter heating the following shall be the sequence of operations
- Airhandling unit
- Hot water pumps.
- Hot Water Generator/Boiler

During switch of operations the sequence shall be reverse.

2.14 FIRE FIGHTING

2.14.1 STANDARDS & CODES

Latest CPWD specification shall be followed for the Firefighting works.

The following standards, bye-law, manual has been followed in designing the firefighting system:

a) National Building code 2016 Part IV for fire Protection System .
b) Pumps, Valves and Accessories shall be preferably UL listed and FM approved.
c) CPWD General Specifications for Electrical Works-part V (Wet Riser & Sprinkler System-2006).
d) NFPA/UL/FM certifications & TAC for guidance.
e) Relevant IS codes published by Bureau of Indian Standards.

DESCRIPTION		**IS CODE**
Specifications for GI / MS Pipes	:	IS-1239 / IS3589
Specifications for Gun metal gate, globe and check valves for general purpose.	:	IS778
Specifications for Butterfly valve	:	IS:13095
Specifications for unlined flax canvas hose for firefighting	:	IS-4927
Specifications for branch pipes fire hose coupling and auxiliary equipment's	:	IS-903
Specifications for hydrant landing valves	:	IS-5290
Method of measuring of building & civil Engg. works (Water supply, plumbing drain & sanitary fittings)	:	IS-1200
Recommended practice for radio graphic Inspection of fusion welded butt joints in steel Pipes	:	IS-4853
Specification for non-percolating flexible firefighting delivery hose	:	IS-636
Specification for painting	:	IS-5
Specification for Code for acceptance tests for centrifugal, mixed flow and axial pumps—class c	:	IS-9137
Controlled percolating hose for fire fighting	:	IS-8423
Specification for branch pipe, universal for fire fighting purposes	:	IS-2871
Specification for first-aid hose reel for fire fighting	:	IS-884
Selection, installation and maintenance of first-aid fire extinguishers - code of practice	:	IS-2190
Portable fire extinguishers - performance and construction - specification	:	IS-15683
Specification for washers for water fittings for fire fighting purposes.	:	IS-937
Specification for automatic sprinkler heads	:	IS-9972
Dry chemical powder type fire extinguisher	:	IS-2171
Water type CO2 fire extinguisher	:	IS-940

DESCRIPTION		IS CODE
Carbon-di-oxide type fire extinguisher	:	IS-2878
Selection, installation and maintenance of automatic fire· detection and alarm system code of practice	:	IS-2189
Copper wire	:	IS-694
Specification for elastomer insulated cables	:	IS-9968
Specification for PVC insulated (heavy duty) electric cables	:	IS-1554
Paint shade for main equipment's/accessories	:	Shade No.536 of IS-5
Water Mist System	:	IS 15519
Code of practice for fire safety of buildings (general): electrical installations	:	IS 1646

2.15 MEDICAL GAS PIPELINE SYSTEM

2.15.1 OXYGEN SUPPLY SYSTEM

A. Fully Automatic Oxygen Control Panel

- Automatic control panel shall be constructed in accordance with the requirement of international standards. The fully automatic oxygen control panel shall comply with HTM 02-01/NFPA 99C/ DIN / EN / ISO-7396-1 standards.
- The manifold assembly shall provide two stages of pressure regulation. A single stage primary regulator, one for each cylinder bank shall be used to initially reduce cylinder pressure and two single stage pressure regulators shall be provided in the control cabinet for final delivery pressure regulation. One delivery pressure regulator in service and one shall be ready for service in a standby mode.The Manifold control panel shall be with digital display, fully automatic type and switches from “Bank in Use” to “Reserve bank “ without fluctuation in delivery supply line pressure. Changeover shall be performed by electrically/pneumatically operated valves contained in the control cabinet. In the event of an electrical power failure the valves shall automatically open to provide an uninterrupted gas flow. It shall be
- 100% automatic and shall not require manual adjustment.
- Indication for changing the cylinders shall be clearly identified on the front of the control panel.
- All functional components shall be enclosed in corrosion resistant robust material.
- All components inside the Control Panel like Pressure Regulators, piping and control switching equipment shall be cleaned for Oxygen Service and installed inside the cabinet to minimize tampering with the regulators or switch settings.
- The Control Panel shall include two pressure relief valves, one high pressure approx. 200/350psi and one low pressure approx.75 psi.
- The heavy duty control panel shall be provided with a flow capacity of 1500 or more LPM at 50 to 60 psi.
- The Automatic Control Panel shall be installed in such a way to meet the peak flow requirement of the Hospital/Institute.
- Control panel shall have Alarm reset switch/Mute /acknowledgement switch to control and monitor the alarm indications by the operator.

B. Oxygen Manifold Supply System (without Cylinders)

- The designed size of Manifolds shall be compatible with Class-D type bulk cylinders.
- Manifold shall consist of two high pressure header bar assemblies to facilitate connection of primary and secondary cylinder supplies. Each header bar shall be provided with respective numbers of cylinder pigtail connections to suit cylinder valves as per IS.3224/ BS/ ASME incorporating a check valve at the header connection.
- Each header bar assembly shall be provided with a high pressure shut off valve. Oxygen Manifold shall consist of 2 rows of respective numbers of class

D- type bulk oxygen cylinders. The manifold shall be hydraulically tested to 3500 psig. The manifold shall be so designed that it shall suit easy cylinder changing and positioning. The system shall have non – return valves for easy changing of cylinders without closing the bank. The cylinder shall be placed with the help of cylinder brackets and fixing chains which shall be galvanized.

C. Emergency Oxygen Manifold (without Cylinders)

- The designed size of Manifolds shall be compatible with Class-D type bulk cylinders.
- Manifold shall consist of two high pressure header bar assemblies to facilitate connection of respective numbers of primary and secondary cylinder supplies. Each header bar shall be provided with respective numbers of cylinder pigtail connections to suit cylinder valves as per IS.3224/ BS/ ASME incorporating a check valve at the header connection. Each header bar assembly shall be provided with a high pressure shut off valve.
- Oxygen Manifold shall consist of 2 rows of respective numbers of class D-type bulk oxygen cylinders. The manifold shall be hydraulically tested to 3500 psig. The manifold shall be so designed that it shall suit easy cylinder changing and positioning. The system shall have non – return valves for easy changing of cylinders without closing the bank. The cylinder shall be placed with the help of cylinder brackets and fixing chains which shall be galvanized.

D. Oxygen Flow meter with Humidifier Bottle

Back Pressure Compensated flow meter for accurate gas flow measurement with following features:

- Control within a range of 0-15 LPM.
- It shall meet strict precision and durability standard.
- The flow meter body shall be made of brass chrome plated materials.
- The flow tube and shroud components shall be made of clear, impact resistant polycarbonate.
- Flow tube shall have large and expanded 0-15 LPM range for improved readability at low flows.
- Inlet filter of stainless steel wire mesh to prevent entry of foreign particles
- The humidifier bottle is made of unbreakable & reusable polycarbonate/ polysulfone material autoclavable at 121 degree centigrade.
- Humidifier Bottle shall be covered under warranty & CMC.
- It shall comply with HTM 02-01/NFPA 99C/DIN/EN/ISO-7396-1 standards and bidder shall submit applicable certificates along with the bid"

2.15.2 <u>NITROUS OXIDE SYSTEM</u>

A. Fully Automatic Nitrous Oxide Control Panel

- The fully automatic N2O control panel shall comply with HTM 02-01/ NFPA 99 C/EN /DIN /ISO 7396-1 STANDARD.
- The manifold assembly shall provide two stages of pressure regulation. A single stage primary regulator, one for each cylinder bank shall be used to

initially reduce cylinder pressure and two single stage pressure regulators shall be provided in the control cabinet for final delivery pressure regulation. One delivery pressure regulator in service and one shall be ready for service in a Standby mode.

- The Manifold control panel shall be digital, fully automatic type and switches from “Bank in Use” to “Reserve bank “ without fluctuation in delivery supply line pressure. Changeover shall be performed by electrically/pneumatically operated valves contained in the control cabinet. In the event of an electrical power failure the valves shall automatically open to provide an uninterrupted gas flow. The manifold shall not require any manual resetting or adjustments after the replacements of the depleted cylinders.
- The Control Panel shall include two pressure relief valves, one high pressure approx. 200psi and one low pressure approx.75 psi.
- The control panel shall also have heaters to prevent ice formation on the regulators at high flow rates.
- The Control Panel shall be made to provide Heavy Duty and have a flow capacity of 500 LPM or more at 50 to 60 psi.
- The Automatic Control Panel shall be installed in such a way to meet the peak flow requirement of the Hospital/ Institute
- Control panel shall have Alarm reset switch/ Mute/ acknowledgement switch to control and monitor the alarm indications by the operator.

B. Nitrous Oxide Manifold (Without Cylinders)

- The designed size of Manifolds shall be compatible with Class-D type bulk cylinders.
- Manifold shall consist of two high-pressure header bar assemblies to facilitate connection of primary and secondary cylinder supplies.
- Each header bar shall be provided with respective number of cylinder pigtail connections to suit cylinder valves as per IS.3224/ BS/ ASME incorporating a check valve at the header connection.
- Each header bar assembly shall be provided with a high pressure shut off valve. The manifold shall be hydraulically tested to 3500 psi.
- The manifold shall be so designed that it shall suit easy cylinder changing and positioning.
- The cylinder shall be locked with the help of cylinder brackets and fixing chains which shall be galvanized.

C. Emergency N2O Manifold (Without Cylinders)

- The designed size of Manifolds shall be compatible with Class-D type bulk cylinders.
- Manifold shall consist of two high-pressure header bar assemblies to facilitate connection of primary and secondary cylinder supplies.
- Each header bar shall be provided with respective numbers of cylinder pigtail connections to suit cylinder valves as per IS 3224/ BS/ ASME incorporating a check valve at the header connection.

- Each header bar assembly shall be provided with a high pressure shut off valve. Nitrous oxide manifold shall consist of 2 rows of respective numbers of cylinders.
- The manifold shall be hydraulically tested to 3500 psi.
- The manifold shall be so designed that it shall suit easy cylinder changing and positioning.
- The system shall have non – return valves for easy changing of cylinders without closing the bank. The cylinder shall be placed with the help of cylinder brackets and fixing chains which shall be galvanized.

D. Medical and Surgical Air System (Package Unit) - Tolerance of +/-5% is acceptable on plant flow capacity
   - Air-cooled Oil-Less compressors for continuous duty application with highest output of compressed air, low power consumption and very low vibration resulting in low noise level.
   - The medical air plant shall fully comply with the requirements of the HTM 02-01/NFPA 99 C/EN/DIN/ISO 7396-1.

E. Air Compressor Modules
   - It shall be Oil-Less Screw Compressors to produces the plant output as per the approved design and same capacity shall be provided as standby.
   - Medical quality air shall be delivered at a nominal pressure of 400 kPa (4 bar) and 700 kPa (7 bar) gauge for supply of the hospital medical air and surgical air.
   - Compressor plant shall be designed in such a way that compressors will switch on in a sequential manner as per flow demand.
   - The compressors shall be standalone ones with independent power supply.
   - Each Compressor shall be suitable for both continuous and frequent start/stop operation at a nominal plant pressure of 10bar or more.
   - The duty compressors shall be automatically rotated by the plant control system to ensure even wear. Compressors shall be supplied and installed. Desiccant dryer shall be provided with a dew point sensing switch that shall provide an alarm on the plant control panel a when the water concentration in the delivered air rises above the limit. Duplex desiccant dryer and filtration modules shall be provided with three or more individual stages of filtration as follows:
     - Stage 1: Coalescing filter upstream of the desiccant dryer for removing liquid water particles down to 1micron.
     - Stage 2: Particulate filter after the desiccant dryer for dust protection and removing particles down to 1 micron.
     - Stage 3: Bacteria filter for removing particles down to 0.01 micron.
   - Purity shall be tested as per the American Pharmacopeia / European Pharmacopeia standard.
   - The plant control and power management system shall monitor the safe operation of the plant, providing signal into the alarm system as per the requirements of the standard.

