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*Request for Proposal:*

*Supply, Installation, Testing & Commissioning of Low Side HVAC System at Gopalpur Palm Resort for Swosti Premium Ltd., Gopalpur, Ganjam,*

*on*

*Item Rate Contract Basis*

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## INTRODUCTION

### **Background**

Swosti Premium Ltd., a leading hospitality group in Odisha, the owner and developer of a hospitality project titled Gopalpur Palm Resort located at Gopalpur, Odisha(hereafter referred to as “The Client”) is undertaking the development of a world-class hospitality destination under the brand “**Gopalpur Palm Resort**” at Gopalpur-on-Sea, District Ganjam, Odisha. The project envisions a premium coastal resort comprising a luxury hotel of B+G+9 storied building with 124+ keys, banquet and MICE facilities, restaurants, landscaped areas, spa & wellness, swimming pools, and associated amenities.

In pursuit of delivering a high-standard facility within a fixed timeframe, Swosti Premium Ltd. intends to select a reputed Executing Agency with tie-up with Original Equipment Manufacturers(OEMs) for Supply, Installation, Testing & Commissioning of Low Side HVAC System at Gopalpur Palm Resort for Swosti Premium Ltd.,Gopalpur, Ganjam, on a **Item Rate Contract** Basis.-

### **Project Summary**

<b>Pkg No.</b>	<b>Name of Work</b>	<b>Estimated Cost</b>	<b>Construction Period</b>	<b>Maintenance Period</b>
2	Supply, Installation, Testing & Commissioning of Low Side HVAC System at Gopalpur Palm Resort for Swosti Premium Ltd.,Gopalpur, Ganjam,	₹760 Lakhs*	6(Six) Months	1 Year (DLP)+ 5 (Five) Years Paid

\*Estimated Cost is exclusive of GST and based on current project planning and scope.

### **Scope of Work**

The selected Bidder (hereafter referred to as the “**Contractor**”) shall be responsible for the following deliverables as per the terms of the Item Rate Basis contract:

- **Supply, Execution, Testing & Commissioning** based on issued GFC drawings
- **Procurement & Execution** of materials, manpower, equipment, and tools
- **MEP related facilitation with Civil Contractor in Coordination** with PMC as per client-appointed agency’s requirement.

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## **PREAMBLE**

- 1 The work shall be carried out strictly in compliance with this tender and design requirement. The onus of demonstrating satisfactory performance of entire system shall be sole responsibility of the contractor and supplied material shall be as per specifications and approved shop drawings. Relevant Indian Standards shall be adhered. It is to be understood that all liabilities and risks arising out of the stated conditions of contract shall be covered by contractor and Owner/Consultant shall be indemnified.
- 2 The unit rate for all items in the BOQ shall be quoted in Indian Rupees (INR) and include cost of equipment, wastage, accessories, tools, appliances, labour, installation, testing & commissioning upto satisfactory handover.
- 3 The contractor shall ensure that unit price of each item includes cost of Equipment, materials, fixing accessories, appliances, tools, plants, transport, labour and incidentals required in preparation for and in the full and entire execution, testing, balancing, commissioning and completion of work called for in the item and as per Specifications and Drawings.
- 4 The contractor to ensure that all waste and debris is collected and satisfactorily disposed off from site.
- 5 The contractor shall ensure that unit price of each item includes loading, transporting, unloading, handling/double handling, hoisting to all levels, setting, fixing in position and insurance upto satisfactory handover including security.
- 6 The specifications and drawings shall be read in conjunction to the Bill of Quantities. In case of conflict between Bill of Quantities and other documents including the specifications, the most stringent shall apply. The interpretation of the Architect / Consultant /Project Manager shall be final and binding
- 7 The quantities mentioned in the BOQ are for contractor guidance only.The actual procurement of material shall be done only after written approval of shop drawings & technical submittals. This shall also apply to the Contractor's requisition for Owner supplied materials. The contractor shall be solely responsible for material supplied at site.
- 9 The contractor shall ensure work is carried out in conformity with the approved shop drawings and taking cognizance of latest architectural and other disipline drawings. The execution at site should be based on coordinated shop drawings or after obtaiing written approval of Project Manager/Architect/Consultant.
- 10 The progress of work shall be in accordance with approved pert chart which will be prepared by Contractor at the time of award of work and duly revised from time to time.
- 11 All shop drawings will be made on Autocad or Revit as per Project Manager requirement. Coloured prints shall be provided for site work. The shop drawings will clearly indicate requirement of hangars, supports, quantities and instructions for installation.
- 12 The information contained in this bid document, or any other information subsequently provided to Bidders—whether verbally, in documentary form, or by any other means—by or on behalf of the Client or any of its employees or advisers, is provided to the Bidders on the terms and conditions set out in this bid and such other terms and conditions subject to which such information is provided.
- 13 This bid document is not an agreement, nor is it an offer or invitation by the Client to any prospective Bidder or any other person. The purpose of this bid is to provide interested Bidders with information that may be useful in formulating their Proposals pursuant to this bid process. This document includes statements that reflect various assumptions and assessments made by the Client in relation to the Services. Such assumptions, assessments, and statements do not purport to contain all the information that each Bidder may require. This bid may not be appropriate for all persons, and it is not possible for the Client, its employees, or advisers to consider the objectives, technical expertise, and particular needs of each party who reads or uses this bid.
- 14 The assumptions, assessments, statements, and information contained in this document may not be complete, accurate, adequate, or correct. Each Bidder should therefore conduct its own investigations, analysis, and due diligenG.M(B D),Swosti Premium Ltd and should check the accuracy, adequacy, correctness, reliability, and completeness of the information contained in this

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bid and obtain independent advice from appropriate sources. Information provided in this bid to Bidders covers a wide range of matters, some of which depend on interpretations of law. The information provided is not an exhaustive account of statutory requirements and should not be regarded as a complete or authoritative statement of law. The Client accepts no responsibility for the accuracy or otherwise of any interpretation or opinion on the law expressed herein.

- 15 The Client, its employees, and advisers make no representation or warranty and shall have no liability to any person, including any Bidder, under any law, statute, rule or regulation, or under the principles of tort, restitution, or unjust enrichment, for any loss, damage, cost, or expense which may arise from or be incurred or suffered on account of anything contained in this bid or otherwise, including the accuracy, adequacy, correctness, reliability, or completeness of this document, or any assumption, statement, or information contained in or deemed to form part of this bid, or arising in any way in this selection process.
- 16 The issuance of this bid document does not imply that the Client is bound to select any Bidder for the provision of the Services, and the Client reserves the right to reject all or any of the Proposals without assigning any reasons whatsoever. •The Client may, in its absolute discretion—but without being under any obligation to do so—update, amend, or supplement the information, assessment, or assumptions contained in this bid.
- 17 The Bidder shall bear all its costs associated with or relating to the preparation and submission of its Proposal, including but not limited to preparation, copying, postage, delivery fees, expenses associated with any demonstrations or presentations which may be required by the Client, or any other costs incurred in connection with or relating to its Proposal. All such costs and expenses shall remain with the Bidder, and the Client shall not be liable in any manner whatsoever for the same or for any other costs or expenses incurred by a Bidder in the preparation or submission of the Proposal, regardless of the conduct or outcome of the selection process.

**Swosti Hotels**

(A Unit of Swosti Premium Ltd.)

Corporate Office: Swosti Premium,  
Jaydev Vihar, Bhubaneswar – 751013, Odisha

Email: [info@swostihotels.com](mailto:info@swostihotels.com)

Website: [www.swostihotels.com](http://www.swostihotels.com)

**File No.: PMC/SPL/GPR/2025/01**

**Letter No.: 002 / Gopalpur, Date: 10th March 2026**

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## **LETTER OF INVITATION**

Swosti Premium Ltd, on behalf of Gopalpur Palm Resort (A Unit of Swosti Premium Ltd), invites sealed bids for the Supply, Installation, Testing & Commissioning of Low Side HVAC System at Gopalpur Palm Resort for Swosti Premium Ltd.,Gopalpur, Ganjam, on a Item Rate Contract Basis for selection of a qualified agency to whom the project may be awarded.

The bid documents will be made available from 10.04.2026 10.00 am IST to 27.04.2026 5 pm IST at designated link or upon request physically from Swosti Corporate Office, Bhubaneswar or through official mail ID .Bid document can be downloaded from the website - <https://www.swostihotels.com/tenders.html>

The completed proposals shall be submitted in hard copy (physical submission) at the address specified in the bid document no later than 4:00 PM on 28.04.2026.

Three days before the scheduled Pre-Bid Meeting the intending bidders are requested to visit the site for accessing bid document and submit their queries in written form via their official mail ids or through registered postal service addressed to Swosti corporate office.

The Pre-Bid Meeting will be held on 17.04.2025 at 12.00 Noon via Zoom/Physical mode. Meeting link/Venue shall be shared subsequently.

All received proposals will be opened at 5:00 PM on 28.04.2026 in the presence of authorized representatives of the bidders (not mandatory), at the venue communicated via email.

Swosti Premium Ltd reserves the right to reject any or all bids without assigning any reason thereto and shall not be liable for any costs incurred by bidders in the preparation or submission of proposals.

All subsequent corrigenda, clarifications, or updates (if any) will be circulated through official communication only via:

gm.communications@swostihotels.com

pmc.swosti@arkitechno.com

**Gopalpur Palm Resort**

**(A Unit of Swosti Hotels)**

**gm.communications@swostihotels.com**

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**Swosti Premium Ltd. Gopalpur Palm Resort Project,Gopalpur,Ganjam**

DATED: 10.04.2026

**DETAILED TENDER NOTICE**

1. Last Date & Time of issue of tender documents from 10.04.2026 to 27.04.2026
2. Last Date & Time of receipt of tender 28.04.2026 upto 4.00 p.m.

G.M(B D),SWOSTI PREMIUM LTD Swosti Premium Ltd ,Bhubaneswar on behalf of Swosti Premium Ltd invites sealed item rate tenders from eligible contractors for similar works.

Name of work: **Supply, Installation, Testing & Commissioning of Low Side HVAC System at Gopalpur Palm Resort for Swosti Premium Ltd.,Gopalpur, Ganjam,**

Estimated cost of work put to tender : Rs. 660 Lacs  
Time of completion : 9 Months

Earnest Money Deposit: **Rs. 6,60,000/- (Rupees Six Lacs Sixty Thousand only)** is to be submitted with tender document as earnest money. The above payment shall be made in the shape of deposit at pay order/demand draft of a scheduled bank issued in favour of **Swosti Premium Ltd payable** at New Delhi.

Works to be completed in coordination with the main Civil & MEP Interior works contractor. No extra for non-availability of fronts or coordination with main agency shall be payable on account of the same.

Tender documents can be downloaded from SWOSTI PREMIUM LTD website ([www.Swosti Premium Ltd .ac.in](http://www.Swosti Premium Ltd .ac.in)) and submitted with non-refundable DD of **Rs. 11800/-** in favour of **Swosti Premium Ltd** as cost of tender.

- 1) The tenders shall be placed in sealed envelopes with a name of work and due date written on the envelope and addressed to the G.M(B D),SWOSTI PREMIUM LTD SWOSTI PREMIUM LTD. Complete tender documents shall be submitted by the approved contractors in two envelopes. 1st envelope shall contain the earnest money in the shape of Demand Draft / Pay Order of a scheduled Bank requisite shape as per condition & eligibility criteria and cost of tender as stated above along with "Technical Bid " and supporting documents . The 2nd sealed envelop shall contain the "Financial Bid" . Both the sealed envelops shall be contained in another envelop , sealed and super scribed with the "Name of the Work", the name and detailed address of the bidder as well as contact phone number & e-mail id. This sealed envelop has to be submitted at designated place as indicated in the bid document.
- 2) The eligible contractors who have carried out similar works in Reputed Private Hotel Chain/Govt Depts/PSU/Reputed Pvt sector /MNCs are to submit the experience certificates for the works and registration certificates with Govt. Depts. if any. The said certificates along with the EMD be enclosed in Envelope-1.

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- 3) Experience of having successfully completed similar works during last seven years ending on the 30th June 2023. **The Similar works shall mean Lowside HVAC works of Minimum 2X600 TR capacity Water/Air cooled screw chiller.** The value of executed works shall be brought to current costing level by enhancing the actual value of work at simple rate of 7% per annum calculated from date of completion to last date of receipt of tenders.

Three similar works not less than 40 % of est.cost	Rs 250.00 lacs each Or
Two similar works not less than 60 % of est cost	Rs 400.00 lacs each Or
One similar work not less than 90 % of est cost	Rs 600.00 lacs each

The work of similar nature should have been executed under Central/State/Autonomous/Central PSU/State PSU/local authority/Reputed Hotelier Group formed under any Act in Central/State .

- 4) **The bidder should provide letter of commitment from Original Equipment Manufacturer or authorized dealers of OEM and certificate/corroborative documentary evidences from any of Approved Manufacturer for all equipment/Items listed at Annexure-II of Section BOQ, SPECIFICATIONS & TENDER DRAWINGS: To be submitted by selected bidder within 15 days of signing of contract.**
- 5) The applications not supported with requisite experience certificates, GST registration certificate and ITCC in Envelope-1 shall not be entertained
- 6) Solvency certificate for Rs. 300 lacs from any nationalized /scheduled bank. The applicant shall submit the solvency certificate, not older than six months prior to 30<sup>th</sup> September 2025, issued by any scheduled bank, in original.
- 7) Average Annual Turnover over HVAC works (Lowside) should be at least Rs 1300 lacs during immediate last 3 consecutive financial years ending 31<sup>st</sup> Mar 2025.
- 8) Should not have incurred any loss in the more than two years in the last five years ending 31<sup>st</sup> Mar 2025.
- 9) Company should not have been barred / blacklisted for taking up similar work in any organization- A certification to this effect on the letter head of the bidder.
- 10) Performance certificates issued by past employers must be submitted by the vendors for the works.
- 11) Bidder shall furnish list of the supervisory persons and other technical persons he wishes to deploy in this job along with their experience details.
- 12) Letter of Authority for signing and negotiation of bid.
- 13) The 2<sup>nd</sup> **envelope** shall contain the financial bids including Priced Schedule of Quantities sealed,

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14) The 1<sup>st</sup> envelop should contain Form of Tender, Conditions of Tender, Articles of Agreement, Brief Specifications, Condition of contract, Drawings all duly signed by the authorized signatory of the firms.

1<sup>st</sup> and 2<sup>nd</sup> envelopes are to be put in a single envelope duly super-scribed the name of work, and addressed to G.M(B D),SWOSTI PREMIUM LTD and with their address. In case the tenderer does not fulfill the laid down eligibility criteria or fails to deposit the earnest money in prescribed form, financial bid shall not be opened.

Tenderers shall seal the tender after affixing their initials and put stamp on each and every page of tender document before submission. The tender of the contractor, who submits in-complete tender document or submits more than one tender for one work, shall not be considered at all.

Tenders will be received by the **G.M(B D),SWOSTI PREMIUM LTD up to 4.00 P.M on 28.04.2026** and will be opened by him or his authorized representative in the office of Registrar, SWOSTI PREMIUM LTD on the same day at **5.00 P.M.**

First the Technical Bids will be opened and screened. The bids shall be examined whether the EMD is in order and the bidder meets the minimum eligibility criteria specified above. . Those bidders whose EMD is in order, meets the minimum eligibility criteria, has submitted all the required documents and meet the technical requirements shall be considered for opening of financial bid. Conditional tenders would not be accepted. Financial bids in respect of contractors who do not fulfill above criterion shall not be opened.

15) No Xerox / certified copies of tenders shall be accepted, if submitted these tenders shall be rejected.

16) **Pre- bid meeting** - A pre bid meeting will be held as on **17<sup>th</sup> March 2026** at 12.00 Noon - Any doubts or queries of the potential bidders will be addressed during the meeting. Venue: Hotel SWOSTI PREMIUM LTD

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### **SECTION-1 INSTRUCTION TO BIDDERS (ITB)**

1. The time allowed for carrying out the construction work will be 6 months from the 7<sup>th</sup> day after the date of written orders to commence the work.
2. The site for the work is available.
3. During execution of works, because of some unforeseen circumstances to enable him to complete the work as per terms of the contract, shall not relieve the contractor from any liability or obligations under the contract and he shall be responsible for the acts, defaults and neglects of any sub-contractor, his agents or workmen as fully as if they were the acts, defaults or neglects of the contractor, his agents or workmen.
4. The Contractor shall be required to deposit an amount equal to 3% of the tendered value of the work as performance guarantee in the form of an irrevocable bank guarantee bond of any scheduled bank or State Bank of India in accordance with the form prescribed or in the form of fixed deposit receipt etc. within 15 days of the issue of letter of acceptance. The performance guarantee shall have the validity up to 31st Jan 2027.
5. Tenderers are advised to inspect and examine the site and its surrounding at their own cost and satisfy themselves before submitting their tenders as to the nature of the ground and sub-soil (so far as is practicable), the form and nature of the site, means of access to the site, the accommodation they may require and in general shall themselves obtain all necessary information as to risk, contingencies and other circumstances which may influence or affect their tender. A tenderer 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 tenderer shall be responsible for arranging and maintaining at own cost all materials, tools and 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 tender by a tenderer implies that he has read this notice and all other contract documents and has made himself aware of the scope and specification of the work to be done, local condition and other factors having a bearing on the execution of the work.
6. The Accepting Authority -SWOSTI PREMIUM LTD does not bind himself to accept the lowest or any other tender and reserves to him/herself the authority to reject in whole or part, any or all of the tenders received without the assignment of any reason. All tenders in which any of the prescribed conditions are not fulfilled or for any condition including that of conditional rebate is put forth by the tenderer shall be summarily rejected.

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7. Canvassing, whether directly or indirectly, in connection with tenders is strictly prohibited and the tenders submitted by the contractor who resort to canvassing will be liable to rejection.
8. The Accepting Authority reserves to himself the right of accepting the whole or any part of the tender and the tender shall be bound to perform the same at the rates quoted.
9. Tenders shall remain open for acceptance for a period of 60 days from the date of opening of the tenders. If any tenderer withdraws his tender before the said period for issue of letter of acceptance, whichever is earlier or makes any modification in the terms and condition of the tender which are not acceptable to the SWOSTI PREMIUM LTD , then SWOSTI PREMIUM LTD shall, without prejudice to any other right or remedy, be at liberty to forfeit the said earnest money absolutely besides black listing of the tenderer.
10. The notice-inviting tender shall form a part of the contract document. The successful tenderer/contractor shall, sign the necessary contract documents consisting of the notice inviting tender, all the documents including additional conditions, specification and drawings, if any forming the tender as issued at the time of invitation of tender and acceptance thereof with any correspondence leading thereto within the time specified in the letter communicating the acceptance of the tender. In case of delay, the earnest money may be forfeited and the tender cancelled or the contract enforced as per the terms of the tender and the invitation to tender and the tenderer shall thus be bound by the condition of contract even though the formal agreement has not been executed and signed within the specified time by the tenderer.
11. The work shall be carried out as per general of conditions of contract (Tender Contract) and form part of the agreement/document.
12. Contract is liable to be terminated by the SWOSTI PREMIUM LTD without payment of any compensation, if subsequent to the acceptance of tender the contractor is black- listed by, or enters into partnership of any black listed contractor of the SWOSTI PREMIUM LTD or any other department, or Govt. or its, undertakings.
13. Cost of Bidding
  - 13.1 The bidder shall bear all costs associated with the preparation and submission of his Bid, and the Employer will in no case be responsible and liable for those costs.
14. Clarification of Bidding Documents
  - 14.1** A prospective bidder requiring any clarification of the bidding documents may notify the Employer in writing/mail at the Employer's address indicated in the invitation to bid not later than 3 days before the Date of Submission of Tenders. Email- [admin-project@Swosti Premium Ltd.ac.in](mailto:admin-project@Swosti Premium Ltd.ac.in)

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15. Currencies of Bid and Payment

15.1 The unit rates and the prices shall be quoted by the bidder entirely in Indian Rupees. All payments will be invariably made in Indian Currency (Indian Rupees.)

16. PROTECTION OF ENVIRONMENT AND OTHER LAWS:

The contractor shall take all reasonable steps to protect the environment on and off the Site and to avoid damage or nuisance to persons or to property of the public or others resulting from pollution, noise or other causes arising as a consequence of his methods of operation.

During continuance of the contract, the contractor and his sub-contractors shall abide at all times by all existing enactments on environmental protection and other local Acts/ Laws/ rules made there under, regulations, notifications and bye-laws of local authorities or any other law, bye-laws, regulations that may be passed or notification that may be issued in this respect in future by the State/ Local authority.

17. Evaluation of Bids Received : Detailed at following section

For and on behalf of the  
Swosti Group of Hotels, Resorts, Travels & Educations  
GM Corporate Communications.  
Cell- 9938244538  
Email: [gm.communications@swostihotels.com](mailto:gm.communications@swostihotels.com)

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### Bid Data Sheet

#### Bid Identification No.: SWOSTI/GPR/TENDER/CCW/02/2025-26

The Swosti Premium Ltd., invites sealed, offline bids from reputed and experienced civil construction firms for the following work on Item Rate basis contract. Project details are as under:

#### Tender Summary

Sl. No.	Particulars	Details
1	Name of Work	<b>Supply, Installation, Testing &amp; Commissioning of Low Side HVAC and Allied Works at Gopalpur Palm Resort for Swosti Premium Ltd., Gopalpur, Ganjam, on Item Rate Contract Basis</b>
2	Project Location	Plot No. 182/552/617 & 184/618, Khata No. 102 (AJA), Gopalpur-on-Sea, Ganjam District, Odisha
3	Nature of Contract	Item Rate Contract
4	Estimated Project Cost	₹660 Lalhs (Six Hundred Sixty Lakhs Only)
5	Time for Completion	09(Nine) Calendar Months from date of LOA
6	Number of Packages	01 (One)
7	Eligibility	Reputed private sector entities having successfully completed similar scale works. <b>Relevant Project Experience must include:</b> <ul style="list-style-type: none"><li>•IT/Hotel/Office Buildings</li><li>•Commercial or Hospitality Projects</li></ul>
8	Cost of Tender Document	₹11,800/- (Including GST)(Non-refundable, to be paid via Demand Draft(DD) in favor of "Swosti Premium Ltd.")- Including GST
9	Availability of Tender Documents	From 10.04.2026 to 27.04.2025 up to 5.00 PM – a) From the Swosti Hotels website - <a href="https://www.swostihotels.com/tenders.html">https://www.swostihotels.com/tenders.html</a>
10	Seeking Queries on RFP Document(Through email/Letter)	21.04.2025 upto 3:00 PM a) E-mail id. <a href="mailto:manoj@arkitechno.com">manoj@arkitechno.com</a> b) Address : Swosti Hotels Corporate Office: Swosti Premium, Jaydev Vihar, Bhubaneswar – 751013, Odisha
11	Pre-Bid Meeting	17.08.2025 at 12:00 Noon at Swosti Corporate Office, Bhubaneswar/ In virtual mode
12	Last Date of Submission of Bids	28.04.2026 up to 4:00 PM (Sealed Envelopes at Swosti Corporate)
13	Opening of Technical Bids	28.04.2026 at 5:00 PM in presence of PMC & Client

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Sl. No.	Particulars	Details
14	Technical Presentation (By technically qualified bidders)	Not Applicable (Exact date and time shall be informed to qualified bidders atleast 48 hours of date of presentation)
15	Opening of Financial Bids	Exact date and time shall be informed to qualified bidders atleast 48 hours of date of opening.
16	Mode of Tender	Offline, Physical Submission – Two Envelope System (Technical + Financial)
17	Bid Validity	90 Days from Last Date of Submission of Bids
18	Communication Email	<a href="mailto:manoj@arkitechno.com">manoj@arkitechno.com</a> <a href="mailto:pmc.swosti@arkitechno.com">pmc.swosti@arkitechno.com</a>

The bids must be submitted in hard copy (manual mode) in two separate sealed envelopes contained in another sealed envelope, marked clearly as “Technical Bid” and “Financial Bid”, mentioning the name and address of bidder, superscribed with title of work put to bids, along with all documents as prescribed in the bid document hereunder.

The client reserves the right to cancel the bidding process and/or reject any or all bids without assigning any reason there to. Corrigendum to bidding process/bid document if issued, subsequent to pre-bid meeting, shall be shared directly with bidders seeking clarification on or before pre-bid meeting/ participating in pre-bid meeting via email provided by them.

*Authorized Signatory*

Mr. Nihar Ranjan Sahoo, GM Corporate Communications.

Swosti Group of Hotels, Resorts, Travels & Educations

Cell- 9938244538

Email: gm.communications@swostihotels.com

Gopalpur Palm Resort Project  
On behalf of Swosti Premium Ltd.

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## Evaluation Criteria

(Clause 1.1 of Instructions to Bidders – Gopalpur Palm Resort Project)

### INTRODUCTION

- This Evaluation Criteria outlines the method by which bidders for the bids received will be evaluated based on their technical and financial qualifications, experience, project-specific understanding, organizational setup, and resource readiness.
- The evaluation will be conducted in accordance with the Instructions to Bidders (ITB) and is applicable to **Cover-I: Technical Bid**. Only those bidders who qualify under the technical evaluation will be considered for the opening and evaluation of their **Cover-II: Financial Bid**.

### EVALUATION OF TECHNICAL BID (COVER-I)

The Technical Bid will be evaluated based on the following five main criteria:

Sl. No	Evaluation Criteria	Maximum Marks
a	Financial Strength	25
b	Experience in Similar Nature of Work	25
c	Working Methodology and execution of similar nature of work(DBR)	25
d	Key Personnel	25
	<b>Total</b>	<b>100</b>

### Criteria/Sub-Criteria of TECHNICAL EVALUATION

#### **Financial Strength – 25 Marks**

Component	Max. Marks	Evaluation Basis
(i) Annual Financial Turnover (as per Bid Data Sheet)	20	70% marks for minimum eligibility criteria; 100% for twice the minimum. In between – on pro-rata basis.
(ii) Liquid Assets (as per Clause of Bid Data Sheet)	5	70% marks for minimum eligibility criteria; 100% for twice the minimum. In between – on pro-rata basis.

#### **Experience in Similar Nature of Work – 25 Marks**

Description	Max. Marks	Evaluation Basis
Completion of Similar Projects of Bid Data Sheet)	25	70% marks for minimum eligibility; 100% for twice the minimum. In between – on pro-rata basis.

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**Methodology and Work Program – 25 Marks**

Bidder shall submit a detailed Design Basis Report covering approach to execution of civil works.

Assessment will be based on content, specificity, and alignment to project needs.

Component	Marks
Technical Specifications for Materials & Workmanship	10
Project Execution Schedule / Work Programme	10
Approach & Methodology (project-specific)	5
<b>Total</b>	<b>25</b>

**Key Personnel – 25 Marks**

The following key personnel must be proposed and CVs submitted:

Position	Qualifications & Experience	Max. Marks	Evaluation Basis
<b>Project Manager(1 No)</b>	B.E./B.Tech Mech/Elect with 10+ years	15	Graduation (5), Experience ( Exp. 10 yrs-7 , Higher - 10)
<b>Site Engineer-HVAC (1 No)</b>	B.E. with 3 yrs/Diploma with 7+ years in Mech	5	Graduation (2),Dip- (1), Experience ( Exp. 7 yrs-2 , Higher - 3)
<b>Site Engineer-Elect (1 No)</b>	B.E. with 3 yrs/Diploma with 7+ years in Elect	5	Graduation (2),Dip- (1), Experience ( Exp. 7 yrs-2 , Higher - 3)

**GENERAL NOTES**

- Bidders must furnish all necessary supporting documentation for substantiating the information.
- Only those bidders who score **70 marks or more (out of 100)** in Technical Evaluation shall be considered for opening of their “Financial Proposal”

**Enhancement Factors for Past Financial Years (for Turnover/Experience Updating):**

Year Before	Enhancement Factor
One	1.10
Two	1.21
Three	1.33
Four	1.46
Five	1.61

[Type here]

**SECTION-2-FORMS & FORMATS**

[Type here]

## **DOCUMENTS TO BE FURNISHED BY BIDDER**

1. Documents as specified in Section 1, must be submitted by the Bidder in the Formats mentioned in Section 2 along with the BID.
2. Any other document, if asked by Employer for clarification during evaluation, shall be submitted by the bidder.

### **CHECKLIST OF DOCUMENTS TO BE SUBMITTED IN TECHNICAL BID**

	<b>Criteria</b>	<b>Document to be submitted</b>	<b>Submitted (Yes/No)</b>
1	Cost Of Bid Document	DD/BC	
2	EMD/ Bid Security -	In the form of BG/Bid Security fee deposit details.	
3	Written power of attorney of the signatory of the Bid to commit the Bidder(If any)	Copy of power of attorney	
4	Whether Indian firms (Y/N)	Certificate of Incorporation	
5	OEM firms with proven track record of execution of similar HVAC Projects in IT buildings, commercial complexes, hospitality projects, or high-rise structures (G+9 or above).	Relevant Certificate	
6	Constitution or legal status of Bidder	Incorporation Certificate, Partnership Deed, Trade License, MoA, AoA	
7	Place of registration	Qualification Information	
8	Principal place of business	Qualification Information	
9	Major items of construction equipment proposed to carry out the Contract	Invoices of equipment / Lease agreement/Letter of Commitment	
10	Qualifications and experience of key site management and technical personnel proposed for the Contract	Detailed CV	
11	Reports on the financial standing of the Bidder, such as profit and loss statements and auditor's reports for the past five financial years	CA Certificate along with Audited Financial report for the relevant Financial Years	
12	Evidence of adequacy of working capital for this contract [access to line (s) of credit and availability of other financial resources]; Liquid assets and / or availability of credit facilities	Banker's certificate	

[Type here]

13	Authority to seek references from the Bidder's bankers	Bankers Details	
14	Information regarding any litigation or arbitration resulting from contracts executed by the bidder in the last five years or currently under execution	List of Litigation, if any	
15	Methodology & Programme.	To be submitted	
16	Bids from Joint venture - Bids from Joint ventures / Consortiums / Association of Parties are not acceptable	NA	
17	Annual minimum turnover	Turnover from HVAC Construction works certified by chartered Accountant	
18	The Firm should demonstrate making profit	CA/ Statutory auditor certificate	
19	Should have valid PAN and GSTIN	Scan copy of valid PAN and GSTIN	
20	Experience of successful completion of works / substantial completion of works (90% of the value of the contract to be considered as substantial completion) as referred in Bid Data Sheet C I.2.3).	Completion Certificate from Competent Authority mentioning all the details as per Bid Data Sheet/TDS Certificate for Pvt Sector Project	
21	Bid Validity Undertaking	Undertaking	
22	Affidavit	Affidavit by the bidder duly signed by the Notary Public and as specified in Section 2,	
23	Design Basis Report	NA	
24	Certificate of No Relationships	As per format given in Section-2 of the tender document	
25	Information Regarding Any Conflicting Activities and Declaration Thereof	As per format given in Section-2 of the tender document	
26	Proposal for Sub-Contract	To be mentioned	

[Type here]

**Undertaking by Tenderer**

I/We have read and examined and understood the notice inviting tender, schedules, Specifications applicable, drawings & Designs, General Rules and Directions, Conditions of Contract, clauses of contract, special conditions, & all other documents and Rules referred to in the conditions of contract and all other contents in the tender document for the work.

I / We hereby tender for the execution of the work specified for the SWOSTI PREMIUM LTD within the time specified in schedule of quantities and in accordance in all respects with the specifications, designs, drawings and instructions in General Rules and Directions and Conditions of contract and with such materials as are provided for, by, and in respect in accordance with, such conditions so far as applicable.

We agree to keep the tender open for Ninety (90) days from the due date of its opening and not to make any modifications in its terms and condition.

A sum of Rs.....Rupees.....

.....)  
has been deposited in demand draft of a scheduled bank issued by a scheduled bank as earnest money. If I / we, fail to furnish the prescribed performance guarantee within prescribed period, I / we agree that the said G.M.(BD), SWOSTI PREMIUM LTD or his successors in office shall without prejudice to any other right or remedy, be at liberty to forfeit the said earnest money absolutely. Further, if I / we fail to commence work as specified, I / we agree that Director, SWOSTI PREMIUM LTD or his successors in office shall without prejudice to any other right or remedy available in law, be at liberty to forfeit the said earnest money and the performance guarantee absolutely, otherwise the said earnest money shall be retained by him towards security deposit to execute all the works referred to in the tender documents upon the terms and conditions contained or referred to therein and to carry out such deviations as may be ordered, up to maximum of the 25 percentage and those in excess of that limit at the rates to be determined in accordance with the terms of contract. Further, I / We agree that in case of forfeiture of earnest money or both Earnest Money & Performance Guarantee as aforesaid, I / We shall be debarred for participation in the re-tendering process of the work.

I / We hereby declare that I / we shall treat the tender documents drawings and other records connected with the work as secret / confidential documents and shall no communicate information / derived there from to any person other than a person to whom I / we am / are authorized to communicate the same or use the information in any manner prejudicial to the safety of the State.

Dated. ....

Witness:  
Address:

Signatures of Contractor  
Postal Address  
Occupation:

[Type here]

## **LETTER OF SUBMISSION**

The GM Corporate Communications.  
Swosti Group of Hotels, Resorts, Travels & Educations  
Cell- 9938244538  
Email: gm.communications@swostihotels.com  
Gopalpur Palm Resort Project  
On behalf of Swosti Premium Ltd

Sir,

.I/We, the undersigned, have read and examined in detail, the specifications and all bidding documents and hereby declare that:

### **Price and Validity**

1. All the rates quoted in our proposal are in accordance with the terms and conditions as specified in the bid document. All the prices and other terms and conditions of this proposal are valid for a period of 90 calendar days from the date of opening of bid.
2. We do hereby confirm that our bid prices include all taxes/levies. GST indicated separately.
3. We hereby declare that if any tax law is altered, we shall pay the same.
4. The quoted rates are inclusive of ESI , PF and Green Tax no extra on such heads would be payable on such account.

### **Earnest Money**

We have enclosed EMD in the form of demand draft no..... , dated.....favoring Swosti Premium Ltd. payable at Bhubaneswar issued / drawn on ... Bank for Rs. \_\_\_\_\_/- (Rupees \_\_\_\_\_), as desired.

### **Deviations**

We declare that all the works shall be performed strictly in accordance with the technical specifications and other tender conditions with no deviations.

### **Qualifying Data**

We confirm that all information/data have been submitted as required in tender document.

We hereby declare that our proposal is made in good faith, without collusion for fraud and the information contained in the proposal is true and correct to the best of our knowledge and belief. I/We agree that in case any information is found to be incorrect the tender is liable to be rejected at any point of tendering process.

Bid submitted by us is properly sealed and prepared so as to prevent any subsequent alteration and replacement.

We understand that you are not bound to accept the lowest or any bid you may receive.

Thanking you,  
Yours faithfully,

[Type here]

(Signature and seal of Tenderer with name, designation and contact no.)

[Type here]

## NON-BLACK LISTING DECLARATION

### **FORMAT OF UNDERTAKING, TO BE FURNISHED ON COMPANY LETTER HEAD WITH REGARD TO BLACKLISTING/ NON- DEBARMENT, BY ORGANISATION**

UNDERTAKING REGARDING BLACKLISTING / NON – DEBARMENT

To,  
SWOSTI  
PREMIUM LTD  
Bhubaneswar

We hereby confirm and declare that we, M/s -----, is not blacklisted/ De-registered/ debarred by any Government department/ Public Sector Undertaking/ Private Sector/ or any other agency for which we have Executed/ Undertaken the works/ Services during the last 5 years.

**Signature of Contractor**

**With stamp**

[Type here]

**GENERAL INSTRUCTIONS FOR SITE VISIT**

I, , aged years, son/daughter of , presently residing at and authorized by (name of tenderer) (“Tenderer”) to solemn this affidavit on behalf of the Tenderer, solemnly affirm on oath as hereunder:

The Tenderer confirms that the Tenderer has duly undertaken the visit of the proposed project site of SWOSTI PREMIUM LTD located at Gopalpur ,Ganjam

The Tenderer has inspected and examined its surroundings and has satisfied itself about the site conditions and site logistics. The Tenderer confirms that it is aware of the ground conditions and nature of the site, means of access to the site and the accommodation area required for establishing the labour camp. The Tenderer agrees and confirms it shall be solely responsible for arranging and maintaining the afore- mentioned at its own cost including 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.

The Tenderer confirms and agrees that the submission of the tender implies that the requisite site visit has already been undertaken and that the Tenderer has acquainted itself with the local conditions and other factors having a bearing on the execution of the Work.

**DEPONENT VERIFICATION**

I, , aged years, son/daughter of , presently residing at and authorized by Tenderer verify that the information mentioned above is true and correct to the best of my knowledge and belief.

DEPONE

## LETTER OF ACCEPTANCE

(To be issued to the successful bidder on the letterhead of Swosti Premium Ltd.)

[Date: \_\_\_\_\_]

To,

[Name and Address of the Contractor]

Subject: Letter of Acceptance for Supply, Installation, Testing & Commissioning of HVAC-Low Side and Allied Works at Gopalpur Palm Resort for Swosti Premium Ltd., Gopalpur, Ganjam, on a Lump sum Contract Basis)

Dear Sir(s),

This is to notify you that your Bid dated \_\_\_\_\_ for execution of the following work on a Item Rate basis:

“Supply, Installation, Testing & Commissioning of HVAC-Low Side and Allied Works at Gopalpur Palm Resort for Swosti Premium Ltd., Gopalpur, Ganjam, on a Lump sum Contract Basis)”

for the Contract Price of Rs. \_\_\_\_\_ (Rupees \_\_\_\_\_ only), as corrected and modified<sup>1</sup> in accordance with the Instructions to Bidders, is hereby accepted by Swosti Premium Ltd.

We note that as per your bid,  
 You do not intend to subcontract any component of work  
or

You propose to employ [Insert Name of Sub-Contractor] as sub-contractor for executing [Insert Work Component]

*(Delete whichever is not applicable)*

You are hereby requested to furnish a detailed Work Programme along with milestone-wise activity chart and cash flow forecast (S-curve) as per the Bid Data Sheet within 14 (fourteen) days from the issue of this Letter of Acceptance (LoA).

Further, you are required to furnish the Performance Security as specified in the Bidding Documents for an amount of Rs. \_\_\_\_\_, in the form prescribed, within 21 (twenty-one) days of receipt of this Letter of Acceptance.

Failure to comply with the above conditions may result in actions as specified in Clause 23 and 24 of the Bid Data Sheet.

We look forward to the successful execution of the project.

Yours faithfully,

\_\_\_\_\_  
Authorized Signatory  
Swosti Premium Ltd.  
Bhubaneswar

### NOTICE TO PROCEED WITH THE WORK

(To be issued on Letterhead of Swosti Premium Ltd.)

[Date: \_\_\_\_\_]

To,

[Name and Address of the Contractor]

Subject: Notice to Proceed – Supply, Installation, Testing & Commissioning of HVAC-Low Side and Allied Works at Gopalpur Palm Resort for Swosti Premium Ltd., Gopalpur, Ganjam, on a Lump sum Contract Basis)

Dear Sir(s),

Pursuant to your furnishing of the required Performance Security in accordance with Clause of Bid Data Sheet, and the execution of the Contract Agreement for the work titled:

“Supply, Installation, Testing & Commissioning of Low Side HVAC and Allied Works at Gopalpur Palm Resort for Swosti Premium Ltd., Gopalpur, Ganjam, on a Lump sum Contract Basis”

at a Bid Price of Rs. \_\_\_\_\_ (Rupees \_\_\_\_\_ only), you are hereby instructed to proceed with the execution of the said works effective immediately, in strict accordance with the terms and conditions of the contract documents.

We trust that you will mobilize your resources promptly and commence the work at site without delay as per the agreed programme and milestones.

Wishing you a successful execution.

Yours faithfully,

---

Authorized Signatory  
Swosti Premium Ltd.  
Bhubaneswar

### PERFORMANCE BANK GUARANTEE

To

\_\_\_\_\_ [name of Client]  
\_\_\_\_\_ [address of Client]

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

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

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

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

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

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

This guarantee shall also be operable at our \_\_\_\_\_ Branch at Bhubaneswar, from whom, confirmation regarding the issue of this guarantee or extension / renewal thereof shall be made available on demand. In the contingency of this guarantee being invoked and payment thereunder claimed, the said branch shall accept such invocation letter and make payment of amounts so demanded under the said invocation.

The guarantor/bank hereby confirms that it is on the SFMS (Structural Finance Messaging System) platform & shall invariably send an advice of this Bank Guarantee to the designated bank of Odisha Bridge & Construction Corporation Ltd details of which is as under:

Sl No.	Particulars	Details
1	Name of Beneficiary	Swosti Premium Ltd
2	Name of Bank	Union Bank Of India
3	Account No	128713100000061
4	IFSC Code	UBIN0578827

This guarantee shall be valid until 28 days from the date of expiry of the Defect Liability Period. Signature and Seal of the guarantor \_

Name of Bank \_\_\_\_\_ Address \_\_\_\_\_ Date \_

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

## BID SECURITY– Cover-IV

**Bid Security (EMD):** 8,50,000.00 INR

Affidavit (on Non-Judicial Stamp, attested by Notary Public)

Declaring authenticity of all submitted information and non-involvement in any corrupt or fraudulent practice.

**Authorized Signature:** \_\_\_\_\_

**Name & Title:** \_\_\_\_\_

**Name of the Bidder:** \_\_\_\_\_

**Company Stamp/Seal**

BANK CERTIFICATE

(To be issued by the Bidder's Bank on official letterhead and submitted by the Bidder in Cover-IV)

TO WHOMSOEVER IT MAY CONCERN

This is to certify that M/s. [Insert Name of Bidder] is a reputed company with good financial standing and banking conduct.

If the contract for the work, namely:

“Construction of Gopalpur Palm Resort – Core Civil Works (Item Rate Package)”

is awarded to the above-mentioned firm, we confirm that we shall be in a position to provide overdraft / cash credit / fund-based credit facilities to the extent of:

₹ [Insert Amount in Figures and Words]

to meet their working capital requirements for executing the said contract.

SI No.	Particulars	Details
1	Name of Beneficiary	Swosti Premium Ltd
2	Name of Bank	Union Bank Of India
3	Account No	128713100000061
4	IFSC Code	UBIN0578827

**INFORMATION REGARDING ANY CONFLICTING ACTIVITIES AND DECLARATION THEREOF**

(To be submitted on Bidder’s Letterhead)

To,  
The G M (B.D)

Swosti Premium Ltd.  
Bhubaneswar

Subject: Declaration Regarding Conflicting Activities

Dear Sir,

I, the undersigned, hereby declare that our firm/company is not engaged in any activities that can be termed as conflicting in nature with respect to this tender for the project titled:

“Supply, Installation, Testing & Commissioning of HVAC-Low Side and Allied Works at Gopalpur Palm Resort for Swosti Premium Ltd., Gopalpur, Ganjam, on a Lump sum Contract Basis)”

I also acknowledge that in case of any misrepresentation or concealment of facts related to this declaration, our proposal and/or contract shall be liable for rejection/termination by the Client, and the decision shall be binding upon us without any claim whatsoever.

Authorized Signatory: \_\_\_\_\_  
Name & Designation: \_\_\_\_\_  
Name of the Bidder: \_\_\_\_\_  
Stamp/Seal: \_\_\_\_\_  
Date: \_\_\_\_\_  
Communication Address: \_\_\_\_\_

**Note:**

Conflicting activities refer to any potential conflict of interest arising from prior, current, or proposed agreements, engagements, or affiliations with the Client that may impair the bidder’s objectivity, integrity, or impartiality in the execution of the project.

\_\_\_\_\_

**AFFIDAVIT**

*[To be submitted by the bidder in a non-judicial stamp paper duly signed by the Notary Public]*

1. I, the undersigned, do hereby certify that all the statements made in the required attachments are true and correct.
  
2. The undersigned also hereby certifies that neither our firm M/s.....  
.....have abandoned any work on building in India nor any contract awarded to us by the State of Odisha for such works have been rescinded, during last five years prior to the date of this bid.
  
3. The undersigned hereby authorize(s) and request(s) any bank, person, firm 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.
  
4. The undersigned understand and agrees that further qualifying information may be requested and agrees to furnish any such information at the request of the Department/ project implementing agency.

\_\_\_\_\_

Authorized Signature: Name & Title of Signatory:  
Name of Bidder :

### **SECTION-3-BOQ,SPECIFICATIONS& TENDER DRAWINGS :**

These Particular are to be read in conjunction with other documents issued along with tender. In case of any discrepancy between Design drawings, General conditions or Bill of quantity, Following order of preference shall be applicable.

- BOQ
- Specification
- Tender drawings

The contractor shall refer the tender drawings attached at end of this section.

Sr. No.	Drawing Title (GFCs)	Area / Part /Floor/Description	Drawing No. (If any)
1	LOWER GROUND FLOOR HVAC LAYOUT		AEON/AC/T-01
2	GROUND FLOOR HVAC LAYOUT		AEON/AC/T-02
3	1st FLOOR HVAC LAYOUT		AEON/AC/T-03
4	2nd FLOOR HVAC LAYOUT		AEON/AC/T-04
5	DUCT FLOOR HVAC LAYOUT		AEON/AC/T-05
6	3rd FLOOR HVAC LAYOUT		AEON/AC/T-06
7	4th - 7th FLOOR HVAC LAYOUT		AEON/AC/T-07
8	8th & 9th FLOOR HVAC LAYOUT		AEON/AC/T-08
11	TERRACE FLOOR HVAC LAYOUT		AEON/AC/T-09
12	GROUND FLOOR BOH / KITCHEN LAYOUT		AEON/AC/T-K-02
13	1st FLOOR BOH / KITCHEN LAYOUT		AEON/AC/T-K-03
14	8th FLOOR KITCHEN LAYOUT		AEON/AC/T-K-08

The contractor shall refer the following annexure while bidding and will read them in conjunction with specifications as well as bill of quantity

- Annexure - I : Design Criterion
- Annexure -II : List of approved makes
- Annexure -III : Codes and Standards
- Annexure -IV : Technical Specifications
- Annexure -V : Technical Data Sheets

## ANNEXURE-I

### DESIGN CRITERION

#### 1.0 DESIGN CRITERION

Following shall be basis for developing the design:

Site Location	:	Gopalpur, Odisha
Geographical Data	:	20°15' N, 85°49' E
Altitude	:	46 m above the sea level

#### 1.1 Outdoor Design Temperatures

The recommended outdoor design conditions for Bhubaneswar, (which is approximately 170 km from Gopalpur) mentioned in ISHRAE Weather Data Book-2022 has been selected

S. No.	Season	Outdoor Temperatures	
		DBT	WBT
1.	Summer	38.9 °C (102.02°F)	27.0 °C (80.6 °F)
2.	Monsoon	35.0 °C (95.0 °F)	30.1 °C (86.18 °F)
3.	Winter	14.1 °C (57.38 °F)	-

The outdoor temperatures are based on 0.4 % cumulative frequency of occurrence.

#### 1.2 Envelope Details

Based on recommendations from ECBC for Warm-Humid zone, the minimum performance requirements are given below:

S No.	Description	Recommendation (Btu/Hr.Sqft °F)
1.	Exposed Masonry Wall	0.11
2.	Exposed Roof	0.05
3.	Window to Wall Ratio	As per design
4.	Glazing U-Value	0.50
5.	Glazing SHGC	0.27
6.	Spandrel	0.06

Notes:

200 mm AAC Block-work is required for achieving the recommended thermal conductivity of 0.11 Btu/hr-sqft-deg F and same is considered for design. Additional 25 mm XPS insulation or equivalent shall be required to achieve the value specified by ECBC. However, this is not being pursued due to capital cost implication.

75-100 mm thick over deck PUF insulation or equivalent shall be required to achieve the desired thermal conductivity of roof. It is recommended that integrated roof insulation with water proofing is adopted and made part of civil tender..

100 mm thick Rockwool insulation or equivalent is recommended to achieve the desired U Value of Spandrel.

## 2.0 HVAC SYSTEM

### 2.1 Indoor Design Conditions

In line with the prevalent design practices, following indoor design conditions are proposed for various spaces.

S. No.	Space	Temperature (Deg.C)	RH (%)
		Summer	
1.	Gym/ Health Club	22+1	Not exceeding 60%
2.	Ball Room/Banquet Hall	22+1	
3.	Pre Function	22+1	
4.	Main Entrance Lobby	22+1	
5.	Restaurant	22+1	
6.	Admin Office & Meeting Room	24+1	
7.	Guest Corridor	24+1	
8.	Guest Room	24+1	
9.	Kitchen & Laundry	27+1	Not Controlled
10.	Main Electrical Panel Room	27+1	Not Controlled

### 2.2 Internal Load

S. No.	Area / Room	Electrical System		HVAC System	
		LPD (Watt/Sft)	EPD (Watt/Sft)	LPD (Watt/Sft)	EPD (Watt/Sft)
1.	Ball Room	1.05	2.5	1.05	2.5
2.	Bar/Lounge	0.86	2.5	0.86	2.5
3.	Dining	0.76	1	0.76	1
4.	Pre function	1.05	2.5	1.05	2.5
5.	Kitchen	0.66	2	0.66	2
6.	Guest Room	0.41	2.5 kW	0.41	100 Watts per Room
7.	Toilets	0.56	1	NA	NA
8.	Service areas	0.43	2	NA	NA
9.	Staircase	0.4	-	NA	NA

### 2.3 Outdoor Air Ventilation Rates

In line with the recommendations given in ASHRAE 62.1-2022, the outdoor air ventilation rates for conditioned spaces are given below:

S No.	Description	Outdoor Air Rates	Remarks
1.	Ballroom/Banquet Hall	5 cfm per person + Area sft x 0.06	-
2.	Pre Function	7.5 cfm per person + Area sft x 0.06	-
3.	Entrance Lobby/Reception	7.5 cfm per person + Area sft x 0.06	-
4.	Restaurant/Dining	7.5 cfm per person + Area sft x 0.18	-
5.	Admin Office	5 cfm per person + Area sft x 0.06	-

6.	Guest Room	5 cfm per person + Area sft x 0.06	50 CFM FA to each Guest Room
7.	Gym/SPA	20 cfm per person + Area sft x 0.06	-
8.	Guest Corridor	Area sft x 0.06	-
9.	Kitchen Areas	7.5 cfm per person + Area sft x 0.18	-

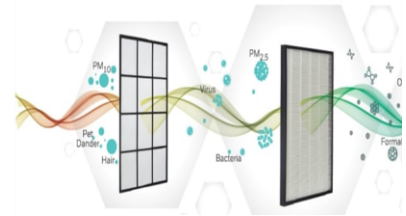
## 2.4 Air Filtration Strategy

Outdoor ventilation air supplied in the guest rooms shall be centrally pre-treated through Dedicated Outdoor Air System (DOAS) which will help in achieving the desired Indoor Air Quality levels and also maintain positive pressure that will prevent the pollutants from entering

**Filter efficiency for each stage is defined below:**

Stage 1: Pre-filter only (MERV 8 efficiency)

Stage 2: Pre-filter + Fine filter (MERV 13/14 efficiency)



All fine filters installed in DOAS units shall be MERV 14 efficiency.

S. No.	Description	Filter Stages	UVGI at coil
1.	DOAS & TFA Units	Stage 2	Yes
2.	Public & BOH area AHU	Stage 2	Yes
3.	Fan Coil Units	MERV 6 filter	No

Ventilation levels within the Guest Rooms shall be maintained by Dedicated Outdoor Air System (DOAS).

The DOAS shall include the following

Supply/exhaust fan

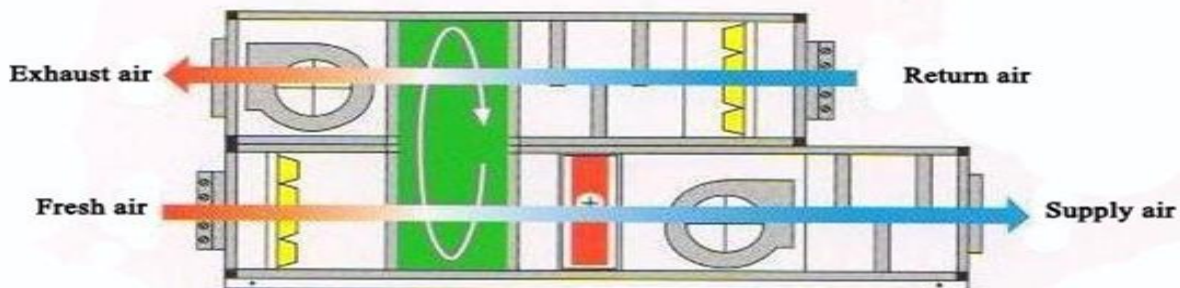
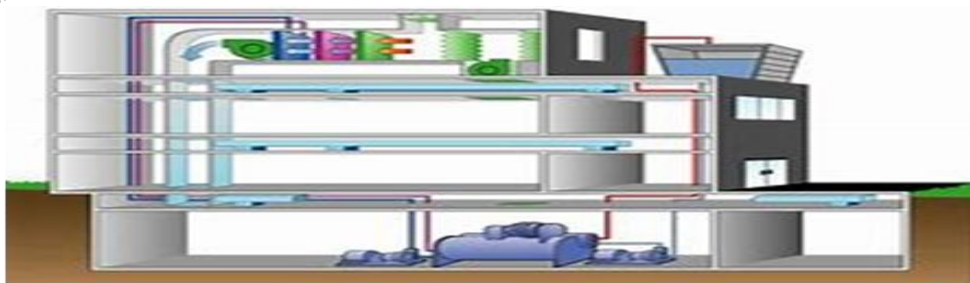
Energy recovery wheel will help to recover the energy from the foul exhaust air of Toilet.

6/8 row deep cooling coil for cooling and dehumidifying the ventilation air

Two stage filtration (MERV 8, MERV 14)

UVGI lamp at cooling coil to prevent growth of bio film over the coil

The DOAS units shall be located at roof of Guest building and ventilation air shall be distributed to each room through ducting.



## 2.4 Mechanical Ventilation Rates

The mechanical ventilation rates for the building are given below based on NBC-2016:

S. No	Space	Air Changes Per Hours (ACPH)
1.	Toilet (Public)	10-12 ACPH exhaust with equivalent draw of air from adjacent areas.
2.	Lift well pressurization	Mechanically pressurized for maintaining 50 Pa differential pressure. (At Roof Level)
3.	Lift lobby Pressurization	Mechanically pressurized for maintaining 25 Pa differential pressure at all levels.
4.	Staircase pressurization	Internal staircases shall be mechanically pressurized for maintaining 50 Pa differential pressure. (At Roof Level)
5.	Plumbing and Fire Plant Rooms	15-20 ACPH exhaust with equivalent draw of make-up Air
6.	HVAC Plant Room	15-20 ACPH exhaust with equivalent draw of make-up Air
7.	STP Plant room	Min 25-30 ACPH exhaust with equivalent draw of make-up Air. The exhaust will be let out at higher level to prevent smell in the vicinity.
8.	DG Room	Ventilation system proposed as per DG set heat dissipation to keep the DG room temperature within limit ( 5 degree centigrade above ambient temperature ). Make up Air through air washer and DG set Exhaust through Axial Fan.
9.	Kitchen	As per kitchen consultant recommendation.
10.	Smoke Extraction	12 ACPH exhaust with equivalent draw of make-up Air

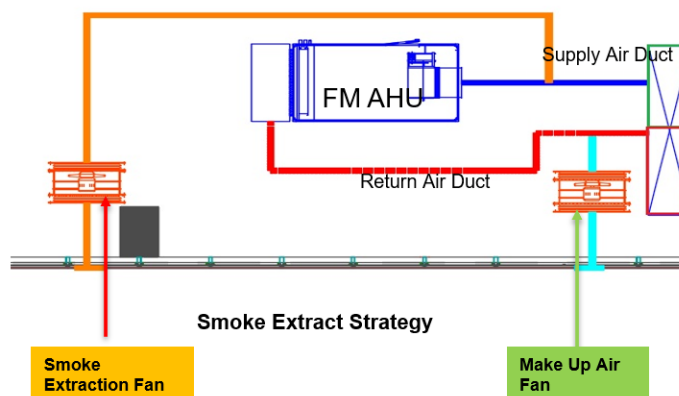
## 2.5 Smoke Extract Strategy

### For Public Spaces:

Smoke extraction shall be designed to achieve air change rate of 12 ACPH in case of emergency.