- Pressure Reducing Station for 4 bar and 7 bar shall fully comply and meet with the requirements of the standard. Simplex pressure reducing station shall comprise as in- line pressure regulator, with downstream pressure gauge. Isolation valves and pressure release valves shall be provided as per the standard. Duplex pressure reducing station to have two branches, connected to the MGPS in parallel in order to allow maintenance on the components of one branch, while the gas flow is maintained in the other branch.
- Ball Valves - Full bore which operate from fully open to fully closed position with a quarter turn of the handle. Complete pressure reducing station with base plate mounted for ease of installation.
- Padlocks available to allow locking of the valves in both open and closed positions and must have easy to read pressure gauges. Base plate mounted and supplied with copper stub pipes for ease of installation using inert jointing procedures.
- The compressor system shall have-
    i. Intake filter Delivery pipe
    ii. Mounting on air tank along with all standard fittings viz. safety valve, pressure gauge, delivery valve, drain valve etc.
    iii. The Contractor shall provide all electric control panels, starters etc required for proper functioning of motor.
    iv. Desiccant Air Dryer – 2 nos.(Duplex)
    v. 2-Stage or more Breathing Air Filters – 2 sets (Duplex)
    vi. Outlet pressures for drills/equipment and ventilators shall be a minimum of 7 bar and 4 bar respectively.
    vii. Duplex pressure reducing station: The compressor shall be heavy duty, reliable with long MTBF. Each compressor cylinder is to be protected by a temperature switch, which will stop the drive motor and provide an alarm signal in the event of abnormal discharge air temperature. Each compressor module shall include an inline filter with particle retention of 10 microns, inlet isolation valve, discharge isolation valve, and pressure relief valve. The capacity shall be capable to take care of total load of all the outlets.

F. Vertical Air Receiver

- Total air receiver capacity shall be at least 50% of the primary plant capacity (capacity as mentioned in the tender) in 1 minute in terms of free air delivered at normal working pressure. Each air receiver shall be protected by a pressure relief valve, a fusible plug and include a pressure gauge with isolating valve and a drain cock.
- The corrosion resistant coated receiver is to be equipped with tested safety pressure relief valve, sight glass pressure gauge, automatic drain, three-valve by-pass and source isolation valve. Shall be fabricated as per ISO/ASME/BS

G. Air Treatment Module

- The air treatment module shall include dual dryers, dual filtration system and a dew point transmitter with local audible and visual signals and dry contacts for remote monitoring. The components shall be mounted on a common base

with interconnecting copper/ brass piping and upstream and downstream isolation valves.

- The isolation valves must allow either set of components to be serviced without shutting down the system.
- Dryers shall be of heatless desiccant design and sized to provide for the peak calculated demand. The desiccant dryers shall be equipped with dew point dependent switching feature to minimize the need for purge air.
- The dual filtration system shall remove liquid and particulate matter, consisting of 0.5micron coalescing filters with differential pressure indicators and automatic drain, airline pressure regulators with gauges, final pressure relief valve, and sampling valve.
- Each bank shall consist of three stage treatment. Digital dew point monitor is to be supplied with alarm contacts as per requirement of the standard.

H. System Controls

- The “Continuous on Demand” feature will stop the operation of the motors during periods of low or no demand. The control include individual self-protected combination motor controls with short circuit protection, single phase and thermal overload protection, individual control circuit with transformers primary and secondary protection, pressure sensors, temperature switches with reset buttons, and an electronic controller to automatically change the operating sequence of the compressors.
- The cabinet shall have status display to include system pressure, dew point pump operation, accumulated time, maintenance interval, fault conditions, and silence button, lighted Hand-Off-Automatic selector switches and safety disconnect operating handles. All required local alarm functions shall be integrated in to the packaged system.
- The system shall be designed to function even if the programmable controller fails.

I. Accessories

- Accessories including for job site installation such as inlet and discharge flexible connectors, vibration mounting pads, and source isolation valve shall be supplied.
- All the filters shall be covered under warranty period and CAMC Period.

2.15.3 <u>VACUUM SYSTEMS (Package unit)</u>

Vacuum system shall fully comply with the requirements of the HTM 02-01/ NFPA 99 C/EN/DIN/ISO 7396-1.

A. Vacuum Pump Module

- It shall be Oil Sealed Rotary Vane Type to produces the plant output as per the approved design and same capacity shall be provided as standby.
- The vacuum plant shall comprise air-cooled, oil lubricated rotary vane vacuum pumps suitable for both continuous and frequent start/stop operation at inlet vacuum levels between 500mmHg and 660 mmHg.

- The control system shall normally employ automatic rotation of the lead pump to maximize pump life and ensure even wear.
- Vacuum pump inlets shall include a wire mesh filter and integral non-return valve to prevent oil suck back and pressure increases in the vacuum system.
- Each vacuum pump shall be fitted with anti-vibration pads between the pump foot and mounting frame. The plant shall be fitted with duplex bacteria filter system.

B. Vacuum Receiver

- The vacuum receiver shall be made of rust free corrosion resistant steel and fabricated as per ASME/BS/ISO for a vacuum pressure of 760mmHg.
- It shall include bypass valves, manual drain valves, vacuum gauge.
- Vacuum reservoir shall have total volume of at least 100 % of primary plant output (capacity as mentioned in the tender) in one minute in terms of free air aspired at normal working pressure.

C. System Controls

- The control include individual self-protected combination motor controls with short circuit, single phase and thermal overload protection, individual control circuit transformers with fuse less/ fused primary and secondary protection, pressure sensors, temperature switches with reset buttons, and an electronic controller to automatically change the operating sequence of the compressors.
- The system shall have a status display to show the system pressure, elapsed time, maintenance interval, fault conditions, and silence button, lighted Hand-Off-Automatic selector switches and safety disconnect operating handles.
- All required local alarm functions shall be integrated into the packaged system.
- The circuitry shall be designed so that the audible signal can be silenced and the visual indicator will remain until the fault has been cleared and the reset button resets. Local alarm functions shall be annunciate for reserve pump.

D. Bacterial Filters

- The filters shall be designed for removal of solid, liquid and bacterial contamination from the suction side of vacuum pump systems, preventing damage to the pump and the potential biological infection of the surrounding environment.
- The dryer shall be particulate filter dryer with ability to remove particles as small as 1micron.
- Each individual filter shall have the capacity to deliver full design flow such that one set is designated duty and the other will be standby.
- Bacteria filters shall have efficiency at least 99.999% when tested by the sodium flame method in accordance with BS 3928:1969/as per required standard utilising particles in the 0.02 to 2 micron size range.
- The pressure drop across each clean filter at 50% of the system design flow shall not exceed 25 mm Hg (3 kPa) at a vacuum of 475mm of Hg (63 kPa).

- Bacteria filters shall be marked with the legend ‘Bio-Hazard’.
- Each bacteria filter shall be provided with a transparent sterilizable collection jar to collect condensate.
- The total water capacity of the pressure vessels shall be at least 100% of the design flow rate of the plant in 1 minute in terms of free air aspired.

E. Accessories

- Accessories included for job site installation are inlet and discharge flexible connectors, vibration mounting pads, and source isolation valve, inlet check valve, thermal malfunction switch and vacuum control switch.
- Flexible connectors on inlet and exhaust of each pump, exhaust tee with union as well as copper tubing with Shutoff- cock for gauge/bypass valve and vacuum switch etc.
- All the filters shall be covered under warranty period and CAMC Period.

F. Ward Vacuum Units

It must consists of the following:-

- 1 no. of Suction Regulator and 1no of 1000 ml polysulfone /polycarbonate collection jar.
- Suction regulator shall be supplied with a safety jar, including and antibacterial filter and an anti-overflow safety device. Shall have wide membrane continuous suction controller
- Shall have vacuum levels: 0-750 mm Hg or more
- Shall have vacuum gauge fitted with a protective bumper device.
- Shall have on/off knob allowing for the quick restoration of a readjusted vacuum level.
- Must have central adjustment knob with a color coded for 0 to 750 mm Hg or more. Shall have Polysulfone/ polycarbonate 100cc safety jar, autoclavable at 121º C at 5mins,unbreakable, fitted with an anti-overflow safety device and equipped with antibacterial filter. It shall be totally transparent, to ensure perfect sucked liquid visibility.
- Low flow ward vacuum unit - Shall have vacuum levels: 0-150 mm of Hg +/- 10%

G. Theatre Vacuum unit for OT

It must consist of the following: -

- Suction Regulator and 2nos. 1500ml or more polysulfone/ polycarbonate collection jar and both to be mounted on a trolley.
- Suction regulator shall be supplied with a safety jar, including an anti-bacterial filter and an anti-overflow safety device. Shall have wide membrane continuous suction controller
- Shall have vacuum levels: 0-750 mm of Hg or more
- Shall have vacuum gauge fitted with a protective bumper device.

- Shall have on/off knob allowing for the quick restoration of a readjusted vacuum level.
- Must have central adjustment knob with a color coded for 0-750 mm Hg or more. Shall have polysulfone/ polycarbonate safety jar, autoclavable at 121º C, unbreakable, fitted with an anti-overflow safety device and equipped with antibacterial filter.
- Collection jar shall be totally transparent, to ensure perfect sucked liquid visibility.

H. AGSS (Anesthetic Gas Scavenging System) Plant –

- Anesthetic Gas Scavenging System (AGSS) of minimum 1000LPM as Primary & 1000LPM as Standby.
- AGSS system shall comply with the requirements of the HTM 02-01/ NFPA 99 C/EN/DIN/ISO 7396-1.
- The package shall consist of rotary vane/claw type vacuum pumps (Dry/Oil less only), a control panel, and mounted on a common base frame.
- AGSS pump: AGSS pump shall operate completely dry. Each pump shall be completely air cooled and have absolutely no water requirements. The suitable wiring from OTs to AGSS plant for remote control/suitable reservoir (as aplicable) is the responsibility of the bidder.
- System in-line non-return values shall allow individual pump servicing. Active anesthetic gas scavenging systems shall be designed to safely remove exhaled anesthetic agents from the operating environment and dispose of them to atmosphere from the highest point of the hospital building, thus preventing contamination of the operating department and providing a safe and healthy workspace for the personal.
- AGSS design shall be dependent upon flow rate and pressure drop characteristics of the individual components of systems. It is essential that terminal units, remote controls (If required) and pump units work in synchronized manner after connection of workstation to the AGSS System.
- Installation shall be on roof top/suitable location. Piping, Non-Return-Valves (NRVs), and inlet nozzle shall be suitably placed. Connecting hose suitable to fit with anesthesia workstation shall be provided.

2.15.4 DISTRIBUTION PIPING

A. Piping specifications

- Copper pipe shall be as per standard BS: EN 13348:2008/ ASTM B819 standards, Solid drawn, seamless, deoxidized, non-arsenical, half hard (hard can be accepted only for sizes 54mm or more), tempered and degreased copper pipe conforming to the standard. All copper pipes shall be degreased & delivered capped at both ends. The pipes shall be accompanied with manufacturers test certificate for the physical properties & chemical composition.
- Copper pipe must have reputed third party inspection certificate (Eg. Lloyd's or TUV or SGS).

- Fittings shall be made of copper and suitable for a working Pressure of up to 17bar and especially made for brazed socket type connections. All valves shall be pneumatically tested for twice the working pressure and factory degreased for medical gas service.
- Copper fittings shall comply with EN 1254:1 factory degreased and brazing filler metals shall comply with EN 1044. Fitting shall be degreased, individually packed for medical use.
- The minimum thickness of copper pipes of 35mm and above outer diameter, shall be 1.2mm and the thickness of copper pipes less than 28mm outer diameter, shall be 1mm minimum.

B. Installation & testing

- Installation of piping shall be carried out with utmost cleanliness. Only pipes, fittings and valves that have been degreased and fittings shall be used at site. Pipe fixing clamps shall be of nonferrous or non-deteriorating plastic suitable for the diameter of the pipe.
- Inert gas welding technique shall be used by passing oxygen Free Nitrogen Gas inside the copper pipes during silver brazing, in order to avoid carbon deposition inside the copper pipes. Only copper-to-copper joints are permitted on site except threaded or flanged joints may be made where pipelines are connected to items such as valves and control equipment. No flux shall be used for joining Copper to Copper joints and on for joints made on site. Copper to copper joints shall be brazed using a 5% silver-copper phosphorous brazing alloy CP104. A total of 5 joints shall be cut out for examination to establish the quality of the joints being made on site. The insides shall be clean and free from oxides and particulate matter and the minimum penetration of the brazing alloy at any point shall be three times the wall thickness of the tube. If the joints examined do not conform to these requirements, then adjacent joints shall be cut out and examined until the extent of faulty workmanship has been made good. Copper-to-brass or gunmetal joints shall only be made under controlled conditions off site. The joints are ordinarily used to join short copper pipe tails to brass, gunmetal or bronze fittings to permit their connection into the pipeline. The sub-assemblies shall be degreased and individually sealed in bags or boxes before delivery to site.
- Adequate supports shall be provided while laying pipelines to ensure that the pipes do not sag.
- Suitable sleeves shall be provided wherever pipes cross through walls / slabs. All pipe clamps shall be non-reactive to copper.
- After erection, the pipes are to be flushed with dry nitrogen gas and then pressure tested with dry nitrogen at a pressure equal to twice the working pressure or 150 psig, whichever is higher for a period of not less than 24 hours.

- Length and quantity of individual items (Copper pipes, AVSUs, Alarm panels, Isolation valves, Outlets, pendants etc.) are mentioned. However quantity will be calculated and paid at actuals.

C. Painting

All the pipes from manifold/plant upto the outlets shall be painted with two coats of synthetic enamel paint and colour codification shall be as per standards followed and approved by the Employer.

2.15.5 GAS OUTLETS

Terminal Units (Gas Outlets) with probes/Adaptors for O2, N2O, Compressed Air 4, Air 7, AGSS, Vacuum & CO2 (CO2 can be optional depending on the requirement)

The Medical gas outlets shall confirm to HTM 02-01/ NFPA 99 C/EN/DIN/ ISO 7396-1. Front Loading Type Terminal Outlets shall be designed to dispense medical gases (or an inlet for medical vacuum) to the secondary equipment (flow meters, Suction regulators, etc.) at the point of use and is gas specific so that secondary devices cannot be “attached” to the wrong gas. When not in use the gas in a non-flowing state within the Outlet (Terminal unit) sealed by “O” ring. The adapter when inserted pushes the poppet inside and the gas starts flowing and sealing is ensured by the “O” ring or a seat. The Outlets are Quick Connect Type and gas specificity is accomplished by "Pin indexing." The outlets shall have following features:

- Push to insert and press-to-release mechanism for probes.
- Allows plugging of probes from front.
- Self-sealing valve on disengaging the probe (Quick disconnect)
- Smooth quite action.
- Non return valve for on line servicing/ repairing
- Indexed to eliminate inter-changeability of gas services
- Color-coded gas specific front plate
- Totally leak proof, safe & easy to operate
- Configurations possible: surface, flush & Bead-head.
- Outlets shall be comply with ISO standards.
- All outlets shall have respective labels (i.e.O2 / N2O / CO2 / Air4 / Air7/ Vacuum/ AGSS etc.) displayed accordingly.

2.15.6 **AREA VALVE SERVICE UNIT**

- Area valve service units shall fully comply and meet with HTM 02-01/NFPA 99C/EN/DIN/ISO7396-1. It shall provide a zone isolation facility for use either in an emergency or for maintenance purpose The Area Valve Service Unit shall incorporate a ball valve in a lockable box with emergency access. It shall be reliable and easy to operate, easy purge, sample & pressure testing and emergency supply system.
- Medical gas/vacuum services shall be fixed copper, piped to and from their respective area valve service units. A color coded service identity label shall

be fitted behind the valve handle. The unit shall provide a zone isolation facility. Gas

- Flow direction shall be indicated.
- The box shall be made from extruded aluminium to prevent corrosion. All wetted parts (except seals and gaskets) shall be brass or copper. Each unit assembly shall be factory tested for gas tightness. Rubber pipe grommets shall be provided to ensure any leaking gas does not escape from the unit into a wall cavity. All visible aluminum surfaces shall be powder coated.

2.15.7 <u>ALARM SYSTEM</u>

A. Master Alarm (Digital)

- Complies with HTM 02-01 / NFPA 99C/EN/DIN/ ISO 7396-1 Standards.
- Each Master Alarm shall be modular in design and be fitted with required number of master alarm modules. The master alarms shall be capable to monitor minimum 40 Point.
- Each point represents an alarm condition that the source equipment might have. When an alarm condition exists, a red light flashes and the audible alarm sounds. If several alarm conditions occur simultaneously, the most recent alarm light shall flash, while the other alarm lights shall remain lit. When an alarm condition is created, an audible alarm shall be actuated. A dry contact module shall be available to interface with a building management system.
- The box material shall be of gauge steel of requisite thickness and equipped with mounting brackets. The emissions from alarms shall conform to applicable standards.
- Master alarm management system shall be designed to display alarm conditions from the source supply units indicating the broad status of the source equipment and manifolds as well as the master distribution status from the source supplies.
- Depending on the alarm priority, a visual and audible alarm shall be initiated to indicate an alarm condition.
- Each panel shall display and/or input up to forty point alarms. Panel shall be ready to use with BMS system.
- The master alarm must be able to monitor the following source alarm conditions.
    - Oxygen Source Empty/Fault
    - Oxygen Cylinder Bank Empty/Fault
    - Oxygen Emergency Bank Empty/Fault
    - Air Compressor Faulty/Operation
    - Vacuum Pump Faulty/Operational
    - Vacuum Deficiency Vacuum Reservoir
    - And Other MGPS Signals & Alarms
    - Master alarm shall be integrated with BMS/HIS

B. Medical Gas Area Alarm

The medical gas central alarms shall be capable of monitoring atleast 5 medical gas services or as approved in the final drawings by the Employer by means of pressure sensors which detect deviations from the normal operating limits of either pressure or medical vacuum. The area alarm shall have a digital display of pressures. The medical gas area alarm shall fully satisfy the HTM 02-01/ NFPA 99 C/EN/DIN/ISO 7396-1 requirements.

An audible warning shall sound simultaneously with any failure indication and a mute facility shall be provided.

C. Line Isolation Valves

The Lockable line valves must degreased and complete valve with stuffed pipe & fittings, factory tested and complies with HTM 02-01/ NFPA 99 C/EN/DIN/ISO 7396-1 standard.

D. Supply of O2 Cylinders – Class D Type
- It shall be as per BIS/IS/ASME Standard

E. Supply of N2O Cylinders – Class D Type
- It shall be as per BIS/IS/ASME Standard

F. Horizontal/ Vertical Bed Head Panel

It shall confirm to HTM 02-01/ NFPA 99 C/EN/DIN/ISO 7396-1. The design shall be approved by the respective institute before installation and it is responsibility of the Contractor to finalize the requirement and design with Hospital Authority and Employer and finalized the Bed Head Panel (Vertical/Horizontal). It shall have following features:-

- Efficient, Safe & Robust design in extruded aluminium section.
- Smooth curved surfaces, and choice of base colour and fascia plates.
- Unit shall have integrated rail system to mount accessories
- The headwall system shall be constructed of aluminium extrusions joined together to form a carcass to suit the particular application. Unit shall be factory assembled for electrical and mechanical components.
- Segregation of services i.e. Low voltage supplies, High Voltage supply and Medical gases shall be maintained with 2 tier/2 channel arrangements.
- Front fascia plate shall be removable individually to access for respective service.
- It shall have one rail for mounting Accessories.
- Each bed-head unit shall be supplied with electrical and electrical outlets pre-fitted, wired and certified. (Wired up to the distribution box provided with leakage protection & proper earthling arrangements)

G. High pressure tubes for O2, N2O, Compressed Air,& Vacuum

It shall be colour coded for individual services i.e. white for Oxygen, Blue for N2O and Yellow for Vacuum, Black for air. Antistatic rubber tube shall be as per ISO standards. It shall be CE marked/UL Listed. (The 200m Hose- Gas wise requirement shall be taken from respective institute before supply total lengths shall be 200m inclusive of all type.

H. Electrical Wiring with Electrical Panels

All wiring inside the Manifold Room and Plant room required for MGPS equipment and General electrification. Institute will provide one point supply only. Other are under the scope of the Contractor. All the work shall be as per BIS standard and material used shall be reputed make only.

I. Site Modification

- The Contractor shall be responsible for antistatic ironite/cota/any heavy duty flooring in the manifold room and thickness of flooring not less than 1 inch.
- The Contractor shall be responsible for all necessary arrangements for the installation of Medical Air plant, Vacuum Plant & AGSS Plant.

J. Manufacturer Authorization

The Contractor shall submit a mandatory letter of authority from the manufacturer, with name of the manufacturing company for major products quoted by them such as:

1. Oxygen Supply System
2. Nitrous oxide system
3. Medical Air plant (package unit) including electrical control panel
4. Medical Vacuum Plant (Package unit)
5. Duplex AGSS System
6. Gas outlet points/ Terminal units with probe
7. Medical gas alarm panel
8. Copper Pipes
9. Line Isolation Valves

SECTION III: MISCELLANEOUS

3.1 DELIVERABLES

The stage wise deliverables have been enumerated in the table below:

S. No.	Description	Deliverables
A.	**SURVEY, INVESTIGATION, PLANNING, DESIGN, ENGINEERING, DRAWINGS & APPROVALS**	**3 Months from Date of Commencement**
1.	On approval of Employer/ Employer's Representative, the survey, investigations, Planning, Design and Architectural and other Associated Drawings submission for approval of Local Bodies and Statutory Authorities before commencement of works.	-
2.	On obtaining of Structural Scrutiny, vetting and recommendation for approval of designs from any Government Engineering College as per relevance and directions of Employer's Representative.	-
3.	On obtaining all Required Approvals from statutory authorities and local bodies for commencement of Construction as per requirements and directions of Employer's Representative.	-
4.	On submission of BIM model and Project Execution Drawings to Employer's Representative.	-
5.	On submission of all Good for Construction (GFC) drawings as per requirements and directions of Employer's Representative.	-
6.	Demolition as per demolition plan in Volume V: Tender Drawings	-
B	**CONSTRUCTION**	**24 Months from issuance of GFC**
7.	On achieving financial progress of 20%	-
8.	On achieving financial progress of 40%	-
9.	On achieving financial progress of 60%	-
10.	On achieving financial progress of 80%	-
11.	On achieving financial progress of 100%	-
C	**COMPLETION/ COMMISSIONING AND HANDING OVER TO THE EMPLOYER (30 days for post construction)**	**-**
12.	Installation, Testing, Trail Run and Commissioning	-
13.	Handing over and submission of As-Built Drawings to the Employer	-

S. No.	Description	Deliverables
14.	Obtaining minimum silver rating, IGBC Green Healthcare Facilities Rating System	-
	TOTAL	**27 Months**