Axial flow fans for Smoke Extraction and Make up air shall be integrated in the floor mounted AHU controller through NO/NC dampers.

Supply/Return air duct shall be used for make-up air/ Smoke Extraction purpose with the help of motorized dampers whereas make up air shall be provided at floor level at designated location through motorized window/fan.

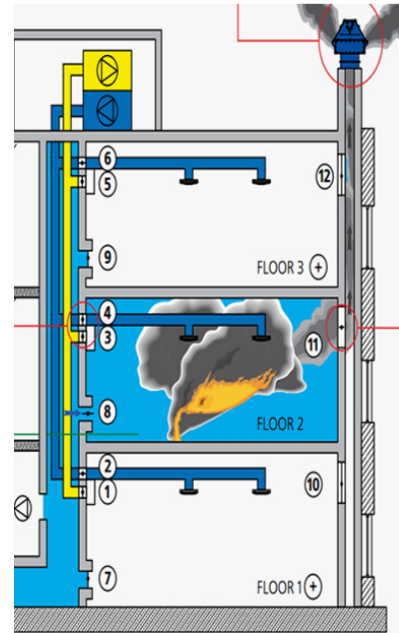


### For Guest Room Floors:

Exit passage/corridor of all Guest room floors shall be provided with a smoke extract system which will be exhausted and fresh air for the same shall be provided at the roof level.

Smoke extraction system shall be designed to permit 12 ACPH exhaust in case of fire. Fan shall be sized for simultaneous exhaust of 3 floors.

Both make-up air and exhaust air shall be connected to a centralized riser which will be designed to cater to three floors at any given time through use of motorized dampers.



2.8 HVAC Calculations

Equipment Selection - Swosti , Gopalpur											
Description	Area (Sq Ft)	Outdoor air as per ASHRAE 62.1	LPD (Total Watt)	EPD( Total Watt )	Dehumidified CFM	Total TR (Summer)	Total TR (Monsoon)	Selected ( TR )	Equipment Selected	Selecte d TR	Selecte d CFM
Ground Floor											
Male Staff Lockers Room	546	173	546	382	949	2.51	2.73	2.73	CSU	7.00	3000
Male Rest Room	189	31	189	132	278	0.63	0.66	0.66			
Female Staff Locker Room	509	81	509	357	735	1.65	1.70	1.70			
Cont. Female Staff Locker Room	118	22	83	35	283	0.56	0.54	0.50			
Female Rest Room	115	43	115	81	407	0.86	0.84	0.86			
Veg. Prep. Area	270	79	270	189	828	1.64	1.63	1.50	FCU	2.50	1000
Butcher Prep. Area	151	42	151	106	597	1.08	1.00	1.00	FCU	1.00	400
Fish Prep. Area	59	26	41	59	206	0.47	0.48	0.40	FCU	1.00	400
Staff Kitchen	239	24	239	167	488	0.82	0.77	0.80	FCU	1.00	400
Sorting Area	67	28	67	53	189	0.51	0.49	1.00	FCU	1.00	400
Empty Bottle Store	46	26	37	9	80	0.31	0.36	0.40	FCU	1.00	400
Trash Room	53	26	42	11	184	0.49	0.47	0.50	FCU	1.00	400
Garbage Area	180	42	144	36	283	0.74	0.72	0.50	FCU	1.00	400
Staff Recreation Room	244	65	244	171	608	1.38	1.41	1.41	CSU	13.00	4000
Staff Dinning Seating Area	1150	732	1150	805	3010	9.86	11.27	11.27			
Corridor -1	561	64	561	393	631	1.54	1.39	1.40	CSU	1.40	1800
Corridor -2	1317	104	1317	922	1157	2.64	2.32	2.64		2.60	

VIP Room	236	24	165	47	444	0.88	0.72	0.88	FCU	1.00	400
Banquet Office	150	29	150	158	482	0.88	0.87	0.88	FCU	1.00	400
Cold Food Area	131	46	105	131	453	0.93	0.94	0.90	FCU	1.50	600
Corridor -3	2010	151	2010	1407	1743	3.92	3.46	3.92	CSU	18.00	9500
Lobby	3376	253	3376	3376	4717	7.65	5.78	7.65			
Corridor -4	817	59	817	572	3027	5.58	4.97	5.58			
CCTV Room	104	11	104	73	174	0.38	0.37	0.38	FCU	1.00	400
Security Office	112	17	112	78	100	0.30	0.31	0.31	FCU	1.00	400
Discussion Area-1	93	26	93	93	129	0.43	0.47	0.47	FCU	1.00	400
Receiving & Purchase Office	76	15	76	53	81	0.25	0.27	0.27	FCU	1.00	400
Discussion Area-2	84	25	84	59	116	0.41	0.45	0.45	FCU	1.00	400
Corridor -1	561	64	561	393	631	1.54	1.39	1.40	CSU	2.00	800
Laundry	1611	122	1611	1128	2516	5.08	4.51	5.00	CSU	5.00	2500
Linen and Uniform Room	463	86	370	139	807	1.64	1.62	1.64	FCU	1.50	600
Discussion Area & HR Office	157	39	157	110	396	0.87	0.89	0.89	FCU	1.00	400
HR M/GR. Office	60	19	60	60	209	0.44	0.44	0.44	FCU	1.00	400
Training M/GR. Office	63	19	63	63	216	0.46	0.45	0.46	FCU	1.00	400
House Keeping M/GR. Office	104	41	104	73	481	0.94	0.89	0.94	FCU	1.00	400
House Keeping Office	325	50	325	228	973	1.68	1.50	1.68	FCU	2.50	1000
Conference Room	150	84	150	105	392	1.23	1.39	1.39	FCU	1.50	600
F & B Manager Office	99	21	99	69	182	0.42	0.45	0.45	FCU	1.00	400
F & B Manager Office	68	21	68	48	143	0.36	0.39	0.39	FCU	1.00	400
Accounts Manager	68	35	68	48	248	0.60	0.62	0.62	FCU	1.00	400

Admin Office Area	607	199	607	425	1047	2.84	3.12	3.12	FCU	3.00	1200
IT M/GR. Office	81	20	81	57	206	0.45	0.47	0.47	FCU	1.00	400
Server Room	341	30	239	341	582	1	1	1	FCU		
Battery Room	111	17	78	111	90	0	0	0	FCU		
Sales Manager Office	110	22	110	77	195	0.45	0.47	0.47	FCU	1.00	400
Training Room	431	402	431	474	1312	4.91	5.78	5.78	CSU	6.00	1500
Cabin Training Room	65	14	52	65	122	0.28	0.30	0.30	FCU	1.00	400
Front Manager Office	91	20	91	64	265	0.53	0.51	0.53	FCU	1.00	400
Front Office	109	22	109	76	172	0.41	0.44	0.44	FCU	1.00	400
Conference Room	147	69	147	103	328	1.01	1.14	1.14	FCU	1.00	400
General Manager Office	90	46	90	63	197	0.62	0.71	0.71	FCU	1.00	400
Banquet Kitchen	1990	351	1990	1393	4218	7.95	7.86	7.95	CSU	8.00	4500
Toilet - Male	671	65	470	336	534	1.36	1.32	1.36	FCU	1.50	600
Toilet - Female	660	65	462	330	526	1.34	1.31	1.34	FCU	1.50	600
Service Bar Area	178	51	142	178	292	0.76	0.84	0.84	FCU	1.00	400

Total	18914	4253	21531	16508	39661	89	87	92			
First Floor											
Banquet -1	3293	948	3293	3458	6906	19.08	20.43	20.43	AHU	21.00	7000
Banquet -2	3293	948	3293	3458	6906	19.08	20.43	20.43	AHU	21.00	7000
Prefunction 1 & 2	5116	532	5116	5372	11627	21.95	19.76	21.95	AHU	11 x 2 NOS	5000x2
Kids play	4021	466	4021	4021	3845	9.49	9.34	9.49	AHU	19.00	7500
Corridor	1106	366	1106	1106	2235	6.41	7.02	7.02			
Lobby ( Triple Height )	1214	123	1214	1214	1198	2.09	1.72	2.09			
All Day Dining	1748	840	1748	1136	5516	14.76	15.38	15.38	AHU	27.00	9000
Service Station Area	1824	703	1824	1459	3025	9.98	11.06	11.06			
Changing Room &	502	55	351	251	418	1.11	1.09	1.11	FCU	1.50	600

Toilet – Male											
Toilet - Female	406	49	284	203	352	0.96	0.96	0.96	FCU	1.00	400
Kitchen	1943	462	1943	1282	3839	8.26	8.64	8.64	AHU	13.39	6400
Bakery & Confectionary Area	606	154	400	1212	1490	3.05	3.08	2.30			
Chefs Office	50	8	50	33	81	0.17	0.18	0.18			
Cold Food Area	109	17	109	71	200	0.40	0.41	0.41			
Room Service area	107	16	70	214	197	0.40	0.41	0.41			
R.S.O.T. Office	21	6	21	14	45	0.12	0.13	0.13			
Corridor	507	55	507	335	553	1.33	1.26	1.33			

Total	25866	5749	25350	24838	48435	119	121	123			
Second Floor											
Meeting Room	4485	1419	4485	4485	6991	22.92	25.05	25.05	AHU	13 X 2 Nos	3500 X2
Pre Function Area 1 & 2	3957	462	3957	4155	14313	23.89	21.89	23.89	AHU	25.00	15000
Corridor	1212	93	848	242	1666	3.44	3.06	3.44	CSU	6.00	3500
Food Prep	494	52	494	395	1596	2.44	2.20	2.44			
Gym	1203	0	1203	1203	4020	6.62	5.96	6.62	AHU	12.00	7000
Spa Room 1	274	0	274	274	367	0.69	0.57	0.69			
Spa Room 2	274	0	274	274	367	0.69	0.57	0.69			
Spa Room 3	157	0	157	157	262	0.48	0.36	0.48			
Spa Room 4	157	0	157	157	262	0.48	0.36	0.48			
Spa Room 5	157	0	157	157	262	0.48	0.36	0.48			
Spa Room 5	157	0	157	157	262	0.48	0.36	0.48			
Corridor	984	0	984	787	734	1.31	0.96	1.31			
Waiting area Spa	229	0	229	183	330	0.59	0.42	0.59			
Toilet - Male	502	55	351	251	418	1.11	1.09	1.11	FCU	1.50	600
Toilet - Female	406	49	284	203	352	0.96	0.96	0.96	FCU	1.00	400
Doas For GYM & SPA					750			6.00			
Total	14648	2131	14012	13081	31434	67	64	75			
Third to Seventh Floor											
Room 1	303	0	212	151	423	0.75	0.58	0.75	FCU	1.50	600
Room 2	303	0	212	151	405	0.72	0.55	0.72	FCU	1.50	600
Room 3	303	0	212	151	405	0.72	0.55	0.72	FCU	1.50	600
Room 4	303	0	212	151	405	0.72	0.55	0.72	FCU	1.50	600
Room 5	303	0	212	151	405	0.72	0.55	0.72	FCU	1.50	600
Room 6	303	0	212	151	405	0.72	0.55	0.72	FCU	1.50	600

Room 7	303	0	212	151	405	0.72	0.55	0.72	FCU	1.50	600
Room 8	303	0	212	151	405	0.72	0.55	0.72	FCU	1.50	600
BOH	166	20	116	83	198	0.46	0.43	0.46	FCU	1.00	400
Room 9	303	0	212	151	405	0.72	0.55	0.72	FCU	1.50	600
Room 10	303	0	212	151	405	0.72	0.55	0.72	FCU	1.50	600
Room 11	303	0	212	151	405	0.72	0.55	0.72	FCU	1.50	600
Room 12	303	0	212	151	405	0.72	0.55	0.72	FCU	1.50	600
Room 13	303	0	212	151	405	0.72	0.55	0.72	FCU	1.50	600
Room 14	303	0	212	151	405	0.72	0.55	0.72	FCU	1.50	600
Room 15	303	0	212	151	405	0.72	0.55	0.72	FCU	1.50	600
Family Room 1	311	0	218	156	458	0.84	0.66	0.84	FCU	1.50	600
Room 16	303	0	212	151	406	0.72	0.55	0.72	FCU	1.50	600
Room 17	303	0	212	151	406	0.72	0.55	0.72	FCU	1.50	600
Family Room 2	311	0	218	156	464	0.85	0.67	0.85	FCU	1.50	600
Room 18	303	0	212	151	402	0.72	0.54	0.72	FCU	1.50	600
Room 19	303	0	212	151	402	0.72	0.54	0.72	FCU	1.50	600
Room 20	303	0	212	151	402	0.72	0.54	0.72	FCU	1.50	600
Room 21	303	0	212	151	402	0.72	0.54	0.72	FCU	1.50	600
Room 22	303	0	212	151	419	0.75	0.57	0.75	FCU	1.50	600
IT Room	175	26	175	525	382	0.69	0.56	0.69	Ductable unit	2.50	1000
Corridor 1	1287	0	901	257	1590	3.38	2.98	3.38	DOAS		
Corridor 2	1019	0	713	204	1303	2.80	2.49	2.80			
Total	9926	45	7001	4709	13330	24.96	19.86	24.96			
TYP - 5 Floors	49629	227	35003	23543	66648	125	99	125			
Eighth Floor											
Room 1	303	0	212	61	454	0.81	0.59	0.81	FCU	1.50	600
Room 2	303	0	212	151	405	0.72	0.55	0.72	FCU	1.50	600
Bedroom 1	240	0	168	120	364	0.65	0.49	0.65	FCU	1.50	600
Living 1	303	0	212	152	415	0.75	0.58	0.75	FCU	1.50	600
Room 3	303	0	212	151	402	0.72	0.54	0.72	FCU	1.50	600
Room 4	303	0	212	151	402	0.72	0.54	0.72	FCU	1.50	600
Living 2	303	0	212	151	418	0.76	0.58	0.76	FCU	1.50	600
Bedroom 2	240	0	168	120	364	0.65	0.49	0.65	FCU	1.50	600
BOH	166	20	116	83	198	0.46	0.43	0.46	FCU	1.00	400
Roof Top Kitchen	765	0	803	2295	3178	4.34	3.64	4.34			
Chefs Office	45	8	29	45	75	0.16	0.16	0.20			
Roof Top Bar Area	82	15	53	82	139	0.30	0.31	0.30			
Resturant	1644	0	1644	2466	4196	8.02	7.33	8.02	CSU	8.00	4000
IT Room	175	26	175	525	382	0.69	0.56	0.69	Ductable unit	2.50	1000
Corridor 1	1287	0	901	257	1357	2.98	2.58	2.98	DOAS		

Corridor 2	414	0	290	83	393	1.00	0.96	1.00				
Total	6874	68	5619	6893	13140	24	20	24				
Ninth Floor												
Bedroom 1	481	0	337	241	841	1.5	1.10	1.48	FCU	1 TR X2	600 x2	
Living & Dining	577	0	577	288	980	1.8	1.39	1.78	FCU	2.5 TR	1000	
Room 1	303	0	212	151	475	0.8	0.63	0.84	FCU	1.50	600	
Room 2	303	0	212	151	475	0.8	0.63	0.84	FCU	1.50	600	
Living 1	303	0	212	151	536	1.0	0.73	0.96	FCU	1.50	600	
Bedroom 2	240	0	168	120	441	0.8	0.59	0.79	FCU	1.50	600	
BOH	166	20	116	83	198	0.5	0.43	0.47	FCU	1.00	400	
Bedroom 3	240	0	168	120	443	0.8	0.60	0.79	FCU	1.50	600	
Living 2	303	0	212	151	554	1.0	0.76	0.99	FCU	1.50	600	
Room 3	303	0	212	151	474	0.8	0.63	0.84	FCU	1.50	600	
Room 4	303	0	212	151	474	0.8	0.63	0.84	FCU	1.50	600	
Living 3	303	0	212	151	500	0.9	0.67	0.89	FCU	1.50	600	
Bedroom 4	240	0	168	120	488	0.9	0.67	0.87	FCU	1.50	600	
IT Room	175	26	175	525	382	0.7	0.56	0.69	Ductable unit	2.50	1000	
Corridor 1	1318	0	923	264	1886	3.9	3.39	3.90	DOAS			
Corridor 2	414	0	290	83	615	1.4	1.19	1.38				
Total	5969	0	4404	2902	9764	18.4	14.61	18.36				
SUB TOTAL	121900	12428	105919	87765	209082	441	407	457				
Dedicated Outdoor Air System -1 ( FOR 3rd Floor to 9th Floor Corridor & Guest Room )						14000 CFM	147.00	147.00				
Dedicated Outdoor Air System -2 ( FOR 3rd Floor to 9th Floor Corridor & Guest Room )						12725 CFM	134.00	134.00				
GRAND TOTAL							688.13	737.87				
Applied Diversity @ 0.80 %	590.30	590 TR	Net Simentenously Load =590 TR ( Chiller Selected 3 x 200 TR )									

**(Ventilation Calculation)**

S.No.	Description	Area	Height	Volume	Ventilation Rate	Application	Air Quantity	Equipment Selection
		(Sq.ft.)	( Ft.)	(Cu.ft.)	(ACPH)		(CFM)	
A	BASEMENT							
1	Plumbing & Fire Pump Room	4359	14.8	64519	15	Exhaust	16130	1 No. 17000 CFM Axial Fans (Fire Rated)
Makeup						16130	1 No. 17000 CFM Axial Fans	

2	STP	2422	21.0	50860	30	Exhaust	25430	1 No. 26000 CFM Axial Fans (Fire Rated)
						Makeup	22887	1 No. 23000 CFM Axial Fans
3	HVAC Plant Room	5221	14.8	77055	15	Exhaust	19264	1 No. 20000 CFM Axial Fans (Fire Rated)
						Makeup	19264	1 No. 20000 CFM Axial Fans
B	LGF							
5	Laundry	2368	14.8	34953	20	Exhaust	11651	1 No. 12000 CFM Fan Section (Fire Rated)
						Makeup	10486	1 No. 9000 CFM Fan Section 1 No. 2000 CFM TFA Unit
6	General Store	1894	9.2	17399	6	Exhaust	1740	1 No. 2000 CFM Cabinet Fan (Fire Rated)
7	Guest Supply Store	129	9.2	1186	6	Exhaust	119	
7	Housekeeping Store	3143	9.2	28866	6	Exhaust	2887	1 No. 2000 CFM Cabinet Fan (Fire Rated)

(General Ventilation Calculation)

S No.	Description	Area	Height	Air Qty	Ventilation	Application	Equipment Selection
		Sqft	Ft.	CFM	Rate (ACPH)		
	Ground Floor						
1	All Day Dining Kitchen	2292	16	25058	40	Exhaust	1 No 25000 CFM Air Scrubber For Exhaust
				21299		Make up	1 No 21500 CFM Fan Section For Make up
2	Banquet Hall Kitchen	3981	16	43528	40	Exhaust	1 No 44000 CFM Air Scrubber For Exhaust
				36999		Make up	1 No 37000 CFM Fan Section For Make up

**(Pressurization Calculation):-**

S No.	Description	Lift Travel	No. of Landings	Pressurization CFM	Equipment Selection	Electrical kW	Qty	Total Electrical kW	
	Lift Well								
1	Service Lift Well- L1 & L2	1st Floor to Terrace	10	16510	1 No.16500 CFM Axial Fan located at Terrace	5.5	2	11	
2	Guest Lift Well L1 & L2	1st Floor to Terrace	10	16510	1 No.16500 CFM Axial Fan located at Terrace	5.5	2	11	
3	Service Lift Well L3	Ground Floor to 2nd Floor	3	11092	1 No.12000 CFM Axial Fan located at Terrace	3.7	1	3.7	
	Staircase								
1	Staircase- ST-01	Ground Floor Duct Floor	4	17827	1 No.18000 CFM Axial Fan located at Terrace	5.5	1	5.5	
	Total Power For Pressurization								82

**Annexure-II****(List of Approved Makes)**

S. No	Equipment/Material	Approved Manufacturer Name
1.	Ultrasonic BTU meter	Kamstrup Siemens Belimo
2.	Air Handling Unit and Fan Sections- AHRI/Eurovent Certified	Daikin (Citizen) Zeco Edgetech VTS Systemair
3.	Fan Coil Unit (Eurovent/ AHRI certified)	Daikin Sinko Midea York
4.	Centrifugal/Plug Fans (AMCA certified)	Kruger Nicotra Airflow Greenheck Akron
5.	EC Fans (AMCA certified)	Ebm Papst Ziehl abbeg
6.	Axial Flow Fan (AMCA certified)	Greenheck Kruger Air flow Flaktwoods
7.	Propeller Fan	Alstom Caryaire Humidin
8.	Inline Fan	Air flow Ruskin-Titus Greenheck Systemair Ostberg
9.	Jet Fan (AMCA certified)	Greenheck Kruger Air flow Flaktwoods
10.	Split Unit (5 Star as per BEE) / Package Unit/ Precision Units	Daikin Mitsubishi Carrier Bluestar Voltas

11.	Chilled Water Cassette Unit	Daikin Sinko Midea York
12.	Copper Pipe	Diamond Total line Rajco
13.	Dedicated Outdoor Air System & heat recovery wheel	DRI Flaktwoods Swegon
14.	Filters	Thermadyne AAF Camfil Spectrum
15.	Variable Air Volume Box	Titus Trox Conaire Tristar(Neptronics)
16.	Kitchen Scrubber (Dry Type)	Rydair Trion
17.	UV lamp/ UVGI coil (UL Listed)	Honeywell Edgetech (American Collaboration) IAQURE Ultrafresh Magneto
18.	Motor	Bharat Bijlee ABB Siemens Kirloskar Marathon
19.	Variable Frequency Drive (VFD)	ABB Danfoss Fuji Electric Siemens
20.	M.S. Pipe	APL Apollo Jindal Hissar Jindal Star Prakash Surya Tata Steel Welspun Zenith
21.	GI Pipe	Jindal Hissar Jindal Star Prakash Surya Tata Steel
22.	Butterfly Valve	Audco Castle Advance SKS Valves

23.	Motorized Butterfly Valve	Advance Belimo Audco Castle SKS Valves
24.	Pressure Independent Balancing Valves/ 3 Way valves	Belimo Flowcon Danfoss Siemens Herz
25.	Ball Valve	KITZ Zoloto Emerald Castle SKS Valves
26.	Insulated FCU Kit	ATS Germany Siemens Kubic Herz
27.	Balancing Valve	Audco Castle Advance SKS Valves
28.	Two way FCU Control Valve	Belimo Flowcon Danfoss Siemens Herz
29.	Room Thermostat with Digital Temperature Indication for FCU & AHU's	Belimo Flowcon Honeywell Siemens
30.	Pressure Gauge	Emerald Fiebig H Guru
31.	Thermometer	Emerald Fiebig H Guru
32.	Y Strainers and Pot strainers	Emerald
33.	Pipe supports	Diamond Hi-tech Seven star Gripple
34.	PUF section for pipe support	Lloyd Malanpur
35.	Anchor Fastener	Fischer Hilti Power Fastener Wuerth
36.	AI/GI Sheets	Bhushan Essar Indian Steel Corporation Jindal

		Lloyd SAIL TATA
37.	Factory Fabricated ducts	Ductofab Eco duct Rolastar Zeco Asawa
38.	Poly Isocyanurate duct (PIR Duct)	Asawa Mecheasy
39.	Flexible duct	Atco Titus UP Twiga Seven Star
40.	Grille/Diffuser/Dampers/ Louvers	Mapro Tristar Servex Systemair
41.	Smoke / Fire Damper	Greenheck Systemair
42.	Duct & Pipe Insulation	Trox Armacell Trocellen Cani
43.	Duct Lining	Armacell Cani
44.	Expanded Polystyrene	Styrene Packaging Beardsell SHI
45.	Fire Sealant	Birla 3 M Hilti Promat
46.	Vibration Isolator	CoriDunlop EasyflexFlexionics Resistoflex
47.	Flexible Pipe Connection	CoriDunlop EasyflexFlexionics Resistoflex
48.	Drum Scrubber	MervX Subhablue Nanochemiqs
49.	VAQ Station	Conaire Honeywell Trox

50. Electrostatic Air Cleaner  
Trion  
Honeywell  
Rydair

51.	Air quality Monitor	JCI Honeywell Iflow Pure vyan
52.	Hanging/ Wire Support	Gripple Hilti Dobi
53.	Auto air vent	Castle Anergy Emerald Rapid Cool
55.	EC filters	Honeywell Rydair
56.	Chemical dosing	NALCO Energeo Ecomax
57.	Water Treatment	NALCO Ion Exchange
58.	BTU Meter	Omicron Kamstrup JCI
59.	Precision Air Conditioning unit	Stulz Bluebox

**B. ELECTRICAL COMPONENTS**

S. No	Equipment/Material	Approved Manufacturer Name
1.	LT Panels	Adlec Control System Ambit Switchgear Pvt. Ltd. SPC Electrotech Neptune Shivalik
2.	Air Circuit Breakers / Moulded Case Circuit Breaker	ABB Mitsubishi Siemens Schneider Electric L&T Legrand
3.	MCB/RCCB	Legrand Hager ABB Siemens Schneider Electric
4.	Motor Protection Circuit Breaker	ABB Mitsubishi Siemens Schneider Electric L&T Legrand

5.	Power/AUX Contractor	ABB Mitsubishi Siemens Schneider Electric L&T Legrand
6.	Control Transformer / Potential Transformers (Epoxy Cast Resin)	Automatic Electric Gilbert & Maxwell Matrix Kappa
7.	Indicating Lamps LED type	Schneider Electric Siemens ESBEE L&T
8.	Digital Meters	Schneider Electric L&T ABB Secure Neptune
9.	LT Cables	Polycab KEI Gemscab Grandlay CMI
10.	Termination kits	3M Raychem
11.	Double Compression Cable Glands with earthing links	Dowells Comet
12.	Bimetallic Cable Lugs	Cosmos Dowells Comet
13.	PVC Insulated Copper/Aluminium conductor wires and cables	RR Kabel KEI Finolex Batra Henlay Polycab
14.	Cable Trays	Profab SMC Indeana Grading Needx

15.	Power Capacitor & Relay	Epcos Schneider Electric Neptune L&T
16.	Protection Relay	ABB Siemens Schneider Electric L&T

17.	Overload Relays with built in Single Phase preventer	ABB Siemens Schneider Electric L&T
18.	Starter	ABB Siemens Schneider Electric L&T Havells
19.	GI/MS Conduit	AKG BEC Rmcom NIC

### ANNEXURE- III

#### **PART LIST OF CODES & STANDARDS**

The installation in entirety shall comply with latest codes/standards published by Bureau of Indian Standards (BIS) as well as local regulations from departments like Pollution Control Board, Electrical inspectorate, Fire Authorities, Airport Authority of India (AAI), High rise committee, Indian Electricity rules etc. Some of the standards are mentioned here below for reference:

ASHRAE Hand Books	Systems & Equipment 2024. Fundamentals 2023. Refrigeration 2022.
Application 2021.	ASHRAE Standard 62.1-2022. ASHRAE Standard 90.1-2022 ASHRAE Standard 55-2022 ASHRAE Standard 52.1 and 52.2
IEC	Energy Conservation Building code of India -2017 (BEE)
IS : 277 - 2003	Galvanized steel sheet (Plain & Corrugated) wire for fencing.
IS : 554 - 1985 (Reaffirmed 1999)	Dimensions for pipe threads where pressure tight joints are required on the threads.
IS : 655 - 1963 (Reaffirmed 2006)	Metal air ducts.
IS : 659 – 1964 (Reaffirmed 2012)	Air conditioning (Safety Code)
IS : 660 – 1963 (Reaffirmed 2017)	Mechanical Refrigeration (Safety Code)
IS : 694 - 1990 (Reaffirmed 2015)	PVC insulated (HD) electric cables for working voltage up to and including 1100 volts.
IS : 732 - 1989 (Reaffirmed 2019)	Code of practice for electrical wiring.
IS : 780 - 1984 (Reaffirmed 1995)	Sluice valves for water works purposes.
IS : 822-1970 (Reaffirmed 2003)	Code of procedure for inspection of welds.
IS : 1239 (Part - I) - 1990 (R2004)	Mild steel tube
IS : 1239 (Part - II) - 1992 (R2011)	Mild steel Tubular and other wrought steel pipe fittings.
IS : 1255 – 1983 (R2016)	Code of Practice for installation and maintenance of Power Cables upto and including 33 KV rating (Second Revision)
IS : 1554 - 1988 (Part – I) (R2012)	PVC insulated ( Heavy Duty) electric cables for working voltages upto and including 1100 volts.
IS : 1897 – 1983 (Reaffirmed 2016)	Copper bus bar / strip for electrical purposes
IS : 2379 – 1990 (R2006)	Colour code for the identification of pipelines.
IS : 2551 – 1982 (R2005)	Danger notice plate

IS : 3043 – 1987 (R2018)	Code of practice for earthing.
IS : 3103 – 1975 (Reaffirmed 2008)	Code of practice for Industrial Ventilation.
IS : 3837 – 1976 (Reaffirmed 2017)	Accessories for rigid steel conduit for electrical wiring.
IS : 4736 – 1986 (Reaffirmed 1998)	Hot-dip zinc coatings on steel tubes.
IS : 4894 - 1987 (R1999)	Centrifugal Fan.
IS : 5133 - 1969 (Part-I) (Reaffirmed 1990)	Boxes for the enclosure of electrical accessories.
IS : 14772 - 2000	Guide for safety procedure and practices in electrical work.
IS : 5312 (Part-I) - 1984 (Reaffirmed 2004)	Swing - check type reflux Non return valves for water works
IS : 15652 – 2006	Rubber mats for electrical purposes.
IS : 5578-1984 (R2016)	Marking and identification of conductors
IS : 11353-1985 (R2017)	Marking and identification of conductors
IS : 6392 – 1971 (Reaffirmed 2003)	Steel pipe flanges.
IS : 8623 Part 01 – 1993 (R2004)	Low voltage switchgear and control gear Assemblies (Requirement for type / partly type tested assemblies)
IS : 8623 Part 02 - 1993	Bus Bar trunking system
IS : 8828 – 1996 (R2006)	Circuit Breakers for over current protection For house hold and similar installation.
IS : 9537 Part 02 – 1981 (R2003)	Conduit for Electrical Installation
IS : 10810 - 1988	Methods of test for cables.
IS : 13947-1993 (Part-I)(R2004)	General rules for low voltage switch gears and control gears.
IS : 13947-1993 (Part-II) (R2004) IEC 947 - 2	Circuit Breakers
IS : 13947 - 1993 (Part-III) (R2004)	Switches, disconnecter and fuse for low voltage switch gear and control gear.
IS : 13947 - 1993 (Part-IV) (R2004)	Low voltage switch gear and control gear for contactors and motor starters
IS : 13947 – 1993 (Part-V) (R2004)	Control Circuit Devices.