3.2 PAYMENT SCHEDULE

Sl. No.	Description	Percentage Breakup of Contract Price	
		Subgroup	Cumulative
CIVIL WORKS			
A.	**SURVEY, INVESTIGATION, PLANNING, DESIGN, ENGINEERING & DRAWINGS**	**1%**	**-**
1.	On approval of Employer/Employer's Representative, the survey, investigations, Planning, Design and Architectural and other Associated Drawings ready for submission for approval of Local Bodies and Statutory Authorities before commencement of works.	0.2%	**0.2%**
2.	On obtaining of Structural Scrutiny and recommendation for approval of designs from agreed Government Academic Institution as per relevance and directions of Employer/ Employer's Representative.	0.2%	**0.4%**
3.	On obtaining all Required Approvals from statutory authorities and local bodies for commencement of Construction as per requirements and directions of Employer / Employer's Representative.	0.2%	**0.6%**
4.	On submission of BIM model and Project Execution Drawings to Employer/ Employer's Representative.	0.2%	**0.8%**
5.	On submission of all Good for Construction (GFC) drawings as per requirements and directions of Employer/ Employer's Representative.	0.2%	**1.0%**
B.	**CONSTRUCTION**	**90%**	**-**
6.	On completion of Excavation, site levelling, Foundation system (Foundation and Column up to Plinth Level) Tie beam, Plinth beam including earth and back filling of all the three buildings as per the scope of work	**9%**	**10.00%**
7.0	On completion of basic structure i.e. RCC framework up-to top of three buildings as per the scope of work	**8%**	**-**
7.1	On completion of 1st slab i.e. Ground/Stilt Floor Roof Slab	2.00%	**12.00%**

Sl. No.	Description	Percentage Breakup of Contract Price	
		Subgroup	Cumulative
7.2	On completion of 2nd slab i.e. First Floor Roof Slab	2.00%	**14.00%**
7.3	On completion of 3rd slab i.e. Second Floor Roof Slab	2.00%	**16.00%**
7.4	On completion of 4th slab i.e. Third Floor Roof Slab	1.00%	**17.00%**
7.5	On completion of terrace tank, waterproofing of terrace slab and tanks including covering of shafts and other works required as per approved drawings.	1.00%	**18.00%**
8.0	On Completion of Block work (Internal & External) of three buildings as per the scope of work	**12%**	**-**
8.1	Up to Ground/Stilt Floor	2.00%	**20.00%**
8.2	Up to First Floor	2.00%	**22.00%**
8.3	Up to Second Floor	2.00%	**24.00%**
8.4	Up to Third Floor	2.00%	**26.00%**
8.5	Up to Fourth Floor as applicable	2.00%	**28.00%**
8.6	Terrace as applicable	2.00%	**30.00%**
9.0	On Completion of All types of flooring work including skirting, acoustics, panelling etc. as per scope of work for all buildings	**13%**	**-**
9.1	Up to Ground/Stilt Floor	3.00%	**33.00%**
9.2	Up to First Floor	3.00%	**36.00%**
9.3	Up to Second Floor	3.00%	**39.00%**
9.4	Up to Third Floor	2.00%	**41.00%**
9.5	Up to Fourth Floor, Terrace & Roof as applicable	2.00%	**43.00%**
10.0	On Completion of Internal & External finishing work as per scope of work for all buildings	**9%**	**-**
10.1	Plaster (Internal & External)	2.00%	**45.00%**
10.2	Fixing of door, windows, ventilators i/c fittings, railings, grills, louvres, false ceiling	2.00%	**47.00%**
10.3	Plinth protection	2.00%	**49.00%**
10.4	Fixing of Structural Glazing	1.00%	**50.00%**
10.5	Painting, finishing, fixing of cladding material	1.00%	**51.00%**
10.6	Roof waterproofing and screeding	1.00%	**52.00%**
11.	On completion of plumbing works , Internal water supply system, all sanitary installations, sewer as per scope of work for all buildings	**9%**	**-**
11.1	Internal water supply	1.00%	**53.00%**

Sl. No.	Description	Percentage Breakup of Contract Price	
		Subgroup	Cumulative
11.2	Sanitary installation & Drainage system	1.00%	**54.00%**
11.3	External water supply line including taking connection from existing water line and distribution supply line, pumping system, water storage tanks etc.	2.00%	**56.00%**
11.4	Sewer line around the building, manholes, chambers, STP etc. sewer with Sewer line, rain water harvesting , storm water drains etc.	2.00%	**58.00%**
11.5	UG. Sump of desired Capacity, Solid Waste Management System etc.	3.00%	**61.00%**
12.	Site Development, Roads, Boundary wall, Horticulture & Landscaping etc. as per scope of work	**4%**	**-**
12.1	Site Development and Covered paved parking shed for Bike & car parking area as specified in drawing, approach & circulation roads etc. as per external development drawing	2.00%	**63.00%**
12.2	Landscaping & horticulture work as per technical specification etc.	1.00%	**64.00%**
12.3	Boundary wall, entrance gates, connecting roads etc. as required	1.00%	**65.00%**
13	FIRE FIGHTING WORKS	**3%**	**-**
13.1	Firefighting works at Pump room including supply, installation, testing and commissioning of fire pumps, laying of pipes, valves & other accessories and allied works	1.00%	**66.00%**
13.2	Firefighting works at Yard including ring main works, installation of hydrant valves, extinguishers, external fire signages and other accessories	1.00%	**67.00%**
13.3	Firefighting works inside building and at terrace including installation of pipe lines, sprinklers, hydrants, extinguishers, fire signages and other accessories	1.00%	**68.00%**
14	HVAC WORKS	**4%**	**-**
14.1	Supply, Installation, testing & Commissioning of Plant Room works including chillers, pumps, cooling towers, piping upto risers, pipe fittings, ventilation works, Insulation works, pressurization unit, Electrical works including cabling, earthing & control panels etc. with necessary required items for the smooth and complete functioning of HVAC System	1.00%	**69.00%**
14.2	Supply, Installation, testing & Commissioning of Riser & floor wise piping works including	1.00%	**70.00%**

Sl. No.	Description	Percentage Breakup of Contract Price	
		Subgroup	Cumulative
	insulation, valves & fittings, supports etc as per requirement for the complete functioning of HVAC System		
14.3	Supply, Installation, testing & Commissioning of floor wise ducting and other air side works including insulation, fittings, supports etc as per requirement for the complete functioning of HVAC System	1.00%	**71.00%**
14.4	Supply, Installation, testing & Commissioning of floor wise low side equipment such as Air handling units, Fan coil units etc. with necessary supports & other accessories etc. as per requirement for the complete functioning of HVAC System	1.00%	**72.00%**
15	LIFTS	**2%**	**-**
15.1	Supply, installation, testing and commissioning of Lifts including comprehensive maintenance contract (CMC) Cost for 5 Years	2.00%	**74.00%**
16	ETP & WTP	**1%**	**-**
16.1	Supplying testing and commissioning of ETP &WTP including plant room	1.00%	**75.00%**
17	ELECTRICAL WORKS	**9%**	**-**
17.1	Internal electrification works - including supply, installation, testing and commissioning as per scope of work.	3.00%	**78.00%**
17.2	Internal electrical works including wiring points for light, ceiling fan, exhaust fan, wall fan, small power points, low side HVAC points, power points for ELV system, distribution boards, cabling from DB to floor panel boards/VDBs, floor panels/VDBs, rising mains, panels for various services (Electrical/Mechanical/Biomedical services), cable support systems(trays or similar items) as per scope of work	2.00%	**80.00%**
17.3	Supply, installation, testing and commissioning of UPS, capacity 420 kVA (total capacity), BMS compatible, modular type 30 minutes back up with SMF batteries including interconnecting cables, racks and all other accessories.	2.00%	**82.00%**
17.4	Supply, installation, testing and commissioning of Substation equipment including all accessories as per scope of work	1.00%	**83.00%**
17.5	Supply, installation, testing and commissioning of DG set consists of all accessories as per scope of work	1.00%	**84.00%**

Sl. No.	Description	Percentage Breakup of Contract Price	
		Subgroup	Cumulative
18	**ELV WORKS**	**5%**	**-**
18.1	Supply, installation, testing and commissioning of Addressable fire alarm/public address/talk back system consists of all accessories as per scope of work	0.50%	**84.50%**
18.2	Supply, installation, testing and commissioning of IP based CCTV system consists of all accessories as per scope of work	0.50%	**85.00%**
18.3	Supply, installation, testing and commissioning of Access control system consists of all accessories as per scope of work.	0.50%	**85.50%**
18.4	Supply, installation, testing and commissioning of Telephone system consists of all accessories as per scope of work.	0.50%	**86.00%**
18.5	Supply, installation, testing and commissioning of Data network system consists of all accessories as per scope of work.	1.00%	**87.00%**
18.6	Supply, installation, testing and commissioning of Intelligent Building Management System consists of all accessories as per scope of work.	1.00%	**88.00%**
18.7	Supply, installation, testing and commissioning of IP based Nurse call system consists of all accessories as per scope of work.	1.00%	**89.00%**
19.0	**MGPS**	**2%**	**-**
19.1	Supply, installation, testing and commissioning of Medical Gas Pipeline System (MGPS) along with Required Manifold, Plant Room Equipment and other accessories as per scope of work.	2.00%	**91.00%**
C.	**COMPLETION/ COMMISSIONING AND HANDING OVER TO THE EMPLOYER**	**6%**	**-**
20.	Testing, Trial Run and Commissioning	3.00%	**94.00%**
21.	Handing over and submission of As-Built Drawings, Operation and Maintenance Manual & all other completion documents to the Employer	3.00%	**97.00%**
D.	**OPERATION AND MAINTENANCE (O&M)**	**3%**	**-**
22.	On completion of operation and maintenance for minimum 30 days as per the scope of work or up to the satisfaction of the Employer / Authority	3.00%	**100.00%**

Note:

- In case, a certain milestone is not applicable in a particular component then the corresponding payment can be claimed along with the subsequent milestone of the same component.

- The supply of any material shall be done after getting prior approval of the Employer in Material Approval Request (MAR). Any material purchased/ supplied at the site without approval of the Employer shall not be liable for payment.
- Operation and Maintenance for 30 days shall be performed by the contractor to provide training to Employer's staff at no extra cost.

3.3 ADDITIONAL CONDITIONS

1. The Contractor shall be responsible for consequential effects arising out during the inspection done by the Chief Technical Examiner Cell, Central Vigilance Commission or by the Building Works Committee or third party authorized by WAPCOS or any statuary committee or by any duly authorized representative of WAPCOS, during the progress or any time after the construction and development of project up to the defect liability period, and will take appropriate action for rectification of defective work. Rectification of defective works or replacement of sub-standard materials or articles, as pointed out by the Chief Technical Cell, Central Vigilance Commission, Building Works Committee or authorized representative of WAPCOS or third party authorized by WAPCOS or any statuary committee, will be carried out or replaced by the Contractor at his own risk and cost. WAPCOS will not pay any extra amount for such rectification or replacement.

2. **FURNISHED OFFICE ACCOMMODATION & MOBILITY AND COMMUNICATION TO BE PROVIDED BY CONTRACTOR TO WAPCOS**

   The contractor shall provide a furnished Project office equipped with all facilities such as telephone, fax, internet, photocopier, computer/ laptop & printer along with operator, regular electric & purified drinking water supply and inspection vehicle etc. as per the requirement of the project. The contractor shall also make sufficient arrangement for Photography/ Videography preferably by maintaining a camera/video camera at site so that video photographs can be taken of a specific activity at any point of time. The contractor shall also provide software like MS Project, MS Office, Autocad or any other software's required for successful completion of the project.

3. **Defect Liability Period (DLP):**

   i. Mechanical, Electrical, ELV, HVAC, Firefighting & Plumbing services

   DLP will be for 3 years from the date of taking over by the Client. Complaints arising due to manufacturing defects and/or installation defects pertaining to the services shall be rectified by the Contractor free of cost. Daily operations of the services will not be under the scope of the Contractor and will be arranged by the Hospital Authorities / Client. Cost of fuel for DG sets / Diesel engine drives for fire pumps are to be borne by the Hospital Authorities. During DLP, check-ups for services shall be done by the contractor free of cost as detailed below:

   ii. HT & LT services:

All HT/LT and its allied installations will be checked for the normal functionality in every six (6) months during DLP. These include, but not limited to, functional status of all switchgears, DBs, relays, meters, transformers, lighting, earthing, and cable terminations. Defects due to improper operations and/or mishandling will not be covered under DLP.

iii. DG sets:

Functional status of DG sets will be checked in every twelve (12) months / 500 running hours during DLP. Cost of consumables, fuel, oil, filters, coolants to be changed as required during DLP will not be under the scope of the Contractor and will be borne by the Hospital Authorities / Client. Defects due to improper operations and/or mishandling will not be covered under DLP.

iv. UPS:

Functional status of UPS will be checked in every six (6) months during DLP. Battery health status will be checked and replacement if required will be done by the Contractor free of cost. Hospital Authorities shall ensure that AC units installed in the UPS room are working. Defects to UPS and/or battery due to non-functioning of AC units will not be covered under the scope of the Contractor during DLP. Defects due to improper operations and/or mishandling will not be covered under DLP.

v. HVAC:

DLP will be for 3 years from the date of taking over by client. Complaints arising due to manufacturing defects and/or installation defects pertaining to the services will be rectified by the Contractor free of cost. During DLP, check-ups of the entire HVAC system will be done by the Contractor free of cost in every quarter of the year. Daily operations of HVAC system will not be under the scope of the Contractor, and will be arranged by the Hospital Authorities. Defects due to improper operations and/or mishandling will not be covered under DLP.

Maintenance of HVAC system as listed below will not be under the scope the Contractor and will be arranged by the Hospital Authorities:

- Periodic cleaning of filters of AHU/FCU/Wall units/Cassette units and filter replacement.
- Periodic cleaning of drain pipes.
- Defects due to improper operations and/or mishandling.

vi. Firefighting:

All pumps, motors, panels, valves installed by the Contractor will be checked for normal functionality once in every year during DLP. Cost of consumables, fuel, oil, filters, coolants to be changed as required during DLP will not be under the scope of the Contractor and will be borne by the Hospital Authorities.

Daily operations of firefighting system will not be under the scope of the Contractor, and will be arranged by the Hospital Authorities. Defects due to improper operations and/or mishandling will not be covered under DLP.

vii. Lifts & Dumb Waiter:

DLP will be for 3 years from the date of taking over. Complaints arising due to manufacturing / installation defects pertaining to the lifts and dumb waiter will be rectified free of cost by the Contractor during DLP. Daily operations of the units will not be under the scope of the Contractor and will be arranged by the Hospital

Authorities / Client. During DLP, check-ups of lifts and dumb waiter will be done by the Contractor free of cost in every month of the year and activities like regular inspection, greasing, lubrication, car level adjustments will be done. Defects arising due to improper operation, negligence, accident, mishandling, lightning and any other incidents or natural calamities beyond control will not be covered under DLP.

4. The contractor shall make all arrangements for ground breaking ceremony/ inaugural function etc for the project as required and the cost towards it deemed to be included in his rates/offer.

5. Contractor shall provide 4 no. of vehicles for Employer and Employer's Representative under the project for the duration of the project including running charges such as POL, driver, repairs, etc. The model of vehicle shall not be older than year of 2022 and category of at least one vehicle shall be either Innova//SUV etc and category of other vehicles shall be either Swift Dzire/Etios/Sedan.

6. The contractor shall install CCTV/Video surveillance/Smart cameras with the latest technology with 24 hour surveillance capability with correct Camera positioning which offers full coverage of the work site to achieve safety objectives, minimize delays and downtime, as well as manage site security threats and enhance the ability to securely monitor and manage the site remotely. Also, the contractor shall display a CCTV signage which is a legal requirement to warn anyone entering the site that they are under CCTV Surveillance.

7. The contractor shall make his own arrangements for obtaining electric connection and water Connection/ arrangement (if required) and make necessary payments directly to the department concerned. No dispute in this regard shall be entertained.

3.4 LIST OF KEY PERSONNEL

Bidders should provide the names and details of the suitably qualified Contractor's Representative and Key Personnel to perform the Contract. Information regarding their experience (including CVs as per **Form "T-6"** and supporting documents) should be supplied using the **Annexure - I** to **Form T-5** below for each candidate. Bidder should submit a comprehensive Key Personnel resource schedule for the entire contract implementation period. The resource schedule must include:

- The name and role for each Key Personnel position
- The duration of each Key Personnel appointment
- The level of effort (time) allocated to each Key Personnel position and its distribution throughout the contract implementation period.

S. No.	Key Personnel position	Qualification	Experience	Proposed Name
1.	Project Manager	B. Tech/ BE (Civil) with MBA (Construction Management)	Should have 15 years of experience of which minimum 10 years shall be in Design and Development of Hospital, covering Civil, MEP and other hospital related works preferably for Central/ State/ PSU's Projects	
2.	Deputy Project Manager	B. Tech/ BE (Civil)	Should have 12 years of experience of which minimum 6 years shall be in Design and Development of Hospital, covering Civil, MEP and other hospital related works preferably for Central/ State/ PSU' Projects	
3.	Deputy Project Manager	B. Tech/ BE (Electrical)	Should have 12 years of experience of which minimum 6 years shall be in Design and Development of Hospital, covering Civil, MEP and other hospital related works preferably for Central/ State/ PSU's Projects	
4.	Deputy Project Manager	B. Tech/ BE (Mechanical)	Should have 12 years of experience of which minimum 6 years shall be in Design and Development of Hospital, covering Civil, MEP and other hospital related works preferably for Central/ State/ PSU's Projects	
5.	Procurement Specialist	Master's degree in civil engineering, or relevant fields	Shouldhave minimum 10-15 years of experience in procurement for work contract	
6.	Environment Expert	B. Tech/ BE (Civil) with M. Tech in Environment Engineering	Should have 10 years experience in handling environmental aspects of hospital projects. This includes conducting Environmental Impact Assessments (EIA) and ensuring compliance with environmental regulations	

S. No.	Key Personnel position	Qualification	Experience	Proposed Name
			throughout the project lifecycle.	
7.	Project Engineer	B. Tech/ BE (Civil) Or Diploma (Civil)	Should have 5 years for B. Tech/ BE or 10 years for Diploma	
8.	MEP Engineer	B.Tech/BE (Electrical) or Diploma (Electrical)	Should have working experience of minimum 5 years for B. Tech/ BE or 10 years for Diploma	
9.	Quality Engineer	B. Tech/ BE (Civil)	Should have minimum 8 years of experience out of which 5 years in Quality supervision	
10.	Structural Engineer	M. Tech in Structural Engineering with B. Tech/ BE (Civil)	Should 10 years of experience (post M. Tech) in designing of multi-storied RCC framed structure.	
11.	Hospital Planner	B. Arch.	Should have 10 years of experience of which minimum 6 years shall be in Design and Development of Multispecialty hospital	
12.	Bio Medical Engineer	Bachelor'sDegree in Bio-Medical Engineering or related fields	Should have 10 years of experience of which minimum 6 years shall be in Design and Development of Multispecialty hospital	
13.	IGBC Expert	Bachelor'sDegree In …..architecture, engineering or environmental sciences Certified by the Indian Green Building Council (IGBC)	Should have 5 years of experience in sustainable design and development of various types of construction projects, of which minimum ~~6~~ 3 years shall be in sustainable Design and Development of Multispecialty hospital	
14.	BIM Expert	Bachelor's Degree In Architecture, Engineering, or a related field.	Should have 6 years of experience in BIM modelling in the field of Construction of buildings	
15.	Surveyor	Diploma	Should have 10 years of experience in survey works	
16.	Billing	B. Tech/BE	Should have 10 years of	

S. No.	Key Personnel position	Qualification	Experience	Proposed Name
	Engineer		experience in relevant field	
17.	Health & Safety Engineer	B. Tech/BE	Should have 5 years of experience in relevant field	
18.	Site Engineers (Number as per requirement)	B. Tech/Diploma	Should have minimum 5 Years of experience	

ANNEXURE A
Soil Investigation Report

REPORT ON SUBSOIL INVESTIGATION

PROJECT : PROPOSED HOSPITAL BUILDING (G+3) FOR GENERAL HOSPITAL THIRUVANAMTHAPURAM HEALTH & FAMILY WELFARE , DEPARTMENT, GOVERNMENT OF KERALA.

LOCATION : GENERAL HOSPITAL TRIVANDRUM

CLIENT : M/s. WAPCOS LTD COCHIN

CIVIL ENGINEERING DEPARTMENT
GOVT .ENGINEERING COLLEGE THRISSUR
FEBRUARY -2020

REPORT ON SUBSOIL EXPLORATION FOR PROPOSED HOSPITAL BUILDING (G +3) FOR GENERAL HOSPITAL THIRUVANAMTHAPURAM HEALTH & WELFARE DEPARTMENT ,GOVERNMENT OF KERALA TRIVANDRUM

1. INTRODUCTION

There is a proposal to construct a hospital building (G+3) at General hospital Thiruvananthapuram for health and family department Govt of kerala. M/s WAPCOS Ltd ,cochin it is decided to carry out a detailed sub soil Investigation to find out safe bearing capacity and selection of appropriate foundation for the building.

The work was awarded to M/s Precision Survey , D. No 52/334, Janatha , Vytilla A Detailed investigation and laboratory studies were carried out from 03/02/2020 to 24/02/ 2020.This report summarizes the subsoil investigations and furnishes the recommendation on the types of the foundation to be provided.

2. SCOPE OF WORK

The scope of work at this site ,entrusted with us comprised of :

2.1 Mobilization of boring rigs with all necessary equipments and skilled / unskilled personals for the filed work.

2.2 Boring Six bore holes of diameter 150 mm , drilling equipments in sand, silit,clay and gravel to maximum depth of 30.00 m or till the spoon rebounded at the selected location fixed by cilents.

2.3 Conduction of standard penetration tests in bore hole at every 1.5m depth or changes of strata and prepare bore log showing details

2.4 Collection of disturbed samples in air tight polythene bags with proper labelling and transportation of laboratory.

2.5 Conducting the laboratory tests on the disturbed samples as per indian standard and furnishing the results.

2.6 Preparation and submission of the detailed report with filed and laboratory results.

3. INVESTIGATION DETAILS

3.1 FIELD INVESTIGATION

3.1.1 One boring unit with all necessary equipment along with a team of technical Personal with skilled labourers were mobilized at work site.

3.1.2 Six bore of 150 mm were bored to a depth suggested by client, below The existing ground level .Bore holes were made as per IS: 1892 – 1979, using rotatry boring.

3.1.3 Representative samples were collected at every 1.0m interval depth or change of strata , whichever is earlier.

3.1.4 The samples collected were carefully scaled and transported to the laboratory for tests.

3.1.5 Standard Penetration tests were conducted at every at every 1.5m intervals after that , as per IS : 2131 - 1981. Before testing borehole was cleaned properly and split spoon sampler is placed centrally in bore

hole. A standard hammer of 63.5kg is dropped from height of 75 cm and number of blows for penetration of sampler for 0 – 15 cm, 15 -30 cm and 30-45 cm were noted. Number of blows required for 15 - 45 cm penetration reported as N value.