# **TECHNICAL SPECIFICATIONS**

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## 1.1 Water Treatment System

Complete water treatment systems shall be supplied and installed including all valves, piping and associated equipment. Chemicals shall be selected to suit the application and shall meet the requirements of the appropriate authority responsible for discharge of effluent to waste. Provision shall be made for the specialist water treatment company to commission the water treatment program and for monthly inspections and testing of system until the completion of the maintenance period.

Following each inspection, a detailed report shall be submitted for approval stating the condition of each water system and the details of chemicals added, together with any comments regarding general operation and condition of systems. Test kits for analysis of water systems together with log sheets product bulletins and dosing instructions shall be provided.

Plant personnel shall be instructed in the correct procedure for dosing and testing of the various systems and routine tests results shall be recorded in a log book.

## 1.2 Pre-Commissioning Cleaning of Water Systems

All water systems shall be given an initial dose and flushed out with non-foaming detergent to remove superficial dirt, oil, etc. All strainers shall be removed and cleaned following this operation. The water treatment program shall be commissioned immediately following the cleaning operation.

## Condenser / Chilled Water Treatment System

The condenser water system shall be protected by the automatic dosing assembly consisting of chemical storage tanks, dosing pumps, sensing/controlling arrangement and complete with piping from the dosing tanks to cooling tower basins. The system shall be capable of remote monitoring & controlling.

## 1.3 Dosing System

Corrosion/scale inhibitor and chemical for legionella control shall be introduced via an automatic dosing assembly. The equipment shall include chemical injection pump with adjustable output to provide proportional addition of chemicals. The system shall be complete with PVC sample water line, motorized ball valve for blowdown, stainless steel frame 304, electrical junction box (230VAC 50/60Hz single phase), with individual pump on/off switches, wireless gateway with 2-way SIM card, start-up kit & chemical storage tanks etc.

The equipment shall maintain dissolved solids at predetermined levels.

The chemical dosing pump and bleed system shall be electrically interlocked with condenser water pump to ensure the chemicals are only dosed when the condenser water system is operative.

All interfacing requirements for electrical supplies and cold water provisions including stop cock and swiveling folding arm over the chemical tanks shall be provided. Initial at the time of installation provisions shall be taken care of to provide for one complete year.

The treatment program must include:-

Monthly Legionella Samples and reports to Building Management Quarterly Cooling Tower cleans and reports to Building Management.

## 2. Differential Pressure Sensor/Transmitter

All sensors / transmitter inputs shall be individually wired to the pumps controller and necessary signal boosters shall be indicated in case of long length of cabling. All analog inputs shall be provided with current limit circuitry to provide short circuit protection and safeguard against incorrect wiring of sensors. Sensor shall have a corrosion resistant steel body with 1/8" NPT process connection with accuracy within 0.5% of full span.

## 3. AIR HANDLING UNITS

The scope of work shall comprise of supply, installation, testing & commissioning of double skin construction air handling units of the capacity & type indicated on drawings as well as Bill of Quantity. The air handling units shall be Eurovent/ AHRI certified, comprise of casing housing filter, coil & fan section. Additional sections, if required, like mixing box, second row of coil, additional filter, dampers etc. would be indicated in drawings and bill of quantities. Computerized fan selection print outs shall be submitted along with the technical data sheets. Air handling unit shall be selected for the lowest operating noise level and fan performance rating, power consumption data along with operating points clearly indicated shall be submitted prior to supply for Client/Consultant approval. These will be verified at the time of testing and commissioning of the installation.

### 3.1 Casing

The casing shall be formed out of two layers of minimum 24 gauge GI sheets with 25 mm or 50 mm thick pressure injected PU foam insulation of 40 kg/m<sup>3</sup> density (K factor not exceeding 0.02 Watt/sqm) in cavity space. The structural framework shall be constructed out of 1.5 mm thick aluminum box section with stainless steel screws. Outer sheet shall be provided with 0.63 mm thick PVC guard film. Neoprene gasket shall be provided for sealing the frame with panels which will be concealed after fixing. No gaps shall be visible between the panel and frame work. Outward opening access doors of double skin construction shall be provided for both coil and fan sections. Actual number of access doors shall be as called for in the approved shop drawing. Door hinges shall be manufactured from hard nylon or die cast aluminum. For doors provided downstream of the fan, especially in high static AHUs, additional clamps shall be provided along periphery of door to maintain constant pressure and ensure proper sealing. A micro switch interlocked with door including power wiring shall be provided such that fan motor stop running upon opening the door. Base frame shall be constructed out of aluminum or galvanized steel as per manufacturer's recommendation. Each partition shall be of sufficient thickness and provided with stiffening arrangement to prevent deflection and vibration during AHU operation. All internal surfaces including internal fittings such as dampers shall be with beveled edges and without sharp corners to prevent operator injury. There shall be no screws projecting into AHU or air stream. Water resistant marine light with power cabling shall be provided inside the AHU for service & maintenance.

AHU's with mixing boxes shall be specified in Bill of Quantities and include outdoor air and return air dampers.

Insulated condensate drain pan using 19 mm thick cross linked polyethylene/nitrile rubber and fabricated from 18 gauge stainless steel sheet shall be provided. It shall be isolated from bottom floor panel for ceiling suspended units externally insulated for floor mounted units.

Factory drilled ports for sensor installation (DPT, Air flow switch, thermometers etc) shall be provided as called for in approved shop drawings. In case a opening is made at site in AHU panel, then a GI C-channel cut at 45 degrees shall be provided all around to prevent entry of PUF into air stream. Double lip & tight fitting rubber grommets shall be provided at all openings in AHU casing such as coil connection, cable entry etc.

All outdoor application, TFA units and those with ducted return air shall be provided with thermal break and casing with 50 mm thick insulation. The supplier shall provide a written guarantee that no sweating on pane surface shall be observed in ambient conditions of 35 0C and 92% RH. Any additional precaution to demonstrate satisfactory compliance to above requirement shall be included in AHU design.

The nameplate mounted outside on the AHU casing shall provide relevant details including AHU model, fan model, motor KW, current drawn, air quantity and total static pressure.

### 3.2 Blower

Fan casing shall be of GI sheet construction and shaft of grounded C 40- 45 carbon steel supported on self-aligning plummet block operating at less than 75% of first critical speed. Blower in AHU shall be either plug type, centrifugal forward curved, centrifugal backward curved or airfoil type which will provide maximum efficiency for given duty condition. Fans used in AHU shall be “AMCA certified” and minimum efficiency of 70%. Fan assembly shall be statically and dynamically balanced to G 6.3 grade as per relevant ISO/AMCA standard. In case of belt drive, fan motor shall be mounted inside the AHU casing on slide rails for easy belt tensioning. The drive shall be selected for minimum 110% of motor horsepower.

Combination spring and rubber anti vibration mounts shall be provided for isolating the unit casing. Flame retardant, waterproof silicone rubber impregnated flexible connection shall be provided at the fan discharge.

### 3.3 Coil

The Chilled/Hot water coils shall be selected complying with following parameters:

- Material of coil : Copper or Aluminum tubes
- Dia of coil : Ranging from 12.5 to 15 mm (O.D)
- Minimum thickness of coil : 0.4 mm.
- Material of Fins : Aluminum
- Fin spacing : 4 - 5 fins per cm
- Maximum air velocity across the coil : 150 meters per minute (500 fpm)
- Water pressure drop in coil : Not exceeding 10 PSIG (0.70 kg/sq cm)
- Material of Coil frame : Stainless Steel
- Test Pressure of Coil : Hydraulically tested @ 21 kg/sqcm air pressure.
- Certification : AHRI/Eurovent

The material of header shall be copper and both supply & return connections shall be with dielectric coupling or adapter for connection with MS pipes. For air purge, a purge valve shall be provided and discharge shall be routed to the condensate drain pan by means of flexible PVC tubing. Purge valve shall be easily accessible.

The row depth for coils shall be as follows until unless specified otherwise in drawings/bill of quantity.

S.No	Application	Coil Row Depth
1.	Ceiling mounted AHU with pre-cooled ventilation air	4
2.	Ceiling mounted AHU with untreated ventilation air	6
3.	Floor Mounted AHU	6
4.	Treated Fresh Air Units	8
5.	Hot Water /Reheat Coil	2

Computerized cooling coil selection output shall be provided at the Technical submittal stage.

### 3.4 Fan Motor

Fan motor shall be single phase 220 + 6% or three phase 415 ± 10% volts, 50 hertz, energy efficient (IE-3),

totally enclosed fan-cooled, Class H insulation and IP-55 protected. Motor speed shall not exceed 1440 rpm for forward curved fan and 2900 rpm for backward curved fans with oil-resistant V or flat belt drive. AHU with direct drive will also be accepted as long as sound & efficiency are within specified limits. For all clean room application including Operation Theatres and applications requiring three stage filtration, only direct driven plug fans shall be installed.

Optionally EC motors shall be provided for air handling units up to 9000 cfm capacity which will be specified on drawings & bill of quantity.

### 3.5 Filters

Factory assembled filters set in anodized aluminum frame shall be provided with the AHU. As a standard fire resistant, MERV 8 efficiency filters shall be provided. Any additional level of filters or stages shall be specified on drawings & bill of quantity. Filters shall be easily accessible and slide out for maintenance. Epoxy or equivalent sealing mechanism shall be provided for ensuring leakages are minimized. Air velocity across filter section shall not exceed 500 FPM.

#### Pre filter (MERV 8)

Pre-filter shall be 50mm thick Box type with anodized aluminum filter frames, washable synthetic media having efficiency of more than 90% up to 10 microns particle size

### 3.6 Electronic Air Cleaner (EAC)

Electronic air filtration system shall be highly efficient with low pressure drops and shall be complete with washable pre-filter, charging section and collector section. Other forms of air filtration systems such as charged media filters, dielectric media filters, or ionizers (which do not have second stage collector plates) shall not be acceptable. The electronic air cleaner (EAC) shall be capable of removing particulates as small as 0.3 microns including microscopic haze particles, smoke, dust, mould spores and bacteria.

The EAC shall be Underwriter Laboratories (UL) Listed. The EAC shall also be EMC (Electromagnetic compatibility) certified. Full documentation must be submitted to confirm compliance to the above requirements.

Ozone level of EACs provided must be within the acceptable limit of 0.05ppm. Tenderers must also provide a test report to confirm conformance.

The EAC must have factory test report to ensure that it meets the following safety and environmental criteria with reference to ES164468, UL 867 and DA 6.2.1:

#### Performance Testing

Dielectric test

Ambient and voltage extremes

E-field test

Oscillatory transient test

Lightning test

EFT (fast transients) test

ESD (high voltage transients) test

EMI susceptibility test

EMI radiation test

#### Environmental

Humidity

Condensation

Vibration

All tenderers must submit a design analysis conditional qualification test report to confirm that tests have been conducted based on the above criteria and that the EAC has passed these tests.

Each EAC cell shall have their automatic interlock switch which disconnects power and discharges the cell when the access door is opened. In addition, the EAC shall be capable of interlocking when disconnecting the power to each individual EAC unit, or when the AHU fan is not running.

A high voltage test button shall be provided for each individual high tension power supply unit to indicate the presence of high voltage on the electronic cells. An overall test button for a group of power supply units to provide a general indication of high tension voltage is not approved.

The average capacity of the EAC shall be at least 1000 cfm for the single cell unit and 2000 cfm for the double cells unit.

The EAC filtration to be certified as MERV14 or above as per ASHRAE 52.2-2012 from a reputed laboratory.

The solid state power supply shall provide dual voltage to the ionizer and collector section. The voltage to the ionizer shall be atleast 8000V DC to create an intense electrostatic field to allow maximum transfer of electrical charge from the ionizing wires to air particles. The voltage to the collector shall be atleast 4000V DC.

For the EAC to perform effectively against PM 2.5 pollutants, the EAC shall have a fractional efficiency test report from a third-party testing laboratory to confirm CME (Composite Minimum Efficiency) of the following:

Particle Size	CME
0.3-0.4µm	68%
1.0-1.3µm	78%
2.2-3.0µm	85%

The entire Filtration system shall be washable and reusable without need for replacements. Electrostatic media filters that collect particles on disposable media pads shall not be acceptable.

The average initial pressure differential drop across the entire filtration system shall not exceed 75 pa at 2000cfm and 2.5 m/s airflow. The ionizing wires and collector plates shall be integrated within one pack. It shall be washable for repeated use. A washable aluminium mesh prefilter shall be provided at the inlet to trap all larger sized particles.

Filter cells shall be universal to allow for a single inventory of filters as spare parts.

The EAC shall be completed with Hot- dipped Galvanized cabinet to protect against rust, heavy duty commercial used electronic cells, solid state power supply, protective screen and prefilter. A washable aluminium mesh prefilter shall be provided at the inlet to trap all larger sized particles.

The EAC shall have the capability for the optional addition of activated carbon (Charcoal) filter. The activated carbon filter shall be able to reside into the EAC cabinet as and when necessary; no modification for the initial installation shall be allowed.

The EAC shall have the capability of interface with the building management system through a Solid State Performance Indicator (SSPI). The following status shall be allowed for remote monitoring by the building management system as common fault:

Normal operation of solid state power supply (ON)

Any malfunction of the system that shall cause an alarm activation (CHECK)

Excessive dirt accumulation in the collector cells that could result in the reduction of the EAC performance

(WASH)

The EAC shall have local LEDs at each individual unit to indicate the above status and it shall be able to provide in addition a signal to link-up with the building management system for monitoring.

Tenderers must submit a Clause-by-Clause Compliance Summary and provide full documentation/technical literature/data sheets/reports to confirm compliance for each clause. Please also submit a project reference list.

### 3.7 Vibration Isolation

Cushy foot mounted vibration isolators shall be provided for all air handling units with minimum vibration isolation efficiency of 90%.

### 3.8 Dampers

Dampers provided in supply/return/exhaust air streams shall be opposed blade type and constructed out of double skin airfoil aluminum section and housed in aluminum frame. An integral gasket shall be provided for minimizing leakages and all linkages shall also be aluminum or nylon, turning in Teflon bushes. Manual dampers shall be provided with a Bakelite knob for locking the damper blades in position. Air leakage through dampers when in the closed position shall not exceed 1.5% of the maximum design air volume flow rate at the maximum design air total pressure.

### 3.9 Outdoor Air Intake

Outdoor air for ventilation to AHU shall either be brought in from Dedicated Outdoor Air Systems (DOAS), Treated Fresh Air Unit (TFA) or through opening in masonry walls. In case of untreated outdoor air from masonry walls, anodized/powder coated extruded aluminum construction rain protection louvers with bird-screen and manual dampers (specification given in previous section) shall be provided. Additional Variable Air Quantity (VAQ) station may be installed. All items for outdoor air intake mechanism shall be specified separately in BOQ & drawings.

### 3.10 UV Lamps

If indicated in Schedule of Quantities, UVC system shall be provided for optimal radiant energy on the coil and drain pan. To maintain energy efficiency, the UVC energy produced shall be of the lowest possible reflected and shadowed losses.

UVC emitter design shall be such that maximum energy emitted is with 254nm.

Key Features of UVGI System:

Modular, Plug-and-Play, State of the art system for quick and easy installation.

Highest Intensity with maximum output and minimal deration at 12,000 run hours

UL Certified high performance emitter.

Sleek, Compact and Best in class Power factor UL Certified Ballast.

Factory Wired input / output cable combinations for optimal performance of UV-C emitters

Channel type frame design to integrate interconnecting cables and wiring harness with emitters, to ensure minimized exposure to UV-C intensity.

Reflectors with High Spectral Aluminum finish with minimum 85 % reflectance of 254 nm UV-C intensity

Reflectors are Parabolic design to maximize UV-C coverage with minimal deration in intensity

Teflon coated multicore cables with color coded mistake proofing connectors and water resistant silicon lamp boots for electrical safety

Integrated Microprocessor based controller for monitoring system functionality and diagnosis.

Following are minimum design requirement of UVC emitters.

Emitters and supporting fixtures shall be installed upstream and / or downstream of the cooling and /or heating coil to

ensure desired effect.

Size of cooling coil shall be considered as per BOQ.

Emitters shall be installed at right angles to cooling coil fins such that UVC energy shall bathe all surfaces of the coil or/and drain pan. The UV emitters system shall be designed to provide minimum cumulative average UVC minimum intensity of  $2812\mu\text{W}/\text{cm}^2$  if installed downstream or minimum  $4016\mu\text{W}/\text{cm}^2$  if installed upstream.

UVC assembly shall include high efficiency electronic UVC source, housing with reflectors and associated control and power wiring with modular design to do interchangeability as an option to maintain lower spares and better operation. The same shall be single unit.

Units shall be high/ standard output, suitable for operation in HVAC system and germicidal operation. Units shall be factory assembled and tested.

Emitters shall be double / single ended as per manufacturer's standard. Double ended units shall have connectors on both sides to simplify gang wiring. Emitters shall be high/standard output T5 (15mm) or T6 (16mm) diameter with medium bi-pin and capable of producing 95% of their energy at 254nm wavelength. Emitters shall be UL certified as per UL 1995 or CE Conformity with high PF and operate on 230V, 50Hz, 1-phase supply and capable of lighting up at operating temperatures between 35 Deg. F and 170 Deg. F in airflow up to 1000FPM. Unit shall be equipped with RF and line noise suppression. Emitters shall not produce ozone or other secondary contamination.

Emitters shall be tested at the manufacturer's factory with solid state Photodiode UV sensor at rated distance as per installation for calibration wavelength of 254nm with + 10% accuracy.

Reflector shall be constructed of high spectrum reflectivity with minimum 85% reflectance of 254nm UVC energy.

Humans are not supposed to come in direct contact with UVC energy rays. For UVC system installed within AHUs, interlock switch shall be provided at the AHU door to cutoff power supply in case of door being opened. Relevant caution stickers shall be installed on all access doors.

Manufacturer shall submit necessary technical documentation for the above and certification of the product as per ASHRAE / accredited Indian laboratory for the same

### 3.11 Air Washer

Air washer section shall be provided in the AHU if indicated in Schedule of quantities. Air washer section shall be designed for adiabatic humidification. Media shall be wet pad type to allow even distribution of water over entire fill surface area of the pad. Pad shall be selected for minimum adiabatic saturation efficiency of 95%.

Water distribution system shall be with IS-1239 Class C galvanized piping. Mono block pump shall be provided for circulation of water within the unit. Pump shall be mounted inside the unit. Power for the same shall be taken from AHU starter panel. Power / control cabling shall be included. Pump shall be along with necessary Y-strainer, NRV and isolation valves.

Water sump shall be of sufficient height for water storage and providing enough pump NPSH. Sump shall be constructed out of 18G thick SS-304. Make up water connection along with float valve shall be provided. Drain connection shall be provided at lowest part of sump.

### 3.12 Installation & Commissioning

The air handling units shall be installed over a MS structure or cement-concrete blocks. Manufacturer shall include necessary vibration isolation mechanism to ensure there is no transmission of vibration to adjacent floors. Sandwich (GI sheet in between) vibration isolation pads shall be included.

Paint that have scratched/damaged during shipment or erection shall be cleaned, wire brushed, spot primed and then coated with spray paint. The contractor shall remove the plastic sheet on AHU casing and clean the surface before handing over. Cooling capacity shall be verified prior to handing over by measuring air flow and dry & wet bulb temperature of air entering and leaving the coil. Flow measurements shall be by an anemometer and temperature measurement by calibrated electronic thermometer. Computed results shall conform to the technical data approved prior to supply and will be in line with tender requirement. Power consumption shall be computed from measurement of incoming voltage and input current.

#### 4. DEDICATED OUTDOOR AIR SYSTEMS

The scope of work shall comprise of supply, installation, testing & commissioning of double skin construction air handling units with a reheat (sensible) and an enthalpy wheel of the capacity & type indicated on drawings as well as Bill of Quantity. The units shall comprise of both treated outside air supply section and a return air section. Such units will be termed as Dedicated Outdoor Air System (DOAS). Computerized performance selection print outs for individual components & collective unit shall be submitted along with the technical data sheets. DOAS shall be selected for the lowest operating noise level and fan performance rating. In addition, enthalpy wheel selection, reheat sensible wheel selection, power consumption data along with operating points clearly indicated shall be submitted prior to supply for Client/Consultant approval. These will be verified at the time of testing and commissioning of the installation.

The supply air section shall include outlet air damper (motorized or manual as described in bill of quantity/drawings), MERV 8 efficiency pre-filter, MERV 13/14 efficiency fine filter (As specified in BOQ), Enthalpy Wheel, 8 row deep Cooling Coil Section, Inspection Section and Fan section comprising of Supply Air fan and motor. The Return Air section shall include Return Air inlet damper, MERV 8 efficiency pre-filter, Sensible reheat wheel, Enthalpy Wheel and Fan section.

The specification for following shall be similar to that given under Air Handling Unit section of the tender. The casing of DOAS shall be with 50 mm thick sandwich insulation. Rest of specification will remain unchanged.

Coil

Condensate drain pan

Blower

Filters

Dampers

Outdoor air intake

The casing of DOAS shall be provided with thermal break profile.

##### 4.1 Inspection Section

An inspection section shall be provided for inspection of other functional sections. It shall be available in two options; long and short version and shall be selected as defined in the Bill of Quantities.

##### 4.2 Sensible Wheel for Reheat of air

A sensible heat recovery wheel shall be provided in return air stream which will be made of alternate layer of corrugated and intervening flat composite material of aluminum foil. The wheel medium shall be bonded to form a rigid heat transfer medium with a multitude of narrow channels ensuring laminar flow. 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 Method of Testing Standard S4-78 for air to air heat exchangers.

All required controls & instrumentation to ensure supply air conditions are as specified in tender shall be responsibility of DOAS supplier. The minimum sensible efficiency shall be 70%.

### 4.3 Enthalpy Wheel

A sensible heat recovery wheel shall be provided in return air stream which will be made of alternate layer of corrugated and intervening flat composite material of aluminum foil. The wheel medium shall be bonded to form a rigid heat transfer medium with a multitude of narrow channels ensuring laminar flow. 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 Method of Testing Standard S4-78 for air to air heat exchangers. The minimum sensible and latent efficiencies shall be 75.

The wheel casing shall be constructed as a 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. The casing shall be equipped with adjustable brush seals, which minimize the carryover to max 0.05 – 0.2%.

Hub and Spokes on one piece rotor shall be Aluminum construction and on sectorized rotor Hub shall be made of steel, painted with anti-corrosion paint and galvanized sheet steel spokes. The wheel shall be belt driven along its perimeter through a constant speed fractional horsepower motor which will be mounted on a self-adjusting base.

### 4.4 Installation & Commissioning

The DOAS shall be installed over a MS structure or cement-concrete blocks. Manufacturer shall include necessary vibration isolation mechanism to ensure there is no transmission of vibration to adjacent floors. Sandwich (GI sheet in between) vibration isolation pads shall be included.

Paint that have scratched/damaged during shipment or erection shall be cleaned, wire brushed, spot primed and then coated with spray paint. The contractor shall remove the plastic sheet on DOAS casing and clean the surface before handing over.

Cooling capacity shall be verified prior to handing over by measuring air flow and dry & wet bulb temperature of air entering and leaving the coil. Flow measurements shall be by an anemometer and temperature measurement by calibrated electronic thermometer. Computed results shall conform to the technical data approved prior to supply and will be in line with tender requirement. Power consumption shall be computed from measurement of incoming voltage and input current.

### 5.0 FAN COIL UNITS

The scope of work shall comprise of supply, installation, testing & commissioning of fan coil units of the capacity & type indicated on drawings as well as Bill of Quantity. The fan coil units shall be vertical type suitable for mounting on floor with top air throw or horizontal type for above false ceiling application with front air throw or wall mounted for exposed application with bottom air throw. Both vertical and horizontal FCU shall be suitable for ducted throw. The units shall consist of chilled/hot water coil, centrifugal fans, motor, filter and an insulated condensate drain pan.

Fan coil unit selection shall be such that sound level shall not exceed NC 30 at low speed and NC 35 at medium/high speed. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted at the technical document stage for approval of Client/Consultant prior to supplying at site and thereafter verified at the time of commissioning. Unit performance shall be ARI/ Eurovent certified.

Fan coil unit shall be fitted at site with ball valve with Y strainer at inlet and ball valve at outlet.

### 5.1 Casing or Cabinet

Casing shall be constructed out of 18 gauge galvanized sheet steel galvanized sheet steel with additional protective coating/ powder coating (of approved shade). The casing shall house fan deck, cooling coil & filter with access panel for easy installation & service of accessories. The fan deck and cooling/heating coil should be easily

removed without need for dismantling or lowering of FCU.

## 5.2 Cooling & Heating Coil

The Chilled/Hot water coils shall be selected complying with following parameters:

Material of coil : Copper or Aluminum tubes

Dia of coil : minimum 9.52 mm (O.D)

Minimum thickness of coil : 0.4 mm.

Material of Fins : Aluminum

Fin spacing : 4 - 5 fins per cm

Maximum air velocity across the coil : 150 meters per minute (500 fpm)

Water pressure drop in coil : Not exceeding 10 PSIG (0.70 kg/sq cm)

Material of Coil frame : Stainless Steel/ galvanised sheet steel

Test Pressure of Coil : Hydraulically tested @ 21 kg/sqcm air pressure.