3.16 Bore holes terminated after the investigation

3.2 LABORATORY INVESTIGATION

3.2.1 The following laboratory tests were conducted on the selected samples as relevants IS codes.

a) Particles size Analysis (IS .2720-Part 4-1985)
b) Walter content (IS .2720-Part 2-1973)
c) Bulk density (IS 2720- Part 9-1992)
d) Specific gravity (IS .2720-Part 3-1980)
e) Direct shear test(IS .2720-Part 13-1986)
f) Liquid limit & plastic limit (.2720 -Part 5-1985)
g) Triaxial Test (IS.2720(Part -11)-1971)

4.SOIL PROFILE

The standard penetration tests result and details of soil layers are shown in the Bore logs (Fig 2 to 7)

Bore hole 1

In BH1, The top 0.70 m comprises of Ordinary laterite soil . This layers was followed by Lateritic clayey sand with gravel from 0.70 m to 2.00m. The SPT value obtained at 1.00 m is > 50 . The thickness of this layer is of 1.30m This layer was followed by Lateritic clayey sand from 2.00 m to 8.80 m. The SPT value obtained at 3.00m is > 50. The SPT value obtained at 4.50 m is > 50. The SPT value obtained at 6.00 m depth is > 50m. The SPT value obtained at 7.50m is >50. This layer was followed by Lateritic clayey sand from 8.80m to 21.70 m. The thickness of this layers is of 12.90 m .The SPT value obtained 10.50 m depth is 38. The SPT value obtained 12.00 m is 36. The SPT value obtained 13.50m depth at 31m. The SPT value obtained at 15.00 m is 29. The SPT value obtained at 17.00m is 26. The SPT value obtained at 19.00 m is 30 . The SPT value obtained at 21.00m is 31. This layer was followed by silly weathered (Grey) from 21.70 m to 28.00 m . The SPT value obtained 23.00 m depth is > 50. The SPT value obtained 25.00 m depth is > 50 . This layer was followed by soft rock from 28.00m to 29.00m .This Layer was followed by soft rock from 29.00 m to 30.00 m. And the borehole also terminated at 30.00m. The result of SPT tests conducted at various depth are presented in Fig2.

Bore hole 2

In BH2 , The top 0.40 m comprises of Ordinary Lateritic soil.This layers was followed by Lateritic clayey sand from 0.40 m to 2.70m. The SPT Value was obtained at 2.00 m depth is 8 . The Thickness of this layer is 2.30 m . This layer was followed by Lateritic clayey sand (red,yellow) from 2.70m to 10.95 m. The SPT value obtained at 4.50m depth is >50. The SPT value obtained at 6.00m is 36. The SPT value was obtained at 7.50 m is 44 . The SPT value obtained at 9.00 m is 39. The SPT value obtained at 10.50 m is 39. And the borehole is terminated at 10.95 m. The result of SPT tests conducted at various depth are presented on fig 3.

Bore hole 3

In BH3 , The top 2.00 m comprises of Ordinary Lateritic clayey sand This layers was followed by laterite clayey sand with gravel from 2.00 m to 6.00m. The SPT value obtained at 3.00 m is > 50. The SPT value obtained at 4.50 m is > 50 . The thickness of this layer is of 4.00 m. This layer was followed by Lateritic clay with sand from 6.00 m to 9.00 m . The thickness of this layer is of 3.00 m. The SPT value obtained at 7.50 m depth is 36. This layer was followed by Lateritic clayey sand from 9.00 to 11.20 m. The SPT value obtained at 9.00 m depth is 27. The SPT value at 10.50 m at 31 . This layers was followed by Lateritic clayey sand from 12.00 m to >50 m. The SPT value obtained at 13.50 m depth is >50 . The SPT value was obtained at 15.00 m depth is >50. And the borehole is terminated at 15.39 m . The result of SPT tests conducted at various depth are presented on fig 4

Bore hole 4

In BH4 , The top 0.80 m comprises of ordinary Laterite soil . This layers was followed by laterite clayey sand from 0.80 m to 1.70 m . The thickness of this layer is of 0.90 m . This layer was followed by Lateritic clay sand from 1.70 m to 4.50 m . The SPT value obtained at 3.00 m depth is > 50 . The thickness of this layer is of 2.80m. This layer was followed by Lateritic Clayey sand from 4.50 m to 10.65 m. The SPT value obtained at 6.00 m is >50. The SPT value 7.50 m is > 50. The SPT value obtained at 9.00m is > 50. The SPT value 10.5m is > 50 . And the borehole is terminated at 10.65m. The result of SPT tests conducted at various depth are presented on fig 5

Bore hole 1(Near ward No: 7)

In BH 1 (Near ward no : 7) , The top 0.80 m comprises of Ordinary laterite soil. This layers was followed by Lateritic clayey with sand & gravel from 0.80m to 2.00m . The SPT value obtained at 1.00 m is > 50. This layer was followed by Lateritic clayey sand from 2.00 m to 9.00m. The SPT value obtained at 3.00m is >50.The SPT value obtained at 4.50m is >50 m. The SPT value obtained at 6.00 m is >50. The SPT value obtained at 7.50 m is 46 . This layers was followed by Lateritic Clay with sand from 9.00 m to 10.90 m. The SPT value obtained at 9.00 m is > 50.The SPT value obtained at 10.50 m is > 50. And the borehole also terminated at 10.90m . The result of SPT tests conducted at various depth are presented in Fig6.

Bore hole II (Near ward no: 7)

In BH6, The top 0.90 m comprises of ordinary Laterite soil . This layer was followed by Lateritic clayey with gravel from 0.90m to 2.00 m. The SPT value obtained at 1.00m depth is 17.This was followed by Lateritic clay with sand from 2.00m to10.85. The SPT value obtained at 3.00 m is > 50 . The SPT value obtained at 4.50m is > 50 .The SPT value obtained at 6.00m is 33. The SPT value obtained at 7.50 m is 42. The SPT value obtained at 9.00 m is >50 . The SPT value obtained at 10.50m is >50 . And the borehole also terminated at 10.85m . The result of SPT tests conducted at various depth are presented in fig 7.

Fig : 1

BORE HOLE LOCATION

CLIENT	M/s. WAPCOS LTD
PROJECT:	PROPOSED HOSPITAL BUILDING (G+3)
SITE:	GENERAL HOSPITAL TRIVANDRUM
BORE HOLE NO. : BH-I	Date of start::03/02/2020
	Date of completion:06/02/2020
TYPE OF BORING: Rotary Drilling	Ground water table: 9.10 m below GL

Description of soil	Thickness of layer m	Depth in m below GL	Bore log	Standard Penetration Test					Graph of 'N' value						Remarks
				depth (m)	15 cm	30 cm	45 cm	N Value	10	20	30	40	50	>50	
Ordinary Laterite Soil	0.70	0.70													
Lateritic Clayey Sand with Gravel (Red)	1.30	2.00		1.00	11	31	19	>50							8cm balance
Lateritic Clayey Sand (Red)	6.80	8.80		2.00	17	28	22	>50							4cm balance
				3.00	>50	-	-	>50							34cm balance
				4.50	22	34	16	>50							9cm balance
				6.00	18	30	20	>50							4cm balance
				7.50	23	23	27	>50							4cm balance
Lateritic Clayey Sand (White,Red)	12.90	21.70		9.00	9	13	27	40							
				10.50	8	18	20	38							
				12.00	14	15	21	36							
				13.50	11	14	17	31							
				15.00	13	15	14	29							
				17.00	12	13	13	26							
				19.00	14	12	18	30							
				21.00	7	12	19	31							
Silty Weathered (Grey)	6.30	28.00		23.00	28	39	>50	>50							9cm balance No Sample
				25.00	>50	-	-	>50							36cm balance
Soft Rock	1.00	29.00		28.00											Recovery-43% RQD-Nil
Soft Rock	1.00	30.00		29.00											Recovery-58% RQD-13%
Bore hole terminated at 30.00m depth															

Fig : 2

CLIENT	M/s. WAPCOS LTD
PROJECT:	PROPOSED HOSPITAL BUILDING (G+3)
SITE:	GENERAL HOSPITAL TRIVANDRUM
BORE HOLE NO. : BH-**II**	Date of start::06/02/2020
	Date of completion:06/02/2020
TYPE OF BORING: Rotary Drilling	Ground water table: 9.00 m below GL

Description of soil	Thickness of layer m	Depth in m below GL	Bore log	Standard Penetration Test depth (m)	15 cm	30 cm	45 cm	N Value	Graph of 'N' value	Remarks
Ordinary Lateritic Soil (Brown)	0.40	0.40								
Lateritic Clayey Sand (Brown)	2.30	2.70		1.00	2	4	6	10		
				2.00	3	4	4	8		
Lateritic Clayey Sand (Red, Yellow)	8.25	10.95		3.00	25	27	23	>50		4cm balance
				4.50	19	34	16	>50		8cm balance
				6.00	10	13	23	36		
				7.50	13	19	25	44		
				9.00	12	18	21	39		
				10.50	16	17	22	39		

Bore hole terminated at 10.95m depth

Fig : 3

CLIENT	M/s.WAPCOS LTD
PROJECT:	PROPOSED HOSPITAL BUILDING (G+3)
SITE:	GENERAL HOSPITAL TRIVANDRUM
BORE HOLE NO. : BH-**III**	Date of start::07/02/2020
	Date of completion:07/02/2020
TYPE OF BORING: Rotary Drilling	Ground water table: 8.80 m below GL

Description of soil	Thickness of layer m	Depth in m below GL	Bore log	Standard Penetration Test depth (m)	15 cm	30 cm	45 cm	N Value	Graph of 'N' value 10 20 30 40 50 V 0	Remarks
Ordinary Lateritic Clayey Sand	2.00	2.00		1.00	4	5	7	12		
Lateritic Clayey Sand With Gravel (Red,Brown)	4.00	6.00		2.00	18	21	23	44		
				3.00	24	>50	-	>50		21cm balance
				4.50	24	30	20	>50		5cm balance
Lateritic Clay with Sand (Red,Brown)	3.00	9.00		6.00	16	27	20	47		
				7.50	18	14	22	36		
Lateritic Clayey Sand (Red,Brown)	2.20	11.20		9.00	8	11	16	27		
				10.50	11	14	17	31		
Lateritic Clayey Sand (Red)	4.19	15.39		12.00	19	35	15	>50		8cm balance
				13.50	22	39	11	>50		10cm balance
				15.00	26	31	19	>50		6cm balance

Bore hole terminated at 15.39m depth

Fig : 4

CLIENT	M/s. WAPCOS LTD
PROJECT:	PROPOSED HOSPITAL BUILDING (G+3)
SITE:	GENERAL HOSPITAL TRIVANDRUM
BORE HOLE NO. : BH-**IV**	Date of start::14/02/2020
	Date of completion:14/02/2020
TYPE OF BORING: Rotary Drilling	Ground water table: 8.10 m below GL

Description of soil	Thickness of layer m	Depth in m below GL	Bore log	Standard Penetration Test depth (m)	15 cm	30 cm	45 cm	N Value	Graph of 'N' value 10 20 30 40 50 >50	Remarks
Ordinary Laterite Soil	0.80	0.80								
Lateritic Clayey Sand (Red)	0.90	1.70		1.00	4	4	9	13		
Lateriteic Clayey Sand with Gravel (Red, Brown)	2.80	4.50		2.00	6	7	10	17		
				3.00	18	33	17	>50		8cm balance
Lateriteic Clayey Sand (Red, Brown)	6.15	10.65		4.50	20	31	19	>50		7cm balance
				6.00	21	34	16	>50		10cm balance
				7.50	19	32	18	>50		6cm balance
				9.00	23	35	15	>50		11cm balance
				10.50	21	33	17	>50		10cm balance

Bore hole terminated at 10.65m depth

Fig : 5

CLIENT	M/s. WAPCOS LTD
PROJECT:	PROPOSED HOSPITAL BUILDING(G+3)
SITE:	GENERAL HOSPITAL TRIVANDRUM
BORE HOLE NO. : BH-I (Near Ward No: 7)	Date of start::08/02/2020
	Date of completion:08/02/2020
TYPE OF BORING: Rotary Drilling	Ground water table: 8.10 m below GL

Description of soil	Thickness of layer m	Depth in m below GL	Bore log	Standard Penetration Test depth (m)	15 cm	30 cm	45 cm	N Value	Graph of 'N' value 10 20 30 40 50 >50	Remarks
Ordinary Laterite Soil	0.80	0.80								
Lateritic Clay with Sand & Gravel (Red)	1.20	2.00		1.00	17	23	27	>50		3cm balance
Lateritic Clayey Sand(Red)	7.00	9.00		2.00	28	21	28	49		
				3.00	23	29	21	>50		6cm balance
				4.50	19	35	15	>50		9cm balance
				6.00	25	31	19	>50		9cm balance
				7.50	16	20	26	46		
Lateritic Clay with Sand(Red)	1.90	10.90		9.00	22	34	16	>50		8cm balance
				10.50	26	26	24	>50		5cm balance

Bore hole terminated at 10.90m depth

Fig : 6

CLIENT	M/s. WAPCOS LTD
PROJECT:	PROPOSED HOSPITAL BUILDING (G+3)
SITE:	GENERAL HOSPITAL TRIVANDRUM
BORE HOLE NO. : BH-**II (Near Ward No: 7)**	Date of start::13/02/2020
	Date of completion:13/02/2020
TYPE OF BORING: Rotary Drilling	Ground water table: 8.10 m belowGL

Description of soil	Thickness of layer m	Depth in m below GL	Bore log	Standard Penetration Test					Graph of 'N' value						Remarks
				depth (m)	15 cm	30 cm	45 cm	N Value	10	20	30	40	50	>50	
Ordinary Laterite Soil	0.90	0.90													
Lateritic Clayey Sand with Gravel (Red)	1.10	2.00		1.00	7	8	9	17							
Lateritic Clay with Sand (Red)	8.85	10.85		2.00	13	20	22	42							
				3.00	18	29	21	>50							4cm balance
				4.50	20	30	20	>50							6cm balance
				6.00	10	11	22	33							
				7.50	14	18	24	42							
				9.00	21	31	19	>50							8cm balance
				10.50	23	33	17	>50							10cm balance

Bore hole terminated at 10.85m depth

Fig : 7

DEPARTMENT OF CIVIL ENGINEERING
GOVERNMENT ENGINEERING COLLEGE, THRISSUR
KERALA– 680 009

CED/GEL/2020 /03-03 05-03-2020

SUB SOIL EXPLORATION FOR PROPOSED HOSPITAL BUILDING (G+3) FOR GENERAL HOSPITAL THIRUVANAMTHAPURAM HEALTH & FAMILY WELFARE, DEPARTMENT,GOVERNMENT OF KERALA .

RECOMMENDATIONS

There is a proposal to construct a hospital building (G+3) at General Hospital Thiruvananthapuram for Health and Family Department Govt of Kerala. M/s.WAPCOS Ltd , Cochin is the PMC. It was decided to carry out a detailed sub soil investigation to find out Safe bearing capacity and selection of appropriate foundation for the building. The work was awarded to M/s Precision Survey,D.No.52/334, Janatha, Vyttila. A detailed investigation and laboratory studies were carried out from 04/02/2020 to 26/02/2020.

M/s Precision Survey,D.No.52/334, Janatha, Vyttila requested Anilkumar P S , Associate Professor, Civil Engineering Department Govt Engineering College Thrissur to recommend the foundation for the structure based on the bore logs and test results furnished.

There are six bore holes done at site. In all boreholes , the borehole data indicates good strata of soil from top layer onwards except borehole II. In borehole II,after top ordinary soil of 0.40m thick, lateritic clay with sand was observed with SPT value of 10 at 1m depth and 8 at 2m depth. The laterite clay layer is met at 2.70m depth.

In all other boreholes good laterite layer is available below 2m depth.

Based on the observations at site and test results the following recommendation for safe bearing capacity of foundation was made.

Recommendation for the area BH 1,2,3,4 & BH1&2 (Near Ward7)

Isolated footing with a safe bearing capacity recommended at respective depth is shown below for area near each borehole .

Recommendation for which the area near borehole is applicable	Depth of Footing	Safe Bearing Capacity
BH I	1.20 m	350 kN/m^2
BH II	2.70 m	350 kN/m^2
BH III	2.00 m	300 kN/m^2
BH IV	2.50 m	300 kN/m^2
BH I (Near ward 7)	1.20 m	350 kN/m^2
BH II (Near ward 7)	2.00 m	300 kN/m^2

Recommendations are based on the assumption that the soil profile found in the boreholes tested is indicative of the entire plot area. During execution of work, any deviation in soil profile other than those observed in the borehole tested is noticed, fresh recommendation shall be obtained.

5/3/20

ANIL KUMAR P.S.
Associate Professor in Civil Engineering
Govt. Engineering College
Thrissur, Kerala - 680 009

Ministry of Jal Shakti
(A Government of India undertaking)

1st Floor, JP Krishna Building, Pallimukh Junction,
Pettah, Thiruvananthapuram, Kerala-695024

EPC TENDER DOCUMENT FOR

DEVELOPMENT OF GENERAL HOSPITAL TRIVANDRUM

WAP/INFRA/KERALA/2025/GHT/512

Date: 18.06.2025

VOLUME- V

TENDER DRAWINGS
(Attached separately)

DRAWING LIST				
SL.NO.	**SHEET NUMBER**	**SHEET NAME**	**DISCIPLINE**	**DRAWING NUMBER**
1.	WAP-001	MASTER PLAN	MP	MP-GH-01
2.	WAP-002	DEMOLITION PLAN	DP	DP-GH-01
3.	WAP-003	MAIN BLOCK - GROUND FLOOR LAYOUT	AR	AR-TRO-01
4.	WAP-004	MAIN BLOCK - FIRST FLOOR LAYOUT	AR	AR-TRO-02
5.	WAP-005	MAIN BLOCK - SECOND FLOOR LAYOUT	AR	AR-TRO-03
6.	WAP-006	MAIN BLOCK - THIRD FLOOR LAYOUT	AR	AR-TRO-04
7.	WAP-007	MAIN BLOCK – TERRACE LAYOUT	AR	AR-TRO-05
8.	WAP-008	MAIN BLOCK – TERRACE OHT LEVEL LAYOUT	AR	AR-TRO-06
9.	WAP-009	LAUNDRY BLOCK – SITE PLAN	AR	AR-LB-01
10.	WAP-010	LAUNDRY BLOCK - BASEMENT & GROUND FLOOR	AR	AR-LB-02
11.	WAP-011	LAUNDRY BLOCK - FIRST AND SECOND FLOOR	AR	AR-LB-03
12.	WAP-012	LAUNDRY BLOCK - TERRACE AND OH FLOOR	AR	AR-LB-04
13.	WAP-013	LAUNDRY BLOCK - SECTION AND ELEVATION	AR	AR-LB-05
14.	WAP-014	LAUNDRY BLOCK - SECTION AND ELEVATION	AR	AR-LB-06
15.	WAP-015	SERVICE BLOCK - SITE PLAN	AR	AR-SB-01
16.	WAP-016	SERVICE BLOCK - GROUND & FIRST FLOOR PLAN	AR	AR-SB-02
17.	WAP-017	SERVICE BLOCK - SECOND & THIRD FLOOR PLAN	AR	AR-SB-03
18.	WAP-018	SERVICE BLOCK - FOURTH AND TERRACE PLAN	AR	AR-SB-04
19.	WAP-019	SERVICE BLOCK - SECTIONS	AR	AR-SB-05
20.	WAP-020	SERVICE BLOCK - ELEVATIONS	AR	AR-SB-06
21.	WAP-021	CONTOUR SURVEY PLAN	SP	SP-GH-01

- MP – Master Plan
- DP – Demolition Plan
- AR- Architectural Layout
- SP – Survey Plan

Ministry of Jal Shakti
(A Government of India undertaking)

1st Floor, JP Krishna Building, Pallimukh Junction,
Pettah, Thiruvananthapuram, Kerala-695024

EPC TENDER DOCUMENT FOR

DEVELOPMENT OF GENERAL HOSPITAL TRIVANDRUM

WAP/INFRA/KERALA/2025/GHT/512

Date: 18.06.2025

VOLUME – VI

FINANCIAL BID

CONTENTS

SECTION A

LETTER OF TRANSMITTAL FOR FINANCIAL BID

(In Bidders letterhead)

Dated:

To,
The Project Director
WAPCOS LIMITED
1st Floor, JP Krishna Building, Pallimukku, Pettah
Trivandrum – 695024.
Kerala.

Sub: Financial Bid for Development of General Hospital, Thiruvananthapuram

Dear Sir,

With reference to your Tender document dated …….., I/we, having examined the Bidding Documents and understood their contents, hereby submit my/our Bid for the aforesaid Project. The Bid is unconditional and unqualified.

1. I / We acknowledge that the WAPCOS will be relying on the information provided in the BID and the documents accompanying the BID for selection of the Contractor for the aforesaid Project, and we certify that all information provided in the Bid are true and correct; nothing has been omitted which renders such information misleading; and all documents accompanying the BID are true copies of their respective originals.
2. The BID Price has been quoted by me / us after taking into consideration all the terms and conditions stated in the NIT, draft Agreement, our own estimates of costs and after a careful assessment of the site and all own the conditions that may affect the project cost and implementation of the project.
3. I/ We acknowledge the right of the Authority to reject our BID without assigning any reason or otherwise and hereby waive, to the fullest extent permitted by applicable law, our right to challenge the same on any account whatsoever.
4. In the event of my/ our being declared as the Selected Bidder, I/we agree to enter into a Agreement in accordance with the draft that has been provided to me/us prior to the BID Due Date. We agree not to seek any changes in the aforesaid draft and agree to abide by the same.
5. I / We shall keep this offer as specified in the Tender.
6. I / We hereby submit our BID and offer a Contract Price of Rs. ..... (Rs..... in words) excluding Goods and Services Tax (GST) for undertaking the aforesaid Project in accordance with the Bidding Documents and the Agreement.

Yours faithfully,

Date:

(Signature, name and designation of the Authorized signatory)

Place:

Name and seal of Bidder

SECTION B
SUMMARY OF COST

Particulars	Total Quoted Amount all the components (excluding GST) (INR)	
	Lumpsum (INR) Excluding GST As per "SECTION C COMPONENT WISE BREAKUP- TOTAL"	**In words Lumpsum (INR) Excluding GST** As per "SECTION C COMPONENT WISE BREAKUP- TOTAL"
Estimated Cost Put to Tender Rs. 1,11,49,15,574/- (Ex. GST)		

- The quoted rate filled in component wise breakup, should include all costs associated with the project including any out of pocket/ mobilization expenses, Taxes if any applicable as per Govt. terms, shall be paid by the Contractor excluding Goods and Services Tax (GST).

- It is mandatory to bidders to deposit GST within time limit framed by the Government of India, if applicable.

- The Bidder shall quote rates up to two decimal places in figures and as well as in words. In case of any discrepancy rate quoted in lowest shall prevail.