Certification : AHRI/Eurovent

The coil shall be fitted with dielectric coupling or adaptor for connection with MS pipes by the HVAC contractor. All bends and joints shall be enclosed within insulated end sections of the base unit for protection against sweating. Air vent shall be provided in headers at a level higher than coils.

## 5.3 Blower & Motor

A direct driven forward curve DIDW centrifugal fan driven by fractional horse power shaded-pole motor or EC/ Brushless DC motor shall be provided in fan deck. The fan deck shall be acoustically lined using open cell nitrile rubber of 19 mm thickness.

Single phase motor rated for  $220 \pm 6\%$  volts, 50 hertz shall be provided. Motor shall be three speed, premium efficiency, six pole, shaded pole type with maximum 1000 rpm speed at maximum rated airflow. Motors shall be factory wired to a terminal block mounted within the fan section.

Alternately EC motor shall be provided if specified on drawings & bill of quantity.

## 5.4 Drain Pan

Single Skin main Drain pan shall be constructed with heavy gauge sheet steel/ stainless steel designed suitable for quick water removal. The material of insulation will be minimum 6 mm thick cross linked polyethylene or nitrile rubber (class O as per BS 476). The pan shall be extended to cover all fittings / connections / valves / copper pipe so that condensate does not drip on false ceiling. Alternative an additional auxiliary drain pan may be provided with specifications same as the main drain pan for the purpose. The drain pan shall be sloped towards one end. All drain pans shall be powder coated in approved shade.

## 5.5 Control Valves

The fan Coil Units shall be provided with factory prepared pre-assembled valve station kits, complete with 2 way control/ Pressure Independent Control cum Balancing Valve, set of ball valves, strainer, inter-connecting copper pipes/ hoses and required fittings for assembly. The entire valve station shall be leak tested and calibrated for direct installation at site. The valve station shall be designed so as to fit completely within the provided extended drain tray of the fan coil unit.

## 5.6 Thermostat

Thermostat shall be modulating or snap acting as specified in drawings & bill of quantity. It shall be suited for both cooling & heating and with a digital display and with a feature of automatic resetting in case of power disruption. The accuracy of thermostat shall be  $+ 1 \text{ }^{\circ}\text{C}$ .

Control & Power wiring laid in 25 mm dia MS conduit between thermostat and fan coil unit shall be part of

scope and included in quoted price of FCU

Thermostat shall be supplied at site only after written approval is received from Client / Architect / Consultant. A physical sample of thermostat shall be furnished for prior approval.

#### 5.7 Installation & Commissioning

The ceiling suspended Fan Coil Unit shall be hung through rubber-in-shear vibration isolator with help of fasteners.

Paint that have scratched/damaged during shipment or erection shall be cleaned, wire brushed, spot primed and then coated with spray paint.

Cooling capacity shall be verified prior to handing over by measuring air flow and dry & wet bulb temperature of air entering and leaving the coil. Flow measurements shall be by an anemometer and temperature measurement by calibrated electronic thermometer. Computed results shall conform to the technical data approved prior to supply and will be inline with tender requirement. Power consumption shall be computed from measurement of incoming voltage and input current.

### 6 CHILLED WATER CASSETTE UNITS

The scope of work shall comprise of supply, installation, testing & commissioning of Chilled water cassette units of the capacity & type indicated on drawings as well as Bill of Quantity.

#### 6.1 Unit Details

Units shall be with Eurovent Certified Performance

The units shall be 1 way / 4 way directional flow Chilled Water Cassettes.

The units shall comprise of multi-row chilled water coil section, 4 speed motor, 3 dimension screw fan forward curve type, circuit box, decorative panel, thermostatic controls, drain pump assembly, all relevant sensors for protection and control, galvanized sheet steel casing with GI coated finish.

The Drain pump should be ideally suited to lift water up to a minimum height of 500 mm. The pump shall be interlocked with the unit's functioning in such a way that if the drain pump mal-functions, then the unit should stop functioning and give a warning signal.

The indoor unit should be fabricated from 18 Gauge G.I. sheets & decorative panel with ABS plastic.

The fan should be statically & dynamically balanced and with directly driven forward curved blades. The fan should be able to deliver air @ 400 CFM / TR at the highest speed.

Fan motor should be single phase suitable for 220 V, 50Hz A.C. supply & should have 4 speeds. Alternatively, the motor may be EC/ Brushless DC type with built-in drive card for its functioning. No additional items should be excluded from the scope for the running of this EC/ BLDC unit.

Cooling coil should be of minimum 7mm O.D. and minimum wall thickness of 0.4mm.

Coil should be minimum 2 rows deep. The coil should be suitable for operation on chilled water and accordingly return headers should be provided. The coil sizes and capacity should be adequate for desired refrigeration performance.

The coil inlet/ outlet distributors should be of brass and of size 20mm. The coils should have hydrophilic aluminum type of fins for prolonged life of equipment. Minimum fins per inch should be 12.

The units should be available with a cordless remote controller. The remote should be able to control set temperature, change modes, change fan speed and preferably with timer on/ off function.

There should be a provision for wired controller with digital display as well.

#### 6.2 Installation & Commissioning

The Chilled Water Cassette should be suspended from the ceiling, using anchor fasteners for robust fitting.

The unit should be hung using threaded hangers for height and level adjustment. These hanging accessories shall be factory provided. The minimum height of the adjustable hanging rods should be 15 inches.

An auxiliary drain tray arrangement should be provided to house the ball valves, strainer and on/off control valve

assembly. Water from this aux. tray arrangement shall go back into the Cassette main drain tray and no additional drain pipe outlet should be required.

The ball valves fitted should be of appropriate sizes. However only a factory prepared valve station should be provided at site.

A onetime riser should be provided by the installer for the drain flow to ensure no return of the drain water under any circumstances. A natural gravity slope should be provided after the riser by the installer. This “N” trap arrangement is mandatory for all Chilled Water Cassettes installment.

## 7. FANS

The scope of work shall comprise of Supply, installation, testing & commissioning of Fans as per the requirement specified in tender BOQ as well as drawings.

### 7.1 Centrifugal Fans

Centrifugal fan shall be DWDI / SWSI Class I construction arrangement 3 (i.e. bearings on both the sides) for DWDI fans complete with access door, squirrel-cage induction motor, V-belt drive, belt guard and vibration isolators, direction of discharge / rotation, and motor position shall be as per the Approved-for-Construction shop drawings.

Housing shall be constructed of 14 gage sheet steel welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans, however neoprene / asbestos packing should be provided throughout split joints to make it air-tight.

18 gauge galvanized wire mesh inlet guards of 5 cm sieves shall be provided on both inlets. Housing shall be provided with standard cleanout door with handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

Fan Wheel shall be backward-curved non-over loading type. Fan wheel and housing shall be statically and dynamically balanced. For fans upto 450 mm dia, fan outlet velocity shall not exceed 550 meter/minute and maximum fan speed shall not exceed 1450 rpm. For fans above 450 mm dia, the outlet velocity shall be within 700 meter/minute and maximum fan speed shall not exceed 1000 RPM. High static pressure fan speed shall be as per manufacturer.

Shaft shall be constructed of steel, turned, ground and polished.

Bearings : shall be of the sleeve / ball-bearing type mounted directly on the fan housing. Bearings shall be designed especially for quiet operation and shall be of the self-aligning, oil / grease pack pillow block type.

Motor : Fan motor shall be energy efficient and suitable for  $415 \pm 10\%$  volts, 50 cycles, 3 phase AC power supply, squirrel-cage, totally enclosed, fan-cooled motor, provided with class F insulation and meeting IE-3 efficiency.

Drive to fan shall be provided through belt with adjustable motor sheave and a standard belt guard. Belts shall be of the oil-resistant type.

Vibration Isolation : MS base shall be provided for both fan and motor, built as an integral part, and shall be mounted on a concrete foundation through Resistoflex vibration isolators. The concrete foundation shall be at least 15 cm above the finished floor level, or as shown in approved-for-construction shop drawings.

Centrifugal fans for smoke extract application shall have external belt drive and motor. Fan & casing shall be internally rated for 300oC for 2 hours.

### 7.2 Axial Flow Fan

Fan shall be complete with motor, motor mount, belt driven (or direct driven) and vibration isolation type, suspension arrangement as per approved for construction shop drawings.

Casing : shall be constructed of heavy gage sheet steel. Fan casing, motor mount and straightening vane shall be of welded steel construction. Motor mounting plate shall be minimum 15 mm thick and machined to receive motor flange.

An inspection door with handle and neoprene gasket shall be provided. Casing shall have flanged connection on both end for ducted applications. Fan casing are with internal punched inlet and outlet flanges to prevent air leakage, for size upto 1600 mm dia and shall be constructed of rolled steel with a continuous seam welded. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bonderized, primed (minimum 2 coats of rust-proof primer) and finish coated with enamel paint or powder coated after phosphating process.

Rotor : hub and blades shall be cast aluminum alloy or cast steel construction. Blades shall be die-formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Rotor shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control may be manually readjusted at site upon installation, for obtaining actual air flow values, as specified and quoted. Taper lock bushing shall be used to mount the propeller to the motor shaft. The impeller and fan casing shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

Motor: shall be energy efficient squirrel-cage, totally-enclosed, fan cooled, standard frame, constant speed, continuous duty, single winding, suitable for 415±10% volts, 50 cycles, 3 phase AC power supply, provided with class 'F' insulation. Motor shall be specially designed for quiet operation. For lowest sound level, fan shall be selected for maximum efficiency or minimum horsepower. Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit.

Drive : Fan shall be provided through direct drive

Vibration Isolation : The assembly of fan and motor shall be suspended from the slab by vibration isolation suspension of heavy duty spring isolators type.

Axial Flow Fan shall be AMCA certified for Air and Sound performance in accordance to AMCA 210 and AMCA 300. Fan shall be suitable for both indoor and outdoor application with all accessories. Base fan performance shall be at standard conditions (density 1.2 Kg/Cu.mt.)

Following table shall be followed while selecting the fan :

S.No	Description	Standard Fan	UL Listed Fan	Fire Rated Fan
1.	Casing	It shall be constructed of heavy gauge sheet steel .	It shall be constructed of heavy gauge sheet steel and should come under UL Standards.	It shall be constructed of heavy gauge sheet steel and shall withstand 300 degree C for 2 hours & should be fire rated.
2.	Rotor	Hub & Blades shall be cast aluminum alloy or cast steel construction .	Hub & Blades shall be cast aluminum alloy or cast steel construction and should come under UL Standards.	Hub & Blades shall be cast aluminum alloy or cast steel construction and shall withstand 300 degree C for 2 hours & should be fire rated.
3.	Motor	Motor shall have	Motor shall pass	Motor for emergency

class insulation. F elevated temperature fire, smoke and heat test and other tests as ventilation shall certified per UL Standards and according to standard shall be UL listed. BS EN 12101-3:2002 for 300 degree C for 2 hours & should be fire rated.

### 7.3 Mixed Flow Inline Fan

Circular Mixed Flow Inline fan shall incorporate dual speed Mixed Flow direct driven ABS Impeller for high pressure & low noise level. The fan assembly shall be encased in shockproof & corrosion resistant casing along with connection box. The fan casing shall be of High Grade plastic material.

The Fan can be easily mounted on ceiling and mounting frame shall be provided to facilitate easy connection and access to the fan/impeller without dismantling the duct for maintenance & cleaning purpose. Flexible anti-vibration joints shall be provided to arrest vibration being transformed to other equipment connected to inline fan. Motor shall be dual speed, single phase having IP44 protection with sealed ball bearing.

The Fan should be installed along with wired plug and 2 speed controller should be wired in connection box for easy electrical connection at site.

### 7.4 Propeller Fans

Propeller fan 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 (reversed for supply applications) coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge sheet steel depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

Fan Blades shall be constructed of aluminum or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the manufacturer's works.

Shaft shall be of steel, accurately ground and shall be of ample size for the load transmitted and shall not pass through first critical speed thru the full range of specified fan speeds.

Motor shall be standard (easily replaceable) permanent split capacitor or shaded pole for small sizes, totally enclosed with prelubricated sleeve or ball bearings, designed for 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  $415 \pm 6\%$  volts, 50 cycles 3 phase power supply, and for smaller fans shall be suitable for  $220 \pm 6\%$  volts, 50 cycles single phase power supply. Motors shall be suitable for either horizontal or vertical service as indicated on Drawings and in Schedule of Quantities.

Accessories : The following accessories shall be provided with propeller fans :

- i. Wire guard on inlet side and bird-screen at the outlet.
- ii. Fixed or gravity louvers built into a steel frame at the outlet.
- iii. Regulator for controlling fan speed for single phase fan motor.
- iv. Single phase preventers for 3 phase fans.

### 7.5 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 the installation.

## 7.6 TESTING:

Capacity of all fans shall be measured by Velometer. Measured air flow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

## 8.0 DRY SCRUBBERS

### 8.1 Scope

The scope of this section comprises the supply, erection, testing and commissioning of dry scrubbers comprising of electrostatic sections manual wash or optionally with auto wash module whenever specified in the SOQ, for use in kitchen exhaust / grease / exhaust air treatment.

### 8.2 Type

The unit shall be CE certified and of the type as indicated on Drawings and identified in Schedule of Quantities.

### 8.3 Capacity

The air-moving capacity of unit shall be as shown on Drawings and in Schedule of Quantities.

### 8.4 Technical Parameters

The unit shall provide minimum efficiency of 90% or better for single pass base on ASHRAE test method. Multiple units can be joined together for the specified air capacities. The system shall be suitable to connect to fan section with average velocity of not more than 3.2 m/s, considering the cross sectional area of the ESP CELLS in the unit.

### 8.5 Unit Housing

Housing shall be minimum 1.2 mm thick zinc coated steel construction to protect against rust and corrosion. Each section shall include single door access, located one side of the unit. The access door shall be mounted on steel hinges and secured with adjustable, gasket sealed lever latches allowing for component access and removal. All doors shall be gasketed to prevent air and water leakage. Doors to charged high voltage components shall be equipped with electrical interlocks, for interconnection into the primary power supply, to prevent access when the components are energized. The housing shall be furnished completely assembled for ease of shipment and installation. Between each section, a permanent 1/8" thick gasket shall be installed to prevent leakage. The bottom drain pan under ESP section containing integral washing systems shall be pitched downward 1/4" per foot minimum toward a 3" NPT drain nipple.

### 8.6 Base Construction

The sections are to be mounted on a structural C-channel or floor mounting or ceiling suspension. Lifting lugs shall be incorporated in the base channel to allow for rigging, if ordered.

### 8.7 Finish

The external casing finish shall be a durable industrial grade semi-gloss baked-on epoxy coating.

### 8.8 Cells Wash Module

The Cells Wash module, whenever specified in SOQ shall incorporate mechanical filtration. The stationary filter

from the direction of airflow will be a metal mesh filters with single, gasketed access doors. Wash manifolds and headers are supplied to wash the module during the normal wash cycle.

#### 10.9 Electrostatic Precipitator Module

The electronic air cleaner shall be the two-stage dual voltage plate type cells, rated at not less than 90% efficiency as per the ASHRAE test standards for dry particulate. The collection cells shall be in Single Pass arrangement to provide for maximum collection efficiency.

#### 8.10 Ionizing Collection Cell

Ionizing-Collecting cell(s) shall be of one-piece construction minimum 13.38" inches deep in direction of airflow. All support framing, end plates and ionizer ground electrodes shall be 0.090 inch thick aluminum. Both repelling and collector plates shall be 0.020 inch thick aluminum, minimum 230 mm deep in direction of airflow and rigidly retained in place with tubular spacers and tie rods. Spacing between plates shall be no less than 6 mm. Ionizing electrodes shall be heavy duty tungsten wire or 24 gauge stainless steel spiked design, rigidly supported both vertically and laterally. High voltage support insulators shall be of made of Teflon or self-glazing Cordierite ceramic with all surfaces, including center hole, glazed to enhance dielectric strength and retard tracking. Minimum collection area per 1000 CMH of air flow thru ESP Cell shall be 2.0 sqm.

#### 8.11 Power Supplies

Power supplies shall be 100% solid state, CE/ UL Listed. operate on 200 to 240 VAC, 50 HZ, 1 Phase input and provide a dual high voltage output of (+) 12 to 13 KVDC for the ionizer and (+) 6.0 to 6.5 KVDC for the collector. A regulated output of up to 5.5 MA shall be supplied to maintain the specified collection efficiency. Integrally mounted electrical interlocks shall be provided to prevent access to the high voltage components without first interrupting the primary input power. The power supply shall operate over a temperature range of -32 degrees F to 140 degrees F, be self-protecting and accommodate an LED light indicating the performance status of the ionizing/collecting cell. High voltage output leads shall be sealed and a bleed resistor incorporated to remove stored electrical charge where the power supply(s) are de-energized. Module of capacity above 3000 CFM shall be equipped with Pulse width modulating (PWM) to maintain the specified collection efficiency by maintaining a constant charge in the event of Low/High Voltage from source thus ensuring that the unit functionality is not affected with these voltage fluctuations. Power Consumption should not be more that 50 watts per ESP cell.

All power supply components shall be designed for ease of mounting and servicing. High voltage power cables shall be of one continuous length, splicing is not acceptable.

#### 8.12 ARC Suppression Auto Start

The power pack shall incorporate a short circuit arc protection with automatic power restoration system to prevent overload. Should arcing takes place (due to collection cells being loaded with contaminants or should there be a fault in the unit), the power pack shall be able to automatically cut off the supply to stop the arcing and reset after a few seconds. This is to prevent and drastically reduce the risk of fire from continuous arcing.

#### 8.13 BMS Interface

The power supply (pack) shall have a 2 wire dry contacts (NO/NC) for remote link to Building Management System. This is for performance indication of the air cleaning system. Should there be a fault or if service is required, the dry contacts close and a signal is sent to the building BMS System. Should there be multiple units, all the dry contacts can be looped into a set of signal. This ensures proper monitoring of the status of each unit. There shall be 2 LED lights (Green & Red) installed on the access door of the unit to indicate the status of the air cleaning system.

#### 8.14 Static Pressure Drops

The pressure drop shall not exceed the following (inches H2O):

ESP Section	5-8MM
Metal Mesh pre filter or after filter	0.10

The ESP section must have both an internal pre filter and an after filter, select and add for each. External losses for ductwork, exhaust hoods, manufacturing equipment with associated entry losses, kitchen hoods, etc.. must be added with the above internal equipment losses to calculate total fan static pressure required.

## 9. VAV TERMINAL BOXES

### 9.1 VAV Terminal Boxes - General

All the VAV Terminals shall be Pressure Independent type with Direct Digital Controls to regulate the primary air flow rate between the scheduled minimum and maximum values to achieve the specified comfort level within acceptable noise criteria. A separation shall be made in Induction VAV Terminals and Standard VAV Terminals as detailed in the schedule.

The Induction VAV Terminals shall induce room air, without need of an assisting fan, and mix it with conditioned primary air, maintaining a near constant air volume to the room thus providing sufficient air movement necessary to maintain occupant comfort even in extreme load variations.

The VAV terminal shall have the controls, actuators and transformers, etc. pre-fitted, wired and calibrated at the factory and supplied with its appropriate digitally communicating thermostat. The supply of the VAV Terminals and the VAV controls, as well as the commissioning at the site, shall be done by the same specialist/local supplier.

VAV box shall be provided with terminal re-heater section if indicated in Schedule of Quantities.

VAV boxes shall be BMS compatible if such compatibility is specified in SOQ.

#### Construction of Standard Pressure Independent VAV Terminals

The casing shall be a double wall construction made from galvanized sheet steel (non spiral). Casing Leakage Rate shall be according to class II, VDI 3803/DIN 24 194. The insulation thickness shall be 25 mm. and the insulation material shall be fully enclosed by the metal casing. VAV Terminals with insulation materials in direct contact with the air flow will not be accepted.

The VAV Terminals shall have a low leakage, sandwich construction damper blade with SBR gasket and a solid aluminum damper shaft (diameter 12 mm.) with self-lubricating Nylon bearings. The leakage shall be less than 2% of the nominal flow at 750 Pa. inlet static pressure. The duct sleeve connections at the inlet and outlet of the VAV Terminal shall be conform DIN 24 145 or DIN 24 146 respectively.

For large air volumes, Rectangular VAV Terminals shall be provided. These Rectangular VAV Terminals shall have a multi-leaf opposed blade damper with aluminum, aerofoil blade construction, width 50 mm. and external linkage. The damper spindle shall be made of steel (10 mm. diameter), rotating in self-lubricating Nylon bearings. The VAV Terminal shall have 30 mm. flange connections at the inlet and outlet of the terminal.

Each VAV Terminal, Circular or Rectangular shall be factory fitted with a multipoint, averaging air flow sensor in the inlet of the terminal. This air flow sensor shall amplify the air pressure signal linearly with an amplification factor of at least 2.0. The air flow sensor shall contain not less than 2x12 sensing points, which shall be arranged in two perpendicular axis of sensing. The holes shall be arranged in such a way that each four points in a ring sense the air pressure across concentric circles of equal area in a round duct. The signal shall be averaged and measured from the center of the sensor. And the accuracy shall be within 2.5% even with irregular duct approach.

## 10. VARIABLE FREQUENCY DRIVES FOR HVAC SYSTEMS

The VFD shall be a dedicated HVAC engineered design supporting HVAC applications. The VFD and all its options shall be Factory built and Factory tested as a SINGLE unit and not at site.

The VFD shall be tested to UL 508C, CE marked and conform to the European Union Electro Magnetic Compatibility directive. The VFD shall be UL listed for a short circuit current rating of 100 kA and labeled with this rating.

The VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. The VFD shall be using Advanced PWM control methodology for high motor performance. The motor current shall closely approximate a sine wave.

The VFD shall have an in-built dual 5% impedance DC link reactor (Harmonic filters) on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be standard and non-saturating.

IEEE519, 1992 recommendations shall be used for the basis of calculation of total harmonic distortion (THD) at the point of common coupling (PCC) in the Electrical System. The Harmonic Analysis should be done to ascertain the Harmonics levels to decide upon the suitable Harmonic Mitigation Solution for the whole Electrical System. If required, the VFD manufacturer shall provide the Preliminary Harmonic study & Analysis for the Electrical system based on data provided.

All VFDs shall have factory fitted IP55 / 54 enclosure protection with inbuilt Mains Disconnect with no additional cabinets. VFDs with factory fitted IP55 / 54 enclosures not having inbuilt mains disconnect shall have externally provided MCCB of suitable rating for each of the VFDs inside an IP54 / 54 cabinet.

All VFDs up to 90 KW shall contain integral EMC Filters to attenuate RFI conducted to the AC power line and must be complying with the emission and immunity requirements of IEC 61800-3: 2004, Category C1 with 50m motor cable (unrestricted distribution) for all RFI sensitive Installations wherein Electronic Control system is to operate without Radio Frequency Interference emitted by VFDs.

The VFDs shall have minimum Heat loss during operation and should have efficiency close to 98%. The VFD manufacturer should highlight the heat loss data for each size in the technical submittal.

The VFD shall have three additional PID controllers which can be used to control Chilled Water Valve / Hot Water valve / Fresh Air Damper etc. in the system through the VFD as per the application demand.

The VFDs shall have capability to support three-Zone feedback PID controller in order to accept the feedback signals from 3 pressure transmitters or temperature transmitters installed at 3 different zones to control the speed of the AHUs or pumps to support optimization of air distribution or water circulation processes. This controller shall accept up to three feedback signals of same kind to support 3-Zone Feedback Control. The VFD shall be programmable to automatically select the maximum / minimum / average of the 3 feedback signals as the controlling signal. VFDs not having this functionality shall provide an external PLC with each VFD to achieve 3 Zone feedback control.

Standard Control and Monitoring Inputs and Outputs: Four programmable digital inputs Two programmable digital outputs, Two programmable relay outputs, Form C 240 V AC, 2 A with delay timers, Two programmable analog inputs (0-10 V or 4-20 mA), One programmable analog output. The Analogue/ Digital / Relay I/O shall be expandable using the additional modules based on the application requirement.

The VFD shall be able to provide variable torque V/Hz output to give full motor torque at any selected frequency from 20 Hz to base speed. Breakaway current of 150% shall be available.

AUTOMATIC ENERGY OPTIMIZATION (load dependent flux optimization) functionality to automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings shall be available in all the VFDs.

An Automatic Motor Adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. Using AMA should not require de-coupling the motor from the load to perform the test.

The VFD shall be capable of running the HVAC system at programmed lower speed even in case of One Input Phase loss. Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature.

The VFD should allow switching at the output side of Drive happening due to operation of Switches / contactor / isolator without causing tripping and shall be capable of withstanding Output switching safely. The VFD should not require interlocks for Switches on Output side for its safety.

The Local Control Panel shall be alphanumeric, graphical, backlit display with provision for two levels of password protection. It shall be capable of showing five simultaneous parameters or meters display. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

A real-time clock shall be an integral part of the VFD. All VFD faults shall be time stamped to support troubleshooting.

The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time. There shall be a KWH counter available to record the Energy consumption of the equipment.

The VFD shall include a standard EIA-485 (RS 485) communications port and capability to communicate with BMS over Modbus RTU / BacNet / Metasys N2 protocols. VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD.

The VFD shall have 45°C Ambient temperature rating at full speed, full load operation with continuous drive rated output current without any de-rating. Relative Humidity Rating shall be 0 to 95%, non-condensing, Elevation rating Up to 3,300 feet without de-rating

The VFD should have a dedicated Fire mode operation, wherein the Fan Speed in case of Fire operation can be programmed. The VFD should be capable of running in Fire Mode, by passing all programmed parameters and set points to keep the Ventilation system running until the Power Supply is shut off.

## 11. PIPING

### 11.1 Scope

The scope of this section comprises the supply and laying of pipes, pipe fittings and valves, testing and balancing of all water and refrigerant piping required for the complete installation as shown on the Drawings. All piping inclusive of fittings and valves shall follow the applicable Indian Standards.

### 11.2 Pipe Sizes

Pipe sizes shall be as required for the individual fluid flows. Various pipe sizes have been indicated on the Drawings, these are for Contractor's guidance only and shall not relieve contractor of responsibility for providing smooth noiseless balanced circulation of fluids.

### 11.3 Chilled, Hot and Condensing Water Piping

Following material shall be used for pipes and fittings.

Pipes Nominal size (mm)	Material Specification
<150	IS 1239 Part-1
200 and above	IS 3589 Gr. FE 410 (8mm thick)
Fittings Nominal size (mm)	Material Specification
<40	Socket welded, ASTM A105 construction as per ANSI B16.11
50-150	Butt welded, ASTM A234 Gr. WPB as per ANSI B16.11
>200	Site fabricated from IS 3589 Gr. FE 410 (8mm thick)
Flanges Nominal size (mm)	Material Specification
< 150	IS 2062 Gr.A construction as per ANSI B16.5/ Table E
> 200	IS 2062 Gr.A, construction as per ANSI B16.5/ Table E

a. All jointing in the pipe system shall generally be by welding, unless otherwise mentioned, or directed at site. All welding shall be done by qualified welders and shall strictly conform to BIS Code of practice for manual metal arc, welding of Mild Steel.

Out of three weld one butt weld of each welder shall be fully radiographed for testing purposes. Upon approval of welding joints the concerned welder shall be allowed to carry further welding of pipes. Rest of the welds shall have 100% visual inspection.

b. All welded joints (except pipe welded end-to-end) shall be made by use of one-piece welding flanges, caps, nozzles, elbows, branch outlets and tees of approved make. Cut samples shall be submitted for approval, if directed. All such fittings etc., shall be of a type which maintain full wall-thickness at all points, simple radius and fillets, and proper bevels or shoulders at ends. All job welding shall be done by the electric arc welding process in accordance with the following:

All joints shall have 45 degree bevel type, pipe mill-bevelled or machine-bevelled by the contractor.

All scale and oxide shall be removed with hammer, chisel or file and bevel left smooth and clean.

Pipe lengths shall line up straight with abutting pipe ends concentric.

Both conductors from the welding machine shall be extended to locations at which welding work is being done. The leads from welding machine to location of welding work shall be held together with tape or other approved means so as to prevent induced current in structural steel, in piping or in other metals within the building. The ground lead shall be connected to length of pipe through joints in pipe, structural steel of building or steel pipe supports.

c. All pipes and their steel supports shall be thoroughly cleaned and given one primary coat of red oxide paint before being installed. For vibration isolators pre-molded polyurethane pipe sections of 160 Kg/m<sup>3</sup> density with adhesive shall be fixed between pipe and MS support. 10 mm thick MS 'U' clamp with resistoflex shall be fixed on the pipe so that the pipe is kept in position. All welded piping shall be subject to the approval at site. All supports exposed to ambient shall be painted with two coats of epoxy. For condenser water piping running exposed to ambient, 2 coats of Epoxy paint shall be applied over piping. Then One coat of zinc chromate primer shall be applied. Finally color painting shall be provided as per specification in identification of services.

d. Fittings shall be malleable casting of pressure rating suitable for the piping system. Fittings used on welded piping shall be of the weldable type. These shall form part of piping and are not separately identified in Schedule of Quantities.

e. Tee-off connections shall be through equal or reducing tees, otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.

#### 11.4 Cold Water and Drain Piping

a. All pipes to be used for cold water (makeup), drain, condensate drain and fittings shall be GI / U-PVC as indicated in SOQ.

b. All jointing in the pipe system shall be by screwed joints and/or by screwed flanges using 3 mm 3 ply rubber insertion gaskets. Pipe threads and flanges shall be as per relevant BIS Codes.

c. All pipes supports shall be mild steel, thoroughly cleaned and given one primary coat of red oxide paint before being installed.

d. Fittings shall be galvanized steel 'medium class' malleable casting of pressure rating suitable for the piping system. Supply of flanges shall include bolts, nuts, gaskets as required. Sufficient number of flanges and unions shall be provided for future cleaning and servicing of piping. Tee-off connection shall be through equal or reducing tees. All equipment and valve connections, or connections to any other mating pipes shall be through flanges required for the mating connections. Fittings & flanges shall form part of piping and are not separately identified in Schedule of Quantities.

e. Gate valves, globe valves, check valves and strainers shall be similar to those specified for chilled,

condensing and hot water piping.

- f. For proper drainage of AHU Condensate, 'U' trap shall be provided in the drain piping.
- g. All condensate drain piping shall be insulated and painted as per the section "Insulation" as indicated in Schedule of Quantities.

#### 11.5 Refrigerant Piping

- a. All refrigerant pipes and fittings shall be hard drawn copper tubes and wrought copper / brass fittings suitable for connection with silver solder / phos-copper.
- b. All joints in copper piping shall be sweat joints using low temperature brazing and / or silver solder. Before joining any copper pipe or fittings, its interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently, it shall be thoroughly blown out using carbon dioxide / nitrogen.
- c. Refrigerant lines shall be sized to limit pressure drop between the evaporator and condensing unit to less than 0.2 kg per sq.cm.
- d. Sight glass with moisture indicator and removable type combination dryer cum filter with MS housing and brass wire mesh / punched brass sheet shall be installed in liquid line of the refrigeration system incorporating a three valve by pass. After ninety days of operation, liquid line drier cartridges shall be replaced.
- e. Heat exchanger shall be MS heavy duty pipe in pipe type and without any joint in the inner pipe.
- f. Horizontal suction line shall be pitched towards the compressor and no reducers shall be provided for proper oil return.
- g. After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using Freon mixed with nitrogen / carbon dioxide at a pressure of 20 kg per sq. cm (high side) and 10 kg per sq. cm (low side). Pressure shall be maintained in the system for a minimum of 12 hours. The system shall then be evacuated to a minimum vacuum of 70 cm of mercury and held for 24 hours. Vacuum shall be checked with a vacuum gage.
- h. All refrigeration piping shall be installed strictly as per the instructions and recommendations of air conditioning equipment manufacturer.

#### 11.6 Piping Installation

- a. Design Drawings indicate schematically the size and location of pipes. The Contractor, on award of the work, shall prepare detailed shop drawings, showing the cross-section, 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 the building through which pipes are designed to pass.

Pipe shall be cut only with hack saw blades and welding rods shall not be used for this purpose. All the pipes shall be cleaned and applied with one coat of Zinc chromate primer.

- b. Piping shall be properly supported on, or suspended from, stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency.

All pipes in HVAC plant room shall be supported with pipes and channels from floor only with necessary PUF pipe supports and Resistoflex sheet.

- c. Pipe supports shall be of steel, adjustable for height and Zinc chromate primer coated and finish coated

black. Where pipe and clamps are of dissimilar materials, a gasket shall be provided in between. Spacing of pipe supports shall not exceed the following :

Pipe size	Spacing between supports	Rod Size
Upto 12 mm	1.5 Meter	10 mm
15 to 25 mm	2.0 meter	10 mm
30 to 150 mm	2.0 meter	10 mm
Over 150 mm	2.5 meter	12.5 mm

- d. Vertical pipes passing through floors shall be plumb and parallel to wall. Pipes shall be supported on alternate floor. MS cleats shall be welded on pipes and rest on MS channel placed on the floor with 15 mm thick Resistoflex pads between the cleat and channel. U clamps with Resistoflex sheet shall be provided to keep the pipe in position.
- e. Bull heading in water/refrigerant piping shall be avoided.
- f. Pipe sleeves at least 3 mm thick, 50 mm / 100 mm larger in diameter than condenser / chilled water pipes respectively shall be provided wherever pipes pass through retaining wall and slab. Annular space shall be filled with fiber glass and finished with retainer rings welded on the ends of the sleeve.
- g. Wherever pipes pass through the brick or masonry / slab openings, the gaps shall be sealed with fire sealant such as fire barrier caulks.
- h. Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 20 gage metal sheet shall be provided between the insulation and the clamp, saddle or roller, extending at least 15 cm on both sides of the clamp, saddles or roller.
- j. All piping work shall be carried out in a workmen like manner, causing minimum disturbance to the existing services, buildings and structure. The entire piping work shall be organized, in consultation with other agencies work, so that laying of pipes, supports, and pressure testing for each area shall be carried out in one stretch.
- k. Cut-outs in the floor slabs for installing the various pipes are indicated in the Drawings. Contractor shall carefully examine the cut-outs provided and clearly point out where the cut-outs shown in the Drawings do not meet with the requirements.
- l. The Contractor shall make sure that the clamps, brackets, clamp saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.
- m. All pipes shall be accurately cut to the required size in accordance with relevant BIS Codes, edges beveled and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely. In other locations, concentric reducers may be used.
- n. Flanged inspection pieces 1.5 meters long, with bolted flanges on both ends, shall be provided no more than 30 meters centers, or where-ever shown in Approved-for-Construction shop drawings, to facilitate future cleaning of all welded pipes.
- o. All buried pipes shall be cleaned and coated with zinc chromate primer and bitumen paint, and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters and wrapped with three layers of fiber glass tissue, each layer laid in bitumen.
- q. Auto purge valves shall be provided at all highest points in the piping system for venting air. Air valves shall

be 15 mm pipe size with screwed joints.

Discharge from the air valves shall be piped through an equal sized mild steel or galvanized steel pipe to the nearest drain or sump. These pipes shall be pitched towards drain points.

r. Whenever services like piping, ducting and cabling are passing through floor slab, shaft or fire zone wall, opening around services shall be closed with fire retardant material. Contractor shall use either fire compound or fire barriers for this purpose. Fire compound shall be in form of powder and shall be mixed with water in proportion suggested by OEM. Mixed compound shall be poured in shuttering and grid of 30 x 30 x 1.2mm angles placed as 150mm center to center. Minimum thickness of pour shall be 100mm and shall be for fire integrity of 120minutes. Angles shall be securely welded to building re-bars ( if left during construction) or fastened to concrete floor.

Fire barrier shall be in form of high density rock wool slabs with surface treated for fire retardation. Minimum thickness of the slab shall be 100mm and shall be for fire integrity of 120 minutes. Slabs shall be tightly friction fitted in the shaft to cover all open spaces.

Measurement will be on area basis of applied projected area (in m2 / ft2).

#### 11.7 Pressure Gauges and Thermometers

a. Pressure gages shall be stainless steel and shall be provided at suction and at discharge of each pump, at chilled water supply and return at each air handling unit, at each chillers and condenser, and as shown on the Drawings and included in Schedule of Quantities. Care shall be taken to protect pressure gages during testing.

Pressure gage sockets on insulated pipes and accessories shall be extended upto insulation to avoid damage of insulation for replacement of gages. Pressure gauges shall be provided with ball valve and syphon tube.

b. Thermometers shall be stainless steel and shall be provided at chilled water supply and return at each air handling unit, at each chiller and condenser, and as shown on Drawings and included in Schedule of Quantities.

c. Thermometers on CHW lines shall be with long stem. Thermometer socket shall be extended up to insulation thickness so that the thermometer shall be removable without damaging the insulation.

#### 11.8 Valves

a. Ball and butterfly valves conforming to the following specifications shall be provided as shown on Drawings :

Size	Construction	Ends	Type
15 to 40 mm	Forged Brass	Screwed	Ball
50 mm and over	Body Cast iron,	Wafer	Butterfly

Type and requirements shall be as indicated in Schedule of Quantities. Valves shall have non-rising spindles unless specified otherwise and shall be suitable for PN 16 (unless specified otherwise in SOQ) rating. Butterfly valve should be of wafer type long neck construction single stem design with center lugs to ensure proper alignment of pipe flanges. Mount valve onto flanges only after flanges have been welded to pipes using a tool piece and cooled down to room temperature to prevent damage to resilient seat. The rubber liner should be fully supported by the valve flanges. Appropriate dimensions and thickness of Flanges and Bolts, as per the Flange Tables ANSI B16.5 should be used. The flanges should be properly aligned with each other so that bolts are exactly perpendicular to the flanges. Evenly tighten the flange bolts to secure the valves. Counter flanges with nut-bolts and gaskets shall be provided by valve manufacturer.

b. Butterfly valves shall perform the function of isolating valves and shall be suitable for PN 16 (unless specified otherwise in SOQ) rating. Butterfly valves shall have Epoxy Coated cast iron body with Integrally molded EPDM liner of replaceable type. The liner shall be integrally molded on hard backup ring and shall be suitable for PN 16 (unless specified otherwise in SOQ) rating. All butterfly valves shall be provided with locking devices. Valves 250 mm and above dia shall be gear driven.

c. Automatic balancing valves shall automatically control flow rates within  $\pm 5\%$  accuracy. Valve control mechanism shall consist of a stainless steel cartridge with a ported cup and coil / helical spring to avoid corrosion. Four operating ranges shall be available with the minimum range requiring less than 14 kPa to actuate the mechanism. Manufacturer shall provide independent laboratory tests verifying assurance of performance.

d. Balancing cum control valves shall be sized based on flow rates and pressure drops across cooling coil.

e. Manual double regulating balancing valves shall be provided at chiller, condenser, various tapp-offs and each AHU outlet line as indicated in Schedule of Quantities. These valves shall have built-in pressure-drop measuring facility to compute flow rate across the valve. The test cocks shall be long enough to protrude out of pipe insulation. To enable accurate and practical operation, measurement of flow and differential pressure shall be made 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 Programme to provide the following functions:

- i. To balance the HVAC installation and calculate the necessary valve settings, based on system measurements.
- ii. To store the results of balancing.
- iii. To log measured values from a valve (differential pressure, flowrate or temperature).

To printout saved data in computerized measurement protocol (CMP) consisting of :

- Name and size of Balancing Valve (BV)
- Presetting position of BV
- $\Delta P$  at BV
- Flow at BV
- Design Flow

f. The supply of flanges shall form part of piping (not separately identified in Schedule of Quantities) and shall also include supply of bolts, washers, nuts and suitable asbestos fiber / rubber insertion gaskets (minimum 3 mm thick). Flanges shall be as per ANSI B16.5.

g. All ball valves and ball valves with Y strainer shall be brass forged body construction with chrome plated brass ball and handle of stainless steel constructions. These are separately identified in Schedule of Quantities.

h. 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
40 to 300 mm (Epoxy Coated), CI IS 210 Gr. FG 260	Body: Grey Cast iron  Plates: CF-8 (SS-304), Hinge/Stop Pin: SS-410	Flanged

Spring(s): SS-316.  
Seal: EPDM

350 mm to 500 mm  
(Epoxy Coated),  
CI IS 210 Gr. FG 260

Body: Grey Cast iron

Flanged

Plates: SS-409.  
Hinge/Stop Pin: SS-410  
Spring(s): SS-316.  
Seal: EPDM

The bearing shall be PTFE material. Valves shall be PN 16 (unless specified otherwise in SOQ) rating.

## 11.9 Strainers

a. Strainers shall be 'Y' type or Pot Strainer suitable for PN 16 (unless specified otherwise in SOQ) rating as shown on drawings and included in SOQ. 'Y' Strainer shall be fabricated out of MS 'C' class pipe two sizes higher than that of Strainer pipe size. Flanges as per ANSI B16.5 shall be provided at inlet and outlet connectors. The body 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 nonmagnetic 20 gage SS sheet with 3 mm perforation. Cartridge having five different type of filters made out of SS 304 with different mesh sizes shall be provided. These will be replaced so as to get good quality of water in system during commissioning. Strainers shall be provided at inlet of each Air Handling Unit and Pump as shown in drawings and included in SOQ.

Pot Strainers body shall be fabricated out of MS plate IS 2062. 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 included in BOQ. 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 gage SS sheet properly reinforced to avoid damage of the element. A cone with sufficiently large drain pipe with butterfly valve shall be provided at the bottom chamber 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.

Pot strainers shall be provided with automatic backwash system if called for in SOQ. This shall be with heavy duty reduction gear motor provided at top of upper lid. During backwash, motorized drain valve shall be opened along with vent cock. Power supply cabling with tray shall be included in cost of pot strainer. Entire operation shall be through BAS 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 water tight. 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.

Size of various Pot Strainer, Filter Element and Thickness of MS sheet shall be as under:

Pipe size (mm)	Pot Dia (mm)	Pot HT (mm)	Element Dia (mm)	Element HT (mm)	MS Thickness (mm)	Plate
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

Each Port strainer shall be provided with a Manufacturer Test Certificate.

#### 11.10 Pressure Independent Balancing cum Control Valves

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. Pressure Drop across the valve must not exceed 20 kpa up to DN 32 and 30 Kpa in bigger Sizes. The valve should be a Globe Type. Diaphragm (not cartridge) based delta p controller should ensure 100% valve authority & linear characteristics at all loads and all settings. Regarding Control - Valve should be equipped with electronic modulating gear type (not rotary /thermal or Wax) actuator which can accept either “4(0)-20 mA / 2(0)-10V DC signals. Operating voltage for actuator shall be 24V AC.

All Valve actuators should be microprocessor based with self-calibrating feature.

Valve Actuator combination should be able to give logarithmic control characteristics to achieve linear control. Actuator shall be able to work against pump head or maximum closing pressure. Manual Override Flow Balancing should only be done in Valve, not in actuator and should not involve opening of actuator Body.

Regarding Balancing – Each Valve should have a step less adjustable maximum flow limitation as per the designed flow rate of coils. The balancing should 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.

Valve specifications :

Description	For 15 to 32 mm	For 40 to 250 mm
Diff Pressure (P1-P3)	16 To 400 kPa	30 To 400 kPa
Media Temperature	-10 ° to 120 °C, to 248 °F	-10 ° to 120 °C, to 248 °F
Body Material	Brass (CuZn40Pb2 - CW 617N)	Grey iron EN-GJL-250(GG25)
Test Ports	Needle measuring nipple	Needle measuring nipple
Leakage acc. to standard IEC 534	No visible leakage (at 100N)	max.0,01 - 0.05% of kv at 650N
Stem Seals	EPDM - CuZn40Pb2 - CW 617N	EPDM –NBR
Maximum Close Off Pr	1600 kPa,	1600 kPa,
Pressure rating	PN16	PN16
Control Range	Standard IEC 534 Since CV Characteristic is Linear Control Range is Infinity	
Control Valve Character	Valve Actuator combination should be able to give logarithmic control characteristics to achieve linear control	

Actuator specifications :

For Valve Sizes	15- 32mm	40- 100mm	125-150mm
Actuator Type	Modulating	Modulating	Modulating
Supply Voltage	24Volt AC	24Volt AC/DC	24Volt AC

Frequency	50Hz/60 Hz	50Hz/60 Hz	50Hz/60 Hz
Power Consumption	2VA	4.5 VA	9VA
Close of Force	130N	400N	2000N
Maximum Stroke	5mm	20mm	40mm
Speed	24 Seconds/mm	15Seconds/mm	8Seconds/mm
Protection	IP42	IP54	IP54
Body	Non Corrosive Actuator Body		
Weight	0.1Kg	0.45Kg	3.8Kg

### 11.11 Testing

- a. During construction , the contractor shall properly cap all lines, so as to prevent the entrance of sand, dirt, etc. Each system of piping shall be flushed thoroughly after completion (for the purpose of removing dirt, grit, sand etc. from the piping and fittings) for as long a time as is required to thoroughly clean the system.
- b. All piping shall be tested to hydrostatic test pressure of at least two times the maximum operating pressure, but not less than 10 kg per sq. cm gage for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified, retested and gotten approved
- c. Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.
- d. Piping may be tested in sections and such sections shall be securely capped, then re-tested for the entire system.
- 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 Owner's site representative.
- f. The contractors 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 should 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 regular flushing, as per 'f' above, all systems shall be chemically cleaned. Chemical cleaning shall be carried out in 3 stages. In first stage biological cleaning shall be done to remove algae, bacteria, SRB etc which produces slimes. Second stage is pre-cleaning in which loose rust, oil, and debris are removed. Chemical addition and hold up time shall be as per chemical supply agencies recommendations. Third stage is passivation, in which chemicals will be added and passivation film will be formed over inside surfaces of piping system. Type of chemical used and quantity of the same along with detailed method statement shall be submitted by contractor for consultants' approval before starting this activity.

Before handover Owner's site representative shall be provided with certificate of cleaning of pipe systems, signed by the contractor.

- h. After the piping has been installed, tested and run for atleast three days of eight hours each, all insulated exposed piping in plant room shall be given two finish coats, 3 mils 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.

j. The Contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. If proper circulation is not achieved due to air bound connection, the Contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and re-finishing of floors and walls if required.

k. The Contractor shall provide all materials, tools, equipment, instruments, services and labour required to perform the test and to remove water resulting from cleaning and after testing.

#### 11.12 Balancing

a. After completion of the installation, all water system shall be adjusted and balanced to deliver the water quantities as specified, quoted, or as directed.

b. All balancing valves, Automatic control valves and two-way diverting valves shall be set for full flow condition during balancing procedure. Each water circuit shall be adjusted thru balancing valves provided for this purpose; these shall be permanently marked after balancing is completed, so that they can be restored to their correct positions, if disturbed.

c. Complete certified balancing report shall be submitted for evaluation and approval by Owner's site representative. Upon approval, four copies of the balancing report shall be submitted with the as-installed drawings and completion documents.

#### 11.13 Valve Identification

Provide 30 mm dia brass valve tag, with embossed letters and number for each valve and attach the tag to valve handle by "S" hook or by suitable means. Contractor shall provide valve tag schedule and valve chart for each piping system, consisting of schematic drawing of piping layout, along with a valve list, showing and identifying each valve by number, service and location and describing its function.

The contractor shall frame under glass in the air-conditioning plant room or as directed by Owner's site representative two copies of valve chart. Two additional unmounted copies shall be supplied to the Owner's site representative.

Tags shall correspond with the valve schedule and record drawings. In back of house areas, where ceilings are installed and the valve or valve tag is not visible, a self-adhering tag with the valve number shall be installed on the wall or directly under the ceiling. For public area ceiling valves, these tags are to be installed in the service corridor, leading to the public areas.

#### 11.14 Measurement for Piping

Unless specified otherwise, measurement for piping for the project shall be on the basis of center line measurements described herewith.

Piping shall be measured in units of length along the center line of installed pipes including all pipe fittings, flanges (with gaskets, nuts, and bolts for jointing), unions, bends, elbows, tees, concentric and / or eccentric reducers, inspection pieces, expansion loops etc. The above accessories shall be measured as part of piping length along the center line of installed pipes, and no special multiples of pipe lengths for accessories shall be permitted.

The quoted rates for center line linear measurements of piping shall include all wastage allowances, pipe supports including hangers, MS channel, PUF supports, nuts, check nuts, vibration isolator suspension where specified or required, and any other item required to complete the piping installation as per the Specifications. None of these items will be separately measured nor paid for.

However, all valves (gate / globe / check / balancing / purge / butterfly / drain etc), strainers, thermometers, pressure gages shall be separately counted and paid as per their individual unit rates, which shall also include

their insulation as per Specifications. Piping measurements shall be taken before application of the insulation.

Contractor shall get pressure testing of pipes/measurements etc verified by the Owners representative at site.

## 12. G.I DUCTING ( FACTORY/ SITE FABRICATED )

### 12.1 Scope

The scope of this section comprises supply fabrication, installation and testing of all sheet metal ducts, supply, installation, testing and balancing of all grilles, registers and diffusers. All to be in accordance with these specifications and the general arrangement shown on the Drawings.

### 12.2 Duct Materials

#### 12.2.1 Raw Materials

Galvanized steel sheets with Class - VIII Galvanizing – light coating of zinc (Zinc coating shall be Lead free), nominal 120gm/Sq.m surface area and Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by owner’s site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

#### 12.2.2 Factory Fabricated Ducts

All ducts shall be factory fabricated from galvanized steel of the following thickness, as indicated below : For Ducts with External SP up to 250 Pa

Rectangular Ducts G. S.	External Pressure 250 Pa		
	Duct Section Length 1.2 m (4 ft)		
Maximum Duct Size	Gauge	Joint Type	Bracing Spacing
1–500 mm	26	TDF Flange	Nil
501 – 750 mm	26	TDF Flange	Nil
751 – 900 mm	26	TDF Flange	Nil
901 – 1200 mm	24	TDF Flange	Nil
1201 – 1500 mm	22	TDF Flange	Nil
1501 – 1800 mm	22	TDF Flange	JTR or ZEE BAR
1801 – 2100 mm	20	TDF Flange	JTR or ZEE BAR
2101 – above	18	TDF Flange	JTR or ZEE BAR

#### 12.2.3 Site Fabricated Ducts

Rectangular Ducts G. S.	External Pressure 250 Pa
Maximum Duct Size	Gauge
1–75 cm	24
76 – 150 cm	22
151 – 225 cm	20
225 – above	18

FOR ALUMINUM DUCTS MATERIAL SHALL BE ONE COMMERCIAL GAUGE HIGHER WITH 22 G AS MINIMUM

### 12.3 Fabrication Standards & Equipment

All duct construction and installation shall be in accordance with SMACNA standards. In addition ducts shall be factory fabricated utilizing the following machines to provide the requisite quality of ducts.

Coil (Sheet metal in Roll Form) lines to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.

2. All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines.
3. All edges to be machine treated using lock formers, flangers and rollers for turning up edges.
4. Kitchen exhaust ducting shall be with 16 G MS welded construction. Suitable access doors shall be provided at every 3m. Provision shall be made for firefighting agency to install duct mounted sprinklers at every 3m. Generally exhaust ducts shall have slope towards kitchen hood. Spot Welded M.S Stuck-up pins shall be provided facilitating insulation of the Duct .

Laundry and dish washer extract duct shall be air and water tight construction manufactured from Aluminum sheets in accordance to BS 1470

### 12.4 Duct Construction

12.4.1 All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes.

Ducts so identified on the Drawings shall be acoustically lined and insulated from outside as described in the section "Insulation" and as indicated in schedule of Quantities. Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of quantities. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.

Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.

All ducts up to 75cms width within conditioned spaces shall have TDF connector. The internal ends of slip joints shall be in the direction of airflow. Care should be taken to ensure that Cleats are mounted on the longer side of the duct and Cleats on the shorter side. Ducts and accessories within ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint.

Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-turns (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

Ducts shall be fabricated as per details shown on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS / 16gauge aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size.

Plenums shall be shop/factory fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.

Self-adhesive Neoprene rubber / UV resistant PVC foam lining 5mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting installation.

All fire rated duct, smoke exhaust ducts shall be quoted with flamebar BWII or equivalent to achieve the required fire rating also all the related accessories gaskets shall be suitable for the required fire rating.

## 12.5 Installation Practice

All ducts shall be installed generally as per tender drawings, and in strict accordance with approved shop drawings to be prepared by the Contractor:

The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these Specifications and Drawings. The work shall meet with the approval of Owner's site representative in all its parts and details

b) All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstructions in the building, whether or not the same are shown on the drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes, and conduits, the ducts shall be transformed, divided or curved to one side (the required area being maintained) all as per the site requirements.

c) If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available in accordance with other services and as per approval of owner's site representative.

d) All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with hangers formed of galvanized steel wire ropes (as per clause 20.12) and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel wire hangers under ducts, rigid supports may be provided at certain interval if need be. The spacing between supports should be not greater than 2.4 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates or Toggle end wire fixing left in slab at the time of slab casting.

Galvanized steel cleat with a hole for passing the wire rope hanger shall be welded to the plates. Trapeze hanger formed of galvanized steel wire rope using Gripple 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. Wire rope supports shall hang through the cleats or wire rope threaded studs can be screwed into the anchor fasteners.

Alternatively, if mentioned in the SOQ, 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 angle/channel or a pair of brackets, connected by galvanized steel rod under ducts. The spacing between supports should be not greater than 2.0 meter.

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 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 or fully threaded galvanized rods can be screwed into the anchor fasteners.

Ducting over furred ceiling shall be supported from the slab above, or from beams after obtaining approval of Owner's site representative. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other contractor's work in the building.

Where ducts pass through brick or masonry openings, it shall be provided with 25mm thick TF quality expanded polystyrene around the duct and totally covered with fire barrier mortar for complete sealing.

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 10cm long 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.

Duct shall not rest on false ceiling and shall be in level from bottom. Taper pieces shall taper from top.

## 12.6 Fire Rated Ductwork

Ducting for kitchen exhaust & fire evacuation, staircase pressurization if not in a separate shaft shall be fire rated as per following specifications.

- a. All fire rated ductwork constructed for mechanical or dual ventilation / pressurization/ basement car park/smoke extract systems and shall be fabricated from Lock Forming Quality grade prime galvanized steel sheet, constructed to enhanced SMACNA American / DW144 European standard to either low, medium or high velocity/ pressure.
- b. Test requirement of fire rated ductwork should be tested to BS476: Part 24 [1987] and ISO 6944 providing required fire rating for Stability and Integrity.
- c. Stability: the ability of a duct, ductwork & the support system to remain intact & fulfill their intended function for a specified period of time, when tested to the requirements of BS476: Part 24 and ISO 6944.
- d. Integrity: the ability of a duct or ductwork to remain free of cracks, holes or openings outside the compartment in which the fire is present for a specified period of time, when tested to the requirements of BS476 Part 24 ISO 6944.
- e. Insulation: the ability of a duct or ductwork to maintain its separating function without developing temperatures on its external surface outside the compartment in which the fire is present, which exceeds, (i) 140OC as an average value above ambient & or, (ii) 180OC as maximum value above ambient at any point, when tested for a specified period of time to the requirements of BS476: Part 24 ISO 6944.
- f. Its important that the fire rated ductwork has a smooth internal surface in order to minimize the pressure loss within the fire rated ductwork system thereby reduce the power requirements.
- g. All fire rated ducts for Smoke Extract shall have Stability / Integrity and Insulation for smoke temperatures up to 300OC upto 1.5 hrs, restriction of the duct due to twisting or buckling after the fire test shall not cause 25% or more reduction in cross sectional area proven by certification from an independent test house.
- h. Each duct shall have fire rated coating. Fire rated coating compound used for construction of fire rated ductwork shall be protected with minimum 0.7mm to 1mm nominal thickness tested to properties as per the requirements of BS 476: 6 & 7, including non-combustibility Class O and fire propagation - Class 1 surface spread of flame & materials in accordance with Building Regulations.
- i. Fire duct to be tested / assessed to BS476: Part 24 for all sizes up to 25 meters x 3 meters cross-sectional area and fully certified to vertical and horizontal plane.
- j. Fire rated duct fabricated to Method 3 of BS 5588: Part 9, factory produced. The coating compound shall be applied either offsite or onsite on the ground, dried and cured.

k. Fire duct expansion under fire conditions shall not exceed following:

- at 430OC an expansion of 0.006106mm per mm
- at 600OC an expansion of 0.00852mm per mm
- at 1100OC an expansion of 0.01562mm per mm.

### 13. AIR DISTRIBUTION

#### 13.1 Dampers

- a. Dampers: All duct dampers shall be opposed blade louver dampers of robust 16 G GSS construction and tight fitting. The design, method of handling and control shall be suitable for the location and service required.
- b. Dampers shall be provided with suitable links levers and quadrants as required for their proper operation. Control or setting device shall be made robust, easily operable and accessible through suitable access door in the duct. Every damper shall have an indicating device clearly showing the damper position at all times.
- c. Dampers shall be placed in ducts at every branch supply or return air duct connection, whether or not indicated on the Drawings, for the proper volume control and balancing of the air distribution system.
- d. Pressure relief dampers: Pressure relief dampers shall be constructed with 18G Aluminum construction with parallel blade construction. Leafs shall be 100% air tight upon closure. Leafs shall be loaded with spring pressure of stiffness (k value) corresponding to set point pressure.
- e. Non return damper (Back draft damper) : Non return damper shall be constructed out of 16G GSS. Blades shall ensure 100% air leak proof performance on closure. Design shall ensure that no rattling noise is produced at design duty.
- f. Constant Volume Regulator (For Hotel/ Hospital TFA / Exhaust ducts)

Constant volume regulators (KVR) shall be used to obtain constant air volume at a given pressure range.

The constant volume regulators (KVR) shall be of the circular type for high pressures and to be inserted into ductwork and suitable for vertical as well as horizontal mounting and it should be placed at a minimum distance of 3x the duct diameter from air supply grilles and minimum distance of 1x the duct diameter from air exhaust grilles

Constant volume regulator body, valve and piston shall be made out of flame retardant PVC, fire classification M1. They shall contain a self regulating PVC valve, piston, rubber strip for air tightness inside the duct and stainless steel calibrated spring and shall have preset air volume.

Constant volume regulator shall be made of PVC. The range covers an air flow range from 15 up to 1200 m<sup>3</sup>/h within a pressure range from 50 up to 600 Pa.

#### 13.2 Fire & Smoke Dampers

- a. All supply and return air ducts at AHU room crossings and at all floor crossings or as indicated in the drawings shall be provided with Motor operated Fire & smoke damper of at least 90 minutes rating. These shall be of multi-leaf 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 2 smoke damper in accordance with latest version of UL555S. Each fire/smoke damper shall be AMCA licensed and bear the AMCA seal for air Performance. Pressure drop shall not exceed 7.5Pa when tested at 300m/min face velocity on 600x600mm size damper. Actuator shall be UL listed.
- b. Each damper shall be supplied with factory mounted sleeve of galvanized steel of thickness as per SMACNA

and of minimum 500mm long or as specified in schedule of quantities 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 1.6mm galvanized steel . Damper blades shall be airfoil shaped (equivalent to 2.3mm thickness strength) roll formed using 0.8mm 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 180 gm / sqm 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.

c. 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 24V AC supply. In addition actuator shall have elevated temperature rating of 250 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 EFL shall allow the damper to reopen automatically after a test, smoke detection or power failure condition. 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.

d. Each damper shall be provided with its own control panel, mounted on the wall and suitable for 240 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.

e. 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 it's control panel. Control panel shall be wall mounted type.

f. 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.

g. 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.

h. HVAC Contractor shall provide Fire retardant cables wherever required for satisfactory operation and control

of the Damper.

j. 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.

k. 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.

l. 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 commissioning of the installation.

### 13.3 Fire Dampers

a. Whenever a supply/return duct crosses from one fire zone to another, it shall be provided with approved fire damper of at least 1½ hour fire rating as per UL555/1995 tested by CBRI. This shall be curtain type fire damper.

b. Fire damper blades shall be one piece folded high strength 16 gage galvanized steel construction. In normal position, these blades shall be gathered and stacked at the frame head providing maximum air passage and preventing passing air currents from creating noise or chatter. The blades shall be held in position through fusible link of temp 74oC (165°F).

The HVAC contractor shall supply UL classified Fire Dampers meeting or exceeding the specifications. Fire Dampers shall be furnished and installed at locations shown in Drawings and as described in Schedule of quantities. Fire Dampers shall have a fire rating of 1.5/3 Hrs.as specified in BOQ, in accordance with latest edition of UL555. Each Fire damper shall be AMCA licenced and shall bear the AMCA seal for air performance.

Damper shall be equipped with UL labelled Fusible Link with Temperature setting 74oC (165°F) or as specified in Schedule of quantities. Fire dampers shall have been tested to close under dynamic air flow conditions with pressure up to 1000 pa and velocities up to 10.2 m /sec. Fire damper shall be approved for Horizontal or vertical installation as may be required by the location shown in the drawings.

Damper Frame shall be a roll formed structural hat channel, reinforced at corners, formed from a single piece of 1.6mm galvanized steel. Damper blades shall be roll formed 3-v groove (1.6mm thick) or airfoil shaped in case of 3 Hrs. fire rating (equivalent to 2.3mm thickness strength) roll formed using 0.8mm thick single piece of galvanized sheet. Bearings shall be of stainless steel fitted in an extruded hole in the damper frame. All galvanized steel used shall be with minimum 180 gm / sqm Zinc coating Bigger size Dampers shall be supplied in Multiple modules of sizes not exceeding in dimensions of certified module jack shafted together.

Fire damper shall be equipped with a electric limit switch to indicate open and close position of the damper blades.

Fire Damper shall be installed in wall or floor opening using galvanized steel sleeve of minimum 500mm length of sheet thickness for fire & smoke damper as per SMACNA and as per Installation instruction of Manufacturer.

c. In case of fire, the intrinsic energy of the folded blades shall be utilized to close the opening. The thrust of the suddenly released tension shall instantly drive the blades down and keep it down without the use of springs, weights or other devices subject to failure.

d. Fire damper sleeves and access doors shall be provided within the duct in accordance with the manufacturer's recommendation.

e. The contractor shall also furnish to the Owner, the necessary additional fusible links (spares), minimum of 5% of the total number installed, at the time of commissioning of the installation.

### 13.4 Supply & Return Air Registers

Supply & return air registers shall be of either steel or aluminium sections as specified in schedule of

quantities. Steel construction registers shall have primer Coat finish whereas extruded aluminium registers shall be either Anodized or Powder Coated as specified in Schedule of Quantities. These registers shall have individually adjustable louvers both horizontal and vertical. Supply air registers shall be provided with key operated opposed blade extruded aluminium volume control damper anodized in matt black shade.

The registers shall be suitable for fixing arrangement having concealed screws as approved by Architect. Linear continuous supply cum return air register shall be extruded aluminium construction with fixed horizontal bars at 15 Deg. inclination & flange on both sides only (none on top & bottom). The thickness of the fixed bar louvers shall be minimum 5.5 mm in front and 3.8 mm in rear with rounded edges. Flanges on the two sides shall be 20 mm/30 mm wide as approved by Architect.

The grilles shall be suitable for concealed fixing. Volume control dampers of extruded aluminium anodized in black color shall be provided in supply air duct collars. For fan coil units horizontal fixed bar grilles as described above shall be provided with flanges on four sides, and the core shall be & suitable for clip fixing, permitting its removal without disturbing the flanges.

- a. All registers shall be selected in consultation with the Architect. Different spaces shall require horizontal or vertical face bars, and different width of margin frames. These shall be procured only after obtaining written approval from Architect for each type of register.
- b. All registers shall have a soft continuous rubber/foam gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers for air flow shall not be less than 66 percent of gross face area.
- c. Registers specified with individually adjustable bars shall have adjustable pattern as each grille bar shall be pivotable to provide pattern with 0 to +45 degree horizontal arc and up to 30 degree deflection downwards. Bars shall hold deflection settings under all conditions of velocity and pressure.
- d. Bar longer than 45 cm shall be reinforced by set-back vertical members of approved thickness.
- e. All volume control dampers shall be anodized aluminium in mat black shade.

### 13.5 Supply & Return Air Diffusers

Supply and return air diffusers shall be as shown on the Drawings and indicated in Schedule of Quantities. Mild steel diffusers/dampers shall be factory coated with rust-resistant primer. Aluminium diffusers shall be powder coated & made from extruded aluminium section as specified in schedule of quantities.

- a. Rectangular Diffusers shall be steel / extruded aluminium construction, square & rectangular diffusers with flush fixed pattern for different spaces as per schedule of quantities These shall be selected in consultation with the Architect. These shall be procured only after obtaining written approval from Architect for each type of diffuser.
- b. Supply air diffusers shall be equipped with fixed air distribution grids, removable key-operated volume control dampers, and anti-smudge rings as re-required in specific applications and as per requirements of schedule of quantities. All extruded aluminium diffusers shall be provided with removable central core and concealed key operation for volume control damper.
- c. Linear Diffuser shall be extruded aluminium construction with removable core, one or two way blow type. Supply air diffusers shall be provided with volume control/ balancing dampers within the supply air collar. Diffusers for different spaces shall be selected in consultation with the Architect, and provided as per requirements of schedule of quantities. All diffusers shall have volume control dampers of extruded aluminium construction anodized in mat black shade.
- d. Slot Diffuser shall be extruded aluminium construction multisport type with air pattern controller provided

in each slot. Supply air diffusers shall be provided with Hit & Miss volume control dampers in each slot of the supply air diffusers. Diffusers for different spaces shall be selected in consultation with the Architect and provided as per requirement of Schedule of Quantities.

e. Data centers shall be provided with floor grilles. Grilles shall be of nominal size of 600mm x 600mm and shall be fitted in floor tile of false floor. Grille shall be with dampers for flow control. Grill shall be heavy duty 16G Aluminium and shall take care of human traffic load. Damper shall be operable in situ without requirement of removal of grille.

### 13.6 Gripple

Wire Hangers shall be used to suspend all static HVAC Air Distribution services.

Wire Hangers should 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) stud, 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 size as per manufacturers recommendation and design. The end fixings and the wire must be of the same manufacturer with several options available. The system should be secured and tensioned with a Hanger self-locking grip (double channel lock) at the other end. Once the grip is locked for safety purpose unlocking should only be done by using a separate setting key and should 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 should have been independently tested by Lloyds Register, APAVE, TUV, UL NEBS, CSA, Chiltern International fire, ADCAS, Intertek, ECA, and SMACNA, approved by ULC and CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire rope should be manufactured to BSEN 12385: 2002

b. 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 working load limit (which incorporates a 5:1 safety factor).

The correct specification of wire hanger required is determined using the following formula.

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. Lengths from 1-10m lengths. Specials can be made, check with manufacturer. No in–line joints should be made in the rope.

Table. 1

Wire (Gripple) Hanger Safe Working Loads		
Hanger size	minimum breaking load of Wire Rope (Kg / lbs)	working load limit (kg/lbs)
No. 1	80kg/176 lbs	0-10 kg / 0-22 lbs
No. 2	260kg/572 lbs	10-45 kg / 23-100 lbs
No. 3	580kg/1276 lbs	45-90 kg / 101-200 lbs
No. 4	1500kg/3300 lbs	90-225 kg / 210-495 lbs
No. 5	2160kg/4752 lbs	225-325 kg / 496-715 lbs
No. 6	2500kg/5500 lbs	325-500 kg / 715-1100 lbs

The standard range of Hanger Kits should contain galvanized high tensile steel wire rope or stainless steel wire rope as per the application, the minimum specification is as above and should be manufactured to BS 302 (1987), BSEN12385. Comply with manufacturer's load ratings and recommended installation procedures.

### 13.7 Ducting Supports:

All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with hangers formed of galvanized steel wire ropes and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel wire hangers under ducts, rigid supports may be provided at certain interval if need be. The spacing between supports should be not greater than 2.4 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates or Toggle end wire fixing left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the wire rope hanger shall be welded to the plates. Trapeze hanger formed of galvanized steel wire rope using Gripple 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. Wire rope supports shall hang through the cleats or wire rope threaded studs can be screwed into the anchor fasteners. In case of PEB structure Loop and Catenary system can be used based on the site conditions as per approved suspension system drawings.

All horizontal ducts shall be adequately secured and supported. In an approved manner, with trapeze Hangers formed of galvanized steel wire rope in a cradle support method (refer to typical drawings) under ducts at no greater than 3000mm center, for 3001mm-above appropriate size angle along with neoprene pad in between the duct & MS angle should be used with prior approval. All vertical duct work shall be supported by structural members on each floor slab. Duct support shall be through dash / anchor fastener driven into the concrete slab by electrically operated gun. Hanger wires shall then hang around the ducting. Rigid supports shall be used in conjunction with wire rope hangers to assist with alignment of services where recommended for by the manufacturer. Rigid support must also be used in conjunction with wire rope hangers with duct work at each change of direction or connection or as per approved drawings. Support ducting in accordance with Schedule I specified below. Any other Gripple solution can be used based on manufacturer's recommendation on site conditions after prior approval. In cases of Spiral ducting the wire can be wrapped directly around the ducting without the need for a spiral ducting clamp for sizes above 1100 a cradle support should be provided, refer to manufacturer's recommendations.

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. All supports of pipe shall be taken from structural slab/wall by means of fastener.

Catenary Supports: Refer to manufacturer's recommendations on Catenary supports with C-clip, special care should be taken with tensioning of the wire and angles at which the installation of services are made.

Stainless Steel Supports should be provided for food, chemical and High Corrosion areas near coastlines.

For further technical information refer to manufacturers catalogue and installation guide. Comply with manufacturer's load ratings and recommended installation procedures.

#### Schedule I: Duct Hanger Schedule

For ducts with external SP up to 250 Pa		
Maximum Duct Size (mm)	Gauge	Gripple Hanger size
1 – 500	26	No. 1 or 2
501 – 750	26	No. 1 or 2
751 – 900	26	No. 2

901 – 1200	24	No. 2 or 3
1201 – 1500	22	No. 3
1501 – 1800	22	No. 3 or 4
1801-2100	20	No. 3 or 4
2101-3000	18	No. 4
3001 - above (Trapeze type support Arrangement)	18	No. 3 or 4

For ducts with external SP up to 250 Pa		
Maximum Duct Size (mm)	Gauge	Gripple Hanger size
1 – 500	26	No. 1 or 2
501 – 750	26	No. 1 or 2
751 – 900	26	No. 2
901 – 1200	24	No. 2 or 3
1201 – 1500	22	No. 3
1501 – 1800	22	No. 3 or 4
1801-2100	20	No. 3 or 4
2101-3000	18	No. 4
3001 - above (Trapeze type support Arrangement)	18	No. 3 or 4

Notes: All supports are considered at 2400 mm interval in above table and may vary as per the design but should not be greater than 2400mm.

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 to be used in conjunction with wire supports:

Rigid supports if required in conjunction with wire hangers shall be of steel, adjustable for height and Zinc chromate primer coated and finish coated black. Where supports and clamps are of dissimilar materials, a gasket shall be provided in between. If the MS angle at the bottom if required as per design should be as per following table:

Longer size of Duct (mm)	Type of Joints
Up to 750	25x25x3 mm L angle with M8 nuts & bolts
751-1000	25x25x3 mm L angle with M8 nuts & bolts
1001-1500	40x40x5 mm L angle with M8 nuts & bolts
1501-2250	50x50x5 mm L angle with M10 nuts & bolts
2251 & above	50x50x6 mm L angle with M10 nuts & bolts

All the supporting system should be supplied from the same manufacturer.

### 13.7 VAV TERMINAL BOXES

#### VAV Terminal Boxes - General

All the VAV Terminals shall be Pressure Independent type with Direct Digital Controls to regulate the primary air flow rate between the scheduled minimum and maximum values to achieve the specified comfort level within acceptable noise criteria. A separation shall be made in Induction VAV Terminals and Standard VAV Terminals as detailed in the schedule.

The Induction VAV Terminals shall induce room air, without need of an assisting fan, and mix it with conditioned primary air, maintaining a near constant air volume to the room thus providing sufficient air movement necessary to maintain occupant comfort even in extreme load variations.

The VAV terminal shall have the controls, actuators and transformers, etc. pre-fitted, wired and calibrated at the factory and supplied with its appropriate digitally communicating thermostat. The supply of the VAV Terminals and the VAV controls, as well as the commissioning at the site, shall be done by the same specialist/local supplier.

VAV box shall be provided with terminal re-heater section if indicated in Schedule of Quantities.

VAV boxes shall be BMS compatible if such compatibility is specified in SOQ.

#### Construction of Standard Pressure Independent VAV Terminals

The casing shall be a double wall construction made from galvanized sheet steel (non spiral). Casing Leakage Rate shall be according to class II, VDI 3803/DIN 24 194. The insulation thickness shall be 25 mm. and the insulation material shall be fully enclosed by the metal casing. VAV Terminals with insulation materials in direct contact with the air flow will not be accepted.

The VAV Terminals shall have a low leakage, sandwich construction damper blade with SBR gasket and a solid aluminum damper shaft (diameter 12 mm.) with self-lubricating Nylon bearings. The leakage shall be less than 2% of the nominal flow at 750 Pa. inlet static pressure. The duct sleeve connections at the inlet and outlet of the VAV Terminal shall be conform DIN 24 145 or DIN 24 146 respectively.

For large air volumes, Rectangular VAV Terminals shall be provided. These Rectangular VAV Terminals shall have a multi-leaf opposed blade damper with aluminum, aerofoil blade construction, width 50 mm. and external linkage. The damper spindle shall be made of steel (10 mm. diameter), rotating in self-lubricating Nylon bearings. The VAV Terminal shall have 30 mm. flange connections at the inlet and outlet of the terminal.

Each VAV Terminal, Circular or Rectangular shall be factory fitted with a multipoint, averaging air flow sensor in the inlet of the terminal. This air flow sensor shall amplify the air pressure signal linearly with an amplification factor of at least 2.0. The air flow sensor shall contain not less than 2x12 sensing points, which shall be arranged in two perpendicular axis of sensing. The holes shall be arranged in such a way that each four points in a ring sense the air pressure across concentric circles of equal area in a round duct. The signal shall be averaged and measured from the center of the sensor. And the accuracy shall be within 2.5% even with irregular duct approach.

#### Construction of Induction VAV Terminals (Pressure Independent)

The casing shall be rectangular type made from galvanized sheet steel (thickness 1.25 mm.) with a circular inlet, two Induction openings at the sides of the terminal and a rectangular outlet. The duct sleeve connections at the inlet and outlet of the VAV Terminal shall be conform DIN 24 145 or DIN 24 146 respectively. The VAV Terminal shall have internal insulation (thickness 25 mm.), tested HF-1 (UL 94) flame test and erosion proof up to 50 m/s air velocity.

The terminals shall be fitted with a specially constructed jet-tronic damper to regulate the primary air flow between the scheduled minimum and maximum values. The same damper shall also generate and control the Induction effect through the acoustically lined induction chamber of the VAV Terminal. The damper shaft shall be solid aluminum (diameter 12 mm.), rotating in self-lubricating Nylon bearings. The damper shall permit proper operation of the terminal over a range of 20 to 100% of maximum flow without the requirement of special VAV diffusers or assisting fans.

The Induction VAV Terminal shall be factory fitted with a multipoint, averaging air flow sensor in the inlet of the terminal. This air flow sensor shall amplify the air pressure signal linearly with an amplification factor of at least 2.0. The air flow sensor shall contain not less than 2x12 sensing points, which shall be arranged in two perpendicular axis of sensing. The holes shall be arranged in such a way that each four points in a ring sense the air pressure across

concentric circles of equal area in a round duct. The signal shall be averaged and measured from the center of the sensor. And the accuracy shall be within 2.5% even with irregular duct approach.

#### Measurement of Duct, Grilles & Dampers

All ducts fabricated and installed should be accompanied and supported by proper documentation viz:

- a) Bill of material/Packing list for every duct section supplied.

Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise.

Each and every duct piece to have a tag number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement and verification.

Unless otherwise specified, measurements for ducting for the project shall be on the basis of centerline measurements described herewith:

Ductwork shall be measured on the basis of external surface area of ducts. Duct measurements shall be taken before application of the insulation. The external surface area shall be calculated by measuring the perimeter comprising overall width and depth, including the corner joints, in the center of each duct section, multiplying with the overall length from flange face to flange face of each duct section and adding up areas of all duct sections. Plenums shall also be measured in a similar manner.

For tapered rectangular ducts, the average width and depth shall be considered for perimeter, whereas for tapered circular ducts, the diameter of the section midway between large and small diameter shall be adopted, the length of tapered duct section shall be the centerline distance between the flanges of the duct section.

For special pieces like bends, tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centerline.

The quoted unit rate for external surface of ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles with double nuts for supports, rubber strip 5mm thick between duct and support, vibration isolator suspension where specified or required, inspection chamber/access panel, splitter damper with quadrant and lever for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the specifications. These accessories shall NOT be separately measured nor paid for.

- b. Special Items for Air Distribution shall be measured by the cross-section area perpendicular to air flow, as identified herewith :

- i. Grilles and registers - width multiplied by height, excluding flanges. Volume control dampers shall form part of the unit rate for registers and shall not be separately accounted.

- ii. Diffusers - cross section area for air flow at discharge area, excluding flanges. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.

- iii. Linear diffusers - shall be measured by cross-sectional areas and shall exclude flanges for mounting of linear diffusers. The supply air plenum for linear diffusers shall be measured with ducting as described earlier.

- iv. Fire dampers - shall be measured by their cross sectional area perpendicular to the direction of air flow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door, electrical actuators and panel. No special allowance shall be payable for extension of cross section outside the air stream.

v. Flexible connection - shall be measured by their cross sectional area perpendicular to the direction of air flow. Quoted rates shall include the necessary mounting arrangement, flanges, nuts and bolts and treated-for-fire requisite length of canvas cloth.

For smaller sizes which has area less than 0.1 Sqm, minimum 0.1 Sqm cross section shall be considered for measurement.

14. INSULATION

14.1 Scope

The scope of this section comprises the supply and application of insulation conforming to these specifications. The insulation material shall be Closed Cell Elastomeric Nitrile Rubber or Polyethylene Foam XLPE.

14.2 Material

Thermal insulation material for Duct insulation shall be with factory laminated black fiber glass cloth closed cell Nitrile rubber. Density of the nitrile rubber shall be 40-60 Kg/m<sup>3</sup>

or

Al foil faced polyethylene material (XLPE). Density of the polyethylene material shall be 25-30 Kg/m<sup>3</sup>

Thermal conductivity as per BS 874 part 2 – 86 (DIN 52613, 52612) / DIN EN 12667 / EN ISO8497 of the insulation material shall not exceed 0.038 W/moK or 0.212 BTU / (Hr-ft<sup>2</sup>-oF/inch) at an average temperature of 30oC. The product shall have temperature range of

–40 oC to 105oC. The insulation material shall be fire rated for Class 0 as per BS 476 Part 6 : 1989 for fire propagation test and for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test. Water vapour permeability shall be not less than 0.024 per inch (2.48 x 10<sup>-13</sup> Kg/m.s.Pa i.e. μ>7000: Water vapour diffusion resistance) as per DIN 53122 part 2, DIN 52615 / EN 12086 & EN13469.

In addition to above properties the insulation material for ducts shall be anti-microbial. Microbiological growth on insulation surface shall be in accordance with ASTM G-21 and bacterial resistance to ASTM2180/ ISO22196.

The Material shall comply to ISO 5659 / BS 6853 / ABD 0031 for smoke density and toxicity values. The thermal conductivity of insulation material shall not be effected by aging as per DIN 52616 standard.

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer’s test certificate for density and thickness. Adhesive used for sealing the insulation shall be non-flammable and with low VOC content (maximum 850 gm/l less water) as per IGBC guide lines) strictly as per manufacturer’s recommendations. Adhesive shall be externally applied by contractor on site.

Ducting insulation thickness shall be as per table below.

Ducting position	Thk. for non-coastal places
SA duct in RA path	13 mm
Ducted return air system	SA duct: 19 mm RA duct: 13 mm
Both SA & RA exposed	Both 25 mm

14.3 Duct Insulation

External thermal insulation shall be provided as follows :

The thickness of insulation material shall be as shown on drawings 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 insulation to size with sufficient allowance in dimension. Cutting of insulation sheets shall be done with adjustable blade to make 90° cut in thickness of sheet. Hacksaw or blades are not acceptable tools for cutting the insulation.

Material shall be fitted under compression and no stretching of material shall be permitted. All longitudinal and transverse joints shall be sealed by providing 50 mm wide Fibre glass cloth laminated tape as per manufacturer recommendations. The insulation installers shall be certified by manufacture.

Where ducts/pipes penetrates walls / floor it shall be insulated with intumescent properties insulation material for fire protection. The treatment shall be minimum 500 mm extended on both sides.

#### PROTECTIVE COATING / VAPOUR BARRIER OVER INSULATION

All ducts and pipes (On the roof / outside) exposed to UV rays shall be covered with two coats of UV paint / epoxy.

#### 14.4 Chilled/Condensate water pipe insulation (Inside the building)

Plain polyethylene material (XLPE). Density of the polyethylene material shall be 25-30 Kg/m<sup>3</sup>. Insulated pipes shall be covered with 7mil fiberglass fabric. Over fabric one coat of fire proof or Epoxy acrylic compound shall be applied. The coat shall be allowed to cure to non – stick state. Subsequently second coat of compound shall be applied to give tough and smooth finish to the insulated surface.

All chilled water, refrigerant, and condensate drain piping shall be insulated in the manner specified herein. Before applying insulation, all pipe shall be brushed and cleaned. All MS pipes shall be provided with a coat of zinc chromate primer. Thermal insulation shall be applied as follows or as specified in drawings or schedule of quantity:

Piping Insulation thickness shall be as follows :

Pipe nominal bore	Thk. for Non-coastal places
Up to 25 mm	32 mm
32 mm – 50 mm	38 mm
65 mm – 125 mm	44 mm
Above 150 mm	50 mm

Insulating material in tube form (minimum upto 100 dia pipes) shall be sleeved on the pipes. On piping, slit opened tube from insulating material shall be placed over the pipe and adhesive shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre. Wherever flat sheets shall be used it shall be with self adhesive and cut out in correct dimension using correct tools. Scissors or Hacksaw-blade shall not be allowed. All longitudinal and transverse joints shall be sealed by providing 50 mm wide fiber glass cloth laminated tape as per manufacturer recommendations. The adhesive shall be strictly as recommended by the manufacturer. The insulation shall be continuous over the entire run of piping, fittings and valves. All valves, fittings, joints, strainers etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.

Direct contact between pipe and hanger shall be avoided. Hangers shall pass outside the saddle. Manufacturer shall supply PUF saddles with pre-laminated insulation sheet of both side (PUF saddle sandwich between insulation

material on both side) so that the insulation material is joint with insulation material on both side (only for Nitrile & EPDM) and the weight of pipe is transferred to the PUF saddle in the center.

Manufacturer's installation manual shall be submitted and followed for full compliance. All insulation work shall be carried out by skilled workmen specially trained and certified by manufacturer in this kind of work. All insulated pipes shall be labeled (S.R. or R.R.) and provided with 300 mm wide band of paint along circumference at every 1200 mm for colour coding. Direction of fluid shall also be marked. Un-insulated MS pipes shall be painted throughout and direction of fluid marked. All painting shall be as per relevant BIS codes.

#### 14.6 Refrigerant pipe insulation

Base insulation material for Refrigerant pipe shall be same as that of CHW pipe. The factory lamination on the base material shall be of chemically treated blue colored glass cloth of 7 mil thickness tested for UV resistance as per EN ISO 4892-2 Method-A. Thickness of refrigerant piping insulation shall be 13mm and 19mm unless specified separately.

#### 14.7 Drain pipe insulation

Base insulation material for drain pipe shall be same as that of CHW pipe. The factory lamination on the base material shall be of chemically treated blue colored glass cloth of 7 mil thickness tested for UV resistance as per EN ISO 4892-2 Method-A. Thickness of drain piping insulation shall be 13mm unless specified separately

#### 14.8 Duct Acoustic Lining

##### Open Cell Nitrile Rubber

Duct acoustic lining material shall be Nitrile Rubber open cell foam. Thermal conductivity of the insulation material shall not exceed 0.047 W/moK at an average temperature of 20oC. Density of the nitrile rubber shall be 140 – 180 Kg/m3. The material should withstand maximum surface temperature of +85oC and minimum surface temperature of -20oC. The material should conform to Class 1 rating for surface spread of Flame in accordance to BS 476 Part 7 & HBF, HF 1 & HF 2 in accordance to UL 94, 1996.

Insulation should have antimicrobial product protection, and should pass Fungi Resistance as per ASTM G 21 and Bacterial Resistance as per ASTM E 2180. The insulation should pass Air Erosion Resistance Test in accordance to ASTM Standard C 1071-05 (section 12.7).

Thickness of the material shall be 15 mm thick specified for the individual application and with noise absorption proprieties as per IS: 8225 / ISO 354 / ASTM423C. The insulation should be installed as per manufacturer's recommendation.

#### 14.9 Kitchen Duct Insulation

All kitchen exhaust ducts connected to kitchen hoods shall be insulated with 50 mm / 75 mm thick 60 kg/m3 density pre-laminated glass wool. PVC strap of 25 mm width shall be fixed at 300 mm interval to secure the insulation in position. Kitchen duct exposed to outside shall be further treated as under:-

a) Wrapping of "scrim glass fabric" and thereafter applying first coat of resin system formulated with activators and inert fillers. This coat is allowed to cure to a non-stick state.

b) Second coat of activated resin with suitable pigment is applied over the first coat and finished to give a though smooth surface. Duct Insulation VOC limit shall not exceed to 850 (g/L less water)

#### 14.10 Room Lining

##### Open Cell Nitrile Rubber

Two walls and ceiling of air conditioning plant room and air handling unit / fan rooms may be provided with acoustic lining.

The material shall be Nitrile Rubber open cell foam. Thermal conductivity of the insulation material shall not exceed 0.047 W/moK at an average temperature of 20oC. Density of the nitrile rubber shall be 140 – 180 Kg/m<sup>3</sup>. The material should withstand maximum surface temperature of +85oC and minimum surface temperature of -20oC. The material should conform to Class 1 rating for surface spread of Flame in accordance to BS 476 Part 7 & HBF, HF 1 & HF 2 in accordance to UL 94, 1996.

Insulation should have antimicrobial product protection, and should pass Fungi and Bacterial Resistance as per DIN EN ISO 846 Method A and Method C. The insulation should pass Air Erosion Resistance Test in accordance to ASTM Standard C 1071-05 (section 12.7).

Thickness of the material shall be 20mm if not specified separately. Surface shall be cleaned and two coats of adhesive recommended by the manufacturer should be applied on the walls. The foam sheets should be cut to required size and a layer of adhesive should also be applied to it. When it is tack dry it is stuck to the walls / ceiling.

All longitudinal and transfer joint shall be covered with 22 gauge 50 mm wide GI strip with screws as shown below:-

Acoustic lining of walls shall be terminated approximately 15 cm above the finished floor to prevent damage to insulation due to accidental water-logging in plant/AHU / fan rooms.

#### 14.11 Measurement Of Insulation

Unless otherwise specified measurement for duct and pipe insulation for the project shall be on the basis of centre line measurements described herewith

a. Pipe Insulation shall be measured in units of length along the centre line of the installed pipe, strictly on the same basis as the piping measurements described earlier. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers are not separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including cladding, valves, orifice plates and strainers shall be considered strictly by linear measurements along the centre line of pipes and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

b. Duct Insulation and Acoustic Lining shall be measured on the basis of surface area along the centre line of insulation thickness. Thus the surface area of externally thermally insulated or acoustically lined be based on the perimeter comprising centre line (of thickness of insulation) width and depth of the cross section of insulated or lined duct, multiplied by the centre-line length including tapered pieces, bends, tees, branches, etc. as measured for bare ducting. Flanges on ducts shall be insulated with same insulation material and shall not be payable extra.

### 15. ELECTRICAL INSTALLATION

#### 15.1 Scope

The scope of this section comprises of fabrication, supply, erection, testing and commissioning of Motor Control Centre (MCC), wiring and earthing of all air-conditioning equipment, components and accessories.

Note – Configuration of MCC panels shall be design to suit the requirement of system \ process. Necessary single line diagrams \ GA drawings shall be furnished by contractor for approval by consultant \ owner.

#### 15.2 General

Work shall be carried out in accordance with the accompanying specifications and shall comply with the latest relevant Indian Standards and Electricity Rules and Regulations.

All motor control centers shall be suitable for operation on 3 Phase/single phase, 11,000/415/240 volts, 50 cycles, 4 wire system with neutral grounded at transformer. All MCCs be CPRI tested design and manufactured by an approved manufacturer. CPRI certificate be made available.

MCCs comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-8623. MCCs / starter panels for outdoor equipment shall be suitable for outdoor duty application.

### 15.3 Constructional Features

The Motor Control Centre (MCC) shall be of 2 mm thick sheet steel cabinet and suitable for indoor installation, dead front, floor mounting/wall mounting type and shall be form 3b construction. The Distribution panels be totally enclosed, completely dust and vermin proof and be with hinged doors and folded covers, Neoprene gasket, padlocking arrangement and bolted back. All removable/ hinged doors and covers shall be grounded by flexible standard connectors. MCC shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of panels be 2 mm thick and be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All MCCs/panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws not be used in the construction of Distribution panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum operating clearance of 275 mm be provided between the floor of panels and the lowest operating height.

The MCC shall be of adequate size with a provision of spare feeders. Feeders be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Motor Control Centre in conformity with the location of cable/conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required. Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram mounted on inside of door shutter protected with Hylam sheet. All live accessible connections shall be shrouded and minimum clearance between phase and earth be 20 mm and phase to phase be 25 mm.

Panels with ACB shall necessarily have front and rear access as per requirement whereas panels with all MCCB breaker shall be provided with front access with sufficient clearance.

### 15.4 Wiring System

All control wiring shall be carried out by using PVC insulated copper conductor wires in conduits. Minimum size of control wiring be 1.5 sq mm. Minimum size of conductor for power wiring shall be 4 sq. mm 1100 volts grade PVC insulated copper conductor wires in conduit. All conductors shall be stranded.

### 15.5 Circuit Compartment

All components for each feeder shall be housed in a separate compartment and have steel sheets on top and bottom of compartment. Sheet steel hinged lockable door be duly interlocked with the breaker in the "ON" position. Safety interlocks be provided to prevent the breaker from being drawn-out when the breaker is in 'ON' position. The door not form an integral part of the draw-out portion of the panel. Sheet steel barriers shall be provided between the tiers in a vertical section.

All MCCs shall be provided with feeders of appropriate capacity as per Single Line Diagram. All MCCs shall be completely factory wired, ready for connection. All the terminals shall be of proper current rating and sized to suit individual feeder requirements. Each circuit be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits be distinctly marked with a small description of the service installed.

Continuous earth bus sized for prospective fault current shall be provided with arrangement for connecting to station earth at two points. Hinged doors/ frames shall be connected to earth through adequately sized flexible braids.

#### 15.6 Instrument Accommodation

Adequate space shall be provided for accommodating instruments, indicating lamps, control contactors and control MCBs. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker and bus bar 'ON' lamps shall be provided on all outgoing feeders.

#### 15.7 Bus Bar Connection

Bus bar and interconnections shall be of high conductivity electrolytic grade aluminium/copper complying with requirement of IS : 5082 – 1981 and of rectangular cross section suitable for carrying the rated full load current and short circuit current and shall be extendable on either side. Copper conductor shall be used for busbar of rating 1000A and above. Bus bars and interconnections shall be insulated with heat shrinkable sleeve of 1.1 KV grade and shall be colour coded. Bus bars shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bars shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area to be added to the bus bar to compensate for the holes. All connections between bus bars and breakers shall be through solid copper / aluminium strips of proper size to carry full rated current and insulated with insulating sleeves. Maximum current density for the busbars be 0.8 A/sq.mm for aluminium and 1.4 A/sq.mm for copper busbars.

Maximum allowable temperature for the Bus bar to be restricted to 85 deg C

#### 15.8 Temperature \_ Rise Limit

Unless otherwise specified, in the case of external surface of enclosures of bus bar compartment which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per IS 8623(Part-2) 1993.

#### 15.9 Cable Compartments

Cable compartment of adequate size shall be provided in the panel for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports be provided in cable compartment to support cables as per approved for construction shop drawing.

#### 15.10 AIR CIRCUIT BREAKERS (ACB)

The ACB conform to the requirements of IEC 60947-2 / IS 13947-2 and shall be type tested & certified for compliance to standards from CPRI, ERDA/ any accredited international lab. The circuit breaker shall be suitable for 415 V + 10%, 50 Hz supply system. Air Circuit Breakers be with moulded housing flush front, draw out type and shall be provided with a trip free manual operating mechanism or as indicated in drawings with mechanical "ON" "OFF" "TRIP" indications.

The ACB be 3/ 4 pole with modular construction, draw out, manually or electrically operated version as specified. The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (Ics) shall be as specified on the single line diagram and should be equal to the Ultimate breaking capacity(Icu) and short circuit withstand values(Icw) for 1 sec.

Circuit breakers shall be designed to 'close' and 'trip' without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel. Inspection of main contacts should be possible without using any tools. The ACB shall be provided with a door interlock. i.e. door should not be open when circuit breaker is closed and breaker should not be closed when door is open.

All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be

provided to protect the main contacts. The ACB have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and in accessibility to live parts. All electrical closing breaker be with electrical motor wound stored energy spring closing mechanism with mechanical indicator to provide ON/OFF status of the ACB.

The auxiliary contacts blocks shall be so located as to be accessible from the front. The auxiliary contacts in the trip circuits close before the main contacts have closed. All other contacts close simultaneously with the main contacts. The auxiliary contacts in the trip circuits open after the main contacts open. Minimum 4 NO and 4 NC auxiliary contacts be provided on each breaker.

Rated insulation voltage be 1000 volts AC.

#### 15.10.1 Cradle

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements be free from jerks, easy to operate and be on steel balls/rollers and not on flat surfaces.

There shall be 4 distinct and separate position of the circuit breaker on the cradle.  
Racking Interlock in Connected/Test/Disconnected Position.

Service Position : Main Isolating contacts and control contacts of the breaker are engaged.

Test Position : Main Isolating contacts are isolated but control contacts are still engaged.

Isolated Position : Both main isolating and control contacts are isolated.

There shall be provision for locking the breaker in any or all of the first three positions.

The following safety features be incorporated :

Withdrawal or engagement of Circuit breaker not be possible unless it is in open condition.

Operation of Circuit breaker not be possible unless it is fully in service, test or drawn out position.

All modules shall be provided with safety shutters operated automatically by movement of the carriage to cover exposed live parts when the module is withdrawn.

All Switchgear module front covers have provision for locking.

Switchgear operating handles shall be provided with arrangement for locking in 'OFF' position.

#### 15.10.2 Protections

The breaker should be equipped with micro-controller based , communicable type release with RS 485 port for communication to offer accurate and versatile protection with complete flexibility and offer complete over current protection to the electrical system in the following four zones :

Long time protection.

Short time protection with intentional delay.

Instantaneous protection.

Ground fault protection.

The protection release generally have following features and settings however for exact selection of protection

releases shall be made based on project requirement,

a. True RMS Sensing

The release sample the current at the rate of 16 times per cycle to monitor the actual load current waveform flowing in the system and monitor the true RMS value of the load current. It take into account the effect of harmonics also.

b. Thermal Memory

When the breaker reclose after tripping on overload, then the thermal stresses caused by the overload if not dissipated completely, get stored in the memory of the release and this thermal memory ensure reduced tripping time in case of subsequent overloads. Realistic Hot/Cold curves take into account the integrated heating effects to offer closer protection to the system.

c. Defined time-current characteristics :

A variety of pick-up and time delay settings shall be available to define the current thresholds and the delays to be set independently for different protection zones thereby achieving a close-to-ideal protection curve.

d. Trip Indication

Individual fault indication for each type of fault should be provided by LEDs for faster fault diagnosis.

e. Self-powered

The release draw its power from the main breaker CTs and require no external power supply for its operation.

f. Zone Selective Interlocking

The release shall be suitable for communication between breakers to enable zone selective interlocking. This feature shall be provided for both short circuit and ground fault protection zones to offer intelligent discrimination between breakers. This feature enables faster clearance of fault conditions, thereby reducing the thermal and dynamic stresses produced during fault conditions and thus minimizes the damage to the system. To implement ZSI manufacturer should supply all related equipment like power supply, wiring etc.

On-Line change of settings should be possible. It should be possible to carry out testing of release without tripping the breaker.

g. The release meet the EMI / EMC requirements.

h. The setting range of release shall be generally as follows :

	SETTING RANGE OF RELEASE	
Type of Protection	PICK-UP CURRENT	TIME DELAY
Long Time	0.4 to 1.0 times $I_n$ ( $I_r$ )  Steps : 0.4, 0.5, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00.  Operating Limit : 1.05 to 1.2 times $I_r$	0.5 to 30 sec at 6 $I_r$  Steps 0.5,1, 2,4, 6, 8,12,18,24 and 30 secs  Tolerance : Corresponding to $\pm 10\%$ of current.
Short Time	2 to 10 times $I_r$  Steps : 2,3,4,5,6,7,8,9 & 10	20 ms to 600 ms Steps 20,60,100,160,200,260,300 400,500 and 600 ms

	Tolerance : $\pm 10\%$	Tolerance : $\pm 10\%$ or 20ms whichever is higher
Instantaneous	2 to 12 times In Steps : 2,3,4,6,8,10,12 Tolerance : $\pm 10\%$	
Ground Fault	0.2 to 0.6 time In  Steps : 0.2,0.3,0.4,0.5,0.6  Tolerance : $\pm 10\%$	100 ms to 400 ms  Steps : 100,200,300,400ms Tolerance : $+10\%$ or 20 ms whichever is higher.

All incomer ACBs have following additional protections other than mentioned above.

Under and over voltage

Under and over frequency

Restricted Earth Fault protection

Trip Circuit supervision with PS class CT's.

Undercurrent, ( for DG set only)

Reverse power ( for DG set only)

Phase sequence reversal ( for DG set only)

Load shedding and reconnection thru programmable contacts.

Release should display the Contact wear indication.

The release should provide local indication of actual %age loading at any instant. The release should be able to communicate on MODBUS RTU protocol using inbuilt RS485/232/Ethernet port and shall be integral part of supply with trip unit. Parameters of the Protection Release should be changeable from Release as well as thru communication network. Release should have graphical LCD for display of power parameters. The release of incoming breakers should provide comprehensive metering with the following parameters

Phase currents (running, avg & max) – All parameters in single window.

Release should be able to capture short circuit current on which ACB has tripped. The last ten trips and alarms shall be stored in memory with the date & time stamping along with type of fault and alarm. The sensing CT Should be Rogowsky type with measurement precision of 1%.

Release should be self-powered .

Release should have facility to select different type of IDMTL protection(DT,SIT,VIT,EIT,HVF) for better co-ordination with HT Breaker/Fuse.

Phase voltages (running, avg & max)

Energy & power parameters (active, reactive and apparent)

PF

Frequency

Maximum Demand ( KVA& KW)

Total Harmonics distortion

All O/G ACBs have following functions.

Protection

The ACB control unit offer the following protection functions as standard:

Long-time (LT) protection with an adjustable current setting and time delay;

Short-time (ST) protection with an adjustable pick-up and time delay;

instantaneous (INST) protection with an adjustable pick-up and an OFF

Position.

Current and time delay setting be indicated in amperes and seconds respectively

On a digital display.

Earth-fault protection with an adjustable pick-up and time delay be provided if indicated on the appended single-line diagram.

Measurements

An ammeter with a digital display indicate the true rms values of the currents for each phase. Release acknowledge

the current & time delay settings done by user on the LCD display.

A LED bar graph simultaneously display the load level on the three phases.

A maxi meter store in memory and display the maximum current value observed since the last reset. The data continue to be stored and displayed even after opening of the circuit breaker.

### 15.10.3 Safety Features

I. The safety shutter prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.

II. It not be possible to interchange two circuit breakers of two different thermal ratings. For Draw-out breakers, an arrangement be provided to prevent rating mismatch between breaker and cradle.

III. There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB.

IV. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and measuring instrument circuits.

It shall be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.

Draw out breakers should not close unless in distinct Service/Test/Isolated positions.

The insulation material used conform to Glow wire test as per IEC60695.

The ACB provide in built electrical and mechanical anti-pumping.

All EDO ACB`s have Ready to Close Contact to ensure that the ACB gets a command only when it is ready to close for applications of Remote Control, AMF, Synchronization and Auto Source Change Over Systems.

### 15.11 MOULDED CASE CIRCUIT BREAKER (MCCB)

The MCCB should be current limiting type with trip time of less than 10 m.sec under short circuit conditions. The MCCB should be either 3 or 4 poles. MCCB comply with the requirements of the relevant standards IS13947 – Part 2/IEC 60947-2 and should have test certificates for Breaking capacities from independent test authorities CPRI / ERDA or any accredited international lab.

MCCB comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating molded case with high withstand capability against thermal and mechanical stresses

The breaking capacity of MCCB be as specified in the Drawings. The rated service breaking capacity (Ics) should be equal to rated ultimate breaking capacities (Icu). MCCBs for motor application should be selected in line with Type-2 Co-ordination as per IEC-60947-2, 1989/IS 13947-2. The breaker as supplied to meet IP54 degree of protection.

#### 15.11.1 Current Limiting & Coordination

The MCCB employ maintenance free minimum let-through energies and capable of achieving discrimination up to the full short circuit capacity of the downstream MCCB. The manufacturer provide both the discrimination tables and let-through energy curves for all.

#### Protection Functions

MCCBs with ratings less than 100 A shall be equipped with Thermal-magnetic (adjustable thermal for overload and

fixed magnetic for short-circuit protection) trip units

Microprocessor MCCBs with ratings 100A and above shall be equipped with microprocessor based trip units.

Microprocessor and thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorized access to the settings

Microprocessor trip units comply with appendix F of IEC 60947-2 standard (measurement of RMS current values, electromagnetic compatibility, etc.)

Protection settings apply to all poles of circuit breaker.

All Microprocessor components withstand temperatures up to 125 °C

### 15.11.2 Testing

- a) Original test certificate of the MCCB as per IEC 60947-1 &2 or IS13947 be furnished.

Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.

### 15.11.3 Interlocking

Molded, case circuit breakers be provided with the following interlocking devices for interlocking the door of a switch board.

- a) Handle interlock to prevent unnecessary manipulations of the breaker.
- b) Door interlock to prevent the door being opened when the breaker is in ON position.
- c) Defeat-interlocking device to open the door even if the breaker is in ON position.

The MCCB shall be current limiting type and comprise of quick make – Break switching mechanism. MCCBs shall be capable of defined variable overload adjustment. All MCCBs rated 100 Amps and above have adjustable over load & short circuit pick-up .

All MCCB with microprocessor based release unit, the protection be adjustable Overload, Short circuit and earth fault protection with time delay.

The trip command override all other commands.

### 15.12 MOTOR PROTECTION CIRCUIT BREAKER (MPCB)

Motor circuit breakers conform to the general recommendations of standard IEC 947 -1,2 and 4 (VDE 660, 0113 NF EN 60 947-1-2-4, BS 4752) and to standards UL 508 and CSA C22-2 N°14.

The devices shall be in utilization category A, conforming to IEC 947-2 and AC3 conforming to IEC 947-4. MPCB have a rated operational and insulation voltage of 690V AC (50 Hz) and MPCB shall be suitable for isolation conforming to standard IEC 60947-2 and have a rated impulse withstand voltage (Uimp) of 6 kV. The motor circuit breakers shall be designed to be mounted vertically or horizontally without de-rating. Power supply be from the top or from the bottom. In order to ensure maximum safety, the contacts shall be isolated from other functions such as the operating mechanism, casing, releases, auxiliaries, etc, by high performance thermoplastic chambers. The operating mechanism of the motor circuit breakers must have snap action opening and closing with free tripping of the control devices. All the poles close, open, and trip simultaneously. The motor circuit breakers accept a padlocking device in the “isolated” position.

The motor circuit breakers shall be equipped with a “PUSH TO TRIP” device on the front enabling the correct operation of the mechanism and poles opening to be checked. The auxiliary contacts shall be front or side mounting, and both arrangements be possible. The front-mounting attachments not change the breaker surface area. Depending on its mounting direction the single pole contact block could be NO or NC. All the electrical auxiliaries and

accessories shall be equipped with terminal blocks and shall be plug-in type. The motor circuit breakers have a combination with the downstream contactor enabling the provision of a perfectly co-ordinated motor-starter. This combination enable type 1 or type 2 co-ordination of the protective devices conforming to IEC 60947-4-1. Type 2 co-ordination be guaranteed by tables tested and certified by an official laboratory: LOVAG (or other official laboratory). The motor circuit breakers, depending on the type, could be equipped with a door-mounted operator which allow the device setting. The motor circuit breakers shall be equipped with releases comprising a thermal element assuring overload protection and a magnetic element for short-circuit protection. In order to ensure safety and avoid unwanted tripping, the magnetic trip threshold (fixed) be factory set to an average value of 12 Ir.

All the elements of the motor circuit breakers shall be designated to enable operation at an ambient temperature of 60°C without derating. The thermal trips shall be adjustable on the front by a rotary selector. The adjustment of the protection shall be simultaneous for all poles. Phase unbalance and phase loss detection shall be available. Temperature compensation (-20°C to +60°C)

### 15.13 MINIATURE CIRCUIT BREAKER (MCB)

Miniature Circuit Breaker comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 240/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B,C,D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer publish the values. MCB ensure complete electrical isolation & downstream circuit or equipment when the MCB is switched OFF.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP, TPN and 4 Pole miniature circuit breakers have a common trip bar independent to the external operating handle.

### 15.14 Painting

All sheet steel work undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be as indicated in datasheets & relevant BIS code.

### 15.15 Labels

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the control panel shall be pasted on inside of the panel door and covered with transparent plastic sheet.

### 15.16 Meters

- i. All voltmeters and indicating lamps shall be through MCB's.
- ii. Meters and indicating instruments be plug type.
- iii. All CT's connection for meters shall be through Test Terminal Block (TTB).
- iv. CT ratio and burdens shall be as specified on the Single line diagram.

### 15.17 Current Transformers

Current transformers be provided for Control panels carrying current in excess of 60 amps. All phase be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.

The CTs confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast, robust to withstand thermal and dynamic stresses during short circuits. Metering CTs, have inbuilt busbar mounting arrangement. Secondary terminals of CTs be brought out suitable to a terminal block which be easily accessible for testing and terminal connections. The secondary terminal should be covered with insulation cap/cover so that there should not be any possibility of touching the live terminal. The protection CTs be of accuracy class 5P20 and measurement CTs be of accuracy class I.

#### 15.18 Selector Switch

Where called for, selector switches of rated capacity be provided in control panels, to give the choice of operating equipment in selective mode.

#### 15.19 Contactor

Contactor shall be built into a high strength thermoplastic body and shall be provided with an arc shield for quick arc extinguishing. Silver alloy tips shall be provided to ensure a high degree of reliability and endurance under continuous operation. The magnet system consist of laminated yoke and armature to ensure clean operation without hum or chatter.

Starters contactors have 3 main and 2 Nos. NO / NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta and Reduced Voltage Starters. The insulation for contactor coils be of Class "E".

Coil shall be tape wound vacuum impregnated and be housed in a thermostatic bobbin, suitable for tropical conditions and withstand voltage fluctuations. Coil be suitable for 220/415±10% volts AC, 50 cycles AC supply.

#### 15.20 Thermal Overload Relay

Thermal over load relay have built in phase failure sensitive tripping mechanism to prevent against single phasing as well as on overloading. The relay operate on the differential system of protection to safeguard against three phase overload, single phasing and unbalanced voltage conditions.

Auto-manual conversion facility shall be provided to convert from auto-reset mode to manual-reset mode and vice-versa at site. Ambient temperature compensation shall be provided for variation in ambient temperature from -5° C to +55°C.

All overload relays shall be of three element, positive acting ambient temperature compensated time lagged thermal over load relays with adjustable setting. Relays shall be directly connected for motors upto 35 HP capacity. C.T.operated relays be provided for motors above 35 HP capacity. Heater circuit contactors may not be provided with overload relays.

#### 15.21 Time Delay Relays

Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and have one set of auxiliary contacts for indicating lamp connection.

#### 15.22 Indicating Lamp& Metering

All meters and indicating lamps be in accordance with relevant IS standard specification. The meters shall be flush mounted type. The indicating lamp shall be of LED type. Each MCC and control panel be provided with voltmeter 0-500 volts with three way and off selector switch, CT operated ammeter of suitable range with three nos. CTS of suitable ratio with three way and off selector switch, phase indicating lamps, and other indicating lamps as called for. All indicating lamp be backed up with 5 amps MCB.

#### 15.23 Toggle Switch

Toggle switches, where required, shall be in conformity with relevant IS Codes and be of 5 amps rating.

#### 15.24 Push Button Stations

Push button stations shall be provided for manual starting and stopping of motors / equipment Green and Red colour push buttons shall be provided for 'Starting' and 'Stopping' operations. 'Start' or 'Stop' indicating flaps shall be provided for push buttons. Push Buttons shall be suitable for panel mounting and accessible from front without opening door, Lock lever be provided for 'Stop' push buttons. The push button contacts be suitable for 6 amps current capacity.

#### 15.25 Conduits

Conduits and Accessories conform to latest edition of Indian Standards IS-9537 part 1 & 2. 16/14 (16 gauge upto 32mm diameter & 14 gauge above 32 mm diameter) gauge screwed GI or MS conduits to be used. Joints between conduits and accessories shall be securely made by standard accessories, as per IS-2667, IS-3837 and IS-5133 to ensure earth continuity. All conduit accessories shall be threaded type only.

Only approved make of conduits and accessories be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit bear the label of the manufacturer.

Note. : Whatever materials required to be billed by the Contractor should come on site with proper Challan Numbers and quantity mentioned in each such Challan..

Maximum permissible number of 1100 volt grade PVC insulated wires that may be drawn into metallic Conduits are given below :

Size of wires Nominal Cross section Area (Sq. mm.)	Maximum number of wires within conduit size(mm)				
	20	25	32	40	50
1.5	5	10	14	--	--
2.5	5	8	12	--	--
4	3	7	10	--	--
6	2	5	8	--	--
10	--	3	5	6	--
16	--	2	3	6	6
25	--	--	2	4	6
35	--	--	--	3	5

Maximum permissible number of 1100 volt grade PVC insulated wires that may be drawn into rigid nonmetallic or PVC Conduits are given below :

Size of wires Nominal Cross section Area (Sq. mm.)	Maximum number of wires within conduit size(mm)				
	20	25	32	40	50
1.5	7	12	16	--	--
2.5	5	10	14	--	--
4	4	8	12	--	--
6	3	6	8	--	--
10	--	4	5	6	--
16	--	3	3	6	6
25	--	--	2	4	6
35	--	--	--	3	5

## 15.26 Cables

1100V grade Cables of sizes 25 sq. mm. and above shall be XLPE FRLS insulated aluminium conductor armoured type and PVC insulated Copper conductor armoured cables for sizes 16 sq. mm. and below. All cables shall be conforming to IS Codes. Cables shall be suitable for laying in trenches, ducts, and on cable trays as required. Cables shall be termite resistant. Cable glands shall be heavy duty double compression brass glands. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armoured cables.

The equipment inside plant room shall be connected to the control panel by means of suitable cables of adequate size. An isolator shall be provided near each motor/equipment (mounted within 10 ~ 15 mtr distance on nearest wall or self-supported on floor ) wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated copper conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification of control wiring.

Cables shall be cross linked polyethylene (XLPE) insulated PVC inner sheathed and FRLS PVC outer sheath of 1100 volts grade. Cables shall be suitable for laying in trenches, ducts, and on cable trays as required. Cables shall be termite resistant. Cable glands shall be double compression glands. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armoured cables. All conductors shall