- The Bidder will have full freedom to design and plan the construction schedule using best practices to achieve quality, durability, reliability, maintainability and safety as specified along with efficiency and economy. The Project risk as that of soil conditions and weather or commercial and technical risk relating to design and construction are assigned to the bidder.

- The Successful Bidder is liable to pay liquidity damages for each day of delay beyond the specified date of completion, subject to total amount of damages not exceeding 10 (ten) per cent of the contract price. However, the successful bidder is entitled to time extension arising out of delays an account of change of the scope and force majeure. The Employer will order for any change in the scope of the project/ component subject to a ceiling of 10% (ten percent) of contract price.

- To ensure quality, regular inspections and quality checks must be carried out. The Authority/ Employer/ Funding Agency shall carryout stage inspections in execution of activities of the project.

- Broad Technical Specifications and Key output parameters has been furnished in the guiding bid document so as to allow sufficient freedom to the successful bidder to optimize design.

- The Authority/ Employer will ensure the handing over of the land/ beachfronts/ corporation land free from encumbrance and without encroachment.

- The Employer will comments on the design proposal submitted by the successful bidder will communicate in a time bound manner i.e to frame mutually agreed with the successful bidder.

- The quoted rates shall also include expenses towards all Quality Control tests prescribed in the IS codes/ PWD Manuals/ CPHEEO Manual and Central/State Pollution Control Board Standards or as directed by the Employer's Representative and to be done at Government Engineering Colleges or Polytechnic Colleges.

- The quoted rates shall include demolition of buildings, services and utilities falling in the project area and supporting/ shifting & making functional existing services/ sewerage, Electrical transmission & Distribution lines and water supply lines etc.

- The Bidder shall agree to pay value or deduct from the bill (post demolition) of demolished building as per PWD, GoK valuation attached as Section D of Volume VI-Financial Bid.

Yours faithfully,

Date: (Signature, name and designation of the Authorized signatory)

Place: Name and seal of Bidder

SECTION C
COMPONENT WISE BREAKUP

Sl. No	Description of Item	Unit	Rate in Rs. Excluding GST (In Figures)	Rate in Rs. Excluding GST (In Words)
Demolition, Planning, Designing, and Construction on EPC Basis with all required services and utilities including handing over with all necessary statutory approvals etc. complete as per Volume IV: Employer's Requirement				
I	**CIVIL WORKS**			
1	All Civil works including retaining wall part of the building.	Lump sum		
2	All Plumbing works internal and external, sewer line , rain water disposal etc. including Underground sump (Domestic & flushing, fire and rain water harvesting) and solar water heater.	Lump sum		
3	External Development of site including cutting , filling and levelling required for rubble retaining wall , road and parking area .Providing bituminous road,paved area for parking , storm water drain and landscaping works etc,			
i	Levelling for Randon Rubble Retaining wall, road & parking area	Lump sum		
ii	Random Rubble Retaining Wall	Lump sum		
iii	Bituminous Road	Lump sum		
iv	Paved road and parking	Lump sum		
v	Drain & Sewer	Lump sum		
vi	Landscaping works	Lump sum		
4	Internal & external signages	Lump sum		
5	RCC retaining wall.	Lump sum		
6	RO Plant (including Dialysis RO)	Lump sum		
II	**FIRE FIGHTING WORKS**			
1	Fire fighting works at Pump room including supply, installation, testing and commissioning of fire pumps, laying of pipes, valves & other accessories and allied works	Lump sum		
2	Fire fighting works at Yard including ring main works, installation of hydrant valves, extinguishers, external fire signages and other accessories	Lump sum		
3	Fire fighting works inside building and at terrace including installation of pipe lines, sprinklers, hydrants, extinguishers, fire	Lump sum		

	signages and other accessories			
III	**HVAC WORKS**			
1	Supply, Installation, testing & Commissioning of Plant Room works incuding chillers, pumps, cooling towers, piping upto risers, pipe fittings, ventilation works, Insulation works, pressurization unit, Electrical works including cabling, earthing & control panels etc with necessary required items for the smooth and complete functioning of HVAC System	Lump sum		
2	Supply, Installation, testing & Commissioning of Riser & floor wise piping works including insulation, valves & fittings, supports etc as per requirement for the complete functioning of HVAC System	Lump sum		
3	Supply, Installation, testing & Commissioning of floor wise ducting and other air side works including insulation, fittings, supports etc as per requirement for the complete functioning of HVAC System	Lump sum		
4	Supply, Installation, testing & Commissioning of floor wise low side equipments such as Air handling units, Fan coil units etc with necessary supports & other accessories etc as per requirement for the complete functioning of HVAC System	Lump sum		
IV	**LIFTS**			
1	Supply, installation, testing and commissioning of Lifts including comprehensive maintenance contract (CMC) Cost for 5 Years	Lump sum		
V	**ETP & WTP**			
	Supplying testing and commissioning of ETP &WTP including plant room	Lump sum		
VI	**ELECTRICAL WORKS**			
1	Internal electrification works - including supply, installation, testing and commissioning			
	Internal electrical works including wiring points for light, ceiling fan,exhaust fan,wall fan, small power points, low side HVAC points, power points for ELV system, distribution boards, cabling from DB to floor panel boards/VDBs, floor panels/VDBs, rising mains, panels for	Lump sum		

	various services (Electrical/Mechanical/Biomedical services), cable support systems(trays or similar items). Note:- 1.Wiring points shall include all containment system like pipes & accessories, wires, boxes, switches, sockets, ceiling roses, junction boxes, glanding boxes, termination accessories & hardwares and labour charges. 2. Work shall include supply, installation testing and commissioning of items like lights, fans, distribution boards, panel boards (non-essential & essential), rising mains, cables, cable support system (trays and similar items), final connection accessories from outlet to the fixture, fire sealing materials and labour charges. 3. Work shall include SITC of earthing, lightning protection system and surge protection system works. 4. Work shall include SITC of automation system for lighting and other charges to comply with GRIHA rating.			
2	Supply, installation, testing and commissioning of UPS, capacity 420 kVA (total capacity), BMS compatible, modular type 30 minutes back up with SMF batteries including interconnecting cables, racks and all other accessories.	Lump sum		
3	Supply, installation, testing and commissioning of Substation equipment including: 1. Dry type transformers of 2000kVA capacity (total capacity), off load tap changer 2. Busduct from Transformer to AMF panel 3. Essential & Non-essential panels 4. Utility panels 5. Main LT panel cum AMF panel 6. APFC cum harmonic suppression panel 7. Indoor HT panel 8. HT cables between RMU, Indor HT	Lump sum		

	panel and Transformer 9. LT cables - within sub station, other panel boards located in the main building, mechanical equipment (UPS, HVAC, Fire, ETP, STP, Plumbing services, Bio medical equipment) 10. Earthing 11. Auxiliary power supply equipments UPS, distribution boards 12. Control cables 13. Cable containment system/Cable tench/Cable tray/hume pipe/GI pipe etc necessary for laying cables from and to substation 14. Safety equipments, charts, drawings, O & M manuals etc.			
4	Supply, installation, testing and commissioning of DG set consists of the following:- 1. 1500kVA DG set (total capacity) 2. Generator control panel 3. Busduct/Cable between DG set, GCP and AMF panel 4. Fuel tanks, fuel piping and first fill of Diesel 5. Earthing and surge protection system works 6. Exhaust piping with cladding and supporting steel structure (if required) as per PCB regulations 7. Control cable 8.Earthing	Lump sum		
5	Supply, installation, testing and commissioning of Roof top mounted Solar PV station, Off grid type including: 1.Mono/Poly Crystalline silicon solar cells 2.Data Monitoring System complete with accessories. 3.Power conditioning unit 4.Net metering and reverse power protection facility 5.Earthing, Lightning and surge protection system works 6.Supporting Aluminium/GI structure	Lump sum		
6	Supply, installation, testing and	Lump sum		

	commissioning of LED street lights includes: 1. Location: Parking area, Internal roads 2. LED weather proof street light 3. GI octagonal pole (either single arm or double arm) 4. RCC foundation with anchor bolts 5. Feeder pillar with automation arrangement & RCC foundation 6. Earthing 7. Armoured cables from feeder pillar to street lights as per circuit design 8. incoming supply cable to feeder pillar Note:- a.Armoured cable from feeder pillar shall be laid under ground by complying relevant specifications. b.Height of the pole shall be matching with road width and to illumination level shall be as per standards			
VII	**ELV WORKS**			
1	Supply, installation, testing and commissioning of Addressable fire alarm/public address/talk back system 1. Addressable fire alarm system consists of devices, detectors, control panel, software, server, cabling, cable support system etc to fullfil the statutory requirements. 2. Public address cum voice evacuation system consists of speakers, amplifiers, call stations, routers, controller, music player, cabling etc. to full fil the statutory requirements 3. Talk back fire fighters telephone system consists of Fire fighters console, controller, push buttons station, microphone, fire fighter telephone jack, FF telephone hand sets, cabling etc. to full fil the statutory requirements	Lump sum		
2	Supply, installation, testing and commissioning of IP based CCTV system consists of the following:- 1. Field devices like cameras, POE switches, patch panel, floor racks, head end equipments like NVR, Hard disk, Video management software, Main rack, Server PC, Storage Disk, LED display, wiring and conduits etc.	Lump sum		
3	Supply, installation, testing and	Lump sum		

	commissioning of Access control system consists of following:- 1. Door controllers, Electro magnetic locks, Entry /Exit devices, master controller, software, wiring etc.			
4	Supply, installation, testing and commissioning of Telephone system consists of following:- 1.Telephone points with RJ11 sockets, 2 pair wiring, conduits upto floor telephone box 2. Floor telephone boxes, multi pair wires from floor jn box to MDF, cable containment system 3. MDF, PABX, interconnections, external cable entry arrangement etc.	Lump sum		
5	Supply, installation, testing and commissioning of Data network system consists of following:- 1.Data points with RJ45 sockets, 4 pair UTP wiring, conduits upto floor rack 2. Patch panel, Ethernet switch, rack, patch cords etc in all floors 3. Main rack, Layer 2 or Layer 3 switch as per design, LIU, Fiber uplink or copper uplink as per design	Lump sum		
6	Supply, installation, testing and commissioning of Intelligent Building Management System consists of following:- 1. Field devices like temperature/smoke/CO/humidity sensors, flow meters, direct digital controllers, cable from field devices to DDCs 2. LAN works, server, software etc.	Lump sum		
7	Supply, installation, testing and commissioning of IP based Nurse call system consists of following:- 1. Patient bed side devices like call/cancel buttons, room terminal, lamp module, Toilet side devices like pull cord, lamp module, Cat 6 wiring, conduits etc. 2. Main controller, software and monitoring station	Lump sum		
VIII	**MGPS**			
2	Supply, installation, testing and commissioning of Medical Gas Pipeline System (MGPS) along with Required Manifold, Plant Room Equipment and other accessories including	Lump sum		

	comprehensive maintenance contract (CMC) Cost for 5 Years as per the approved drawings & Technical Specification.			

SECTION D
VALUATION DETAILS

Sl No	Name of building proposed for demolition	Valuation Amount (Rs)
1.	Main office building	12,80,554.85
2.	Security room	13,664.99
3.	Kiosk	3,802.60
4.	Old Matron Office	1,84,201.25
5.	Respiratory OP	82,761.02
6.	Paediatric OP	96,782.61
7.	Cancer Care & Chemotherapy unit	2,56,162.76
8.	Paediatric Ward (Ward 10)	3,67,044.14
9.	Canteen building	1,13,519.91
10.	Veranda of Radiology Department	6,837.82
11.	Rabies Clinic	61,906.03
12.	Car parking porches	31,277.68
13.	Ward 7	6,14,894.86
14.	Ward 6	1,39,284.70
	TOTAL	**32,52,695.22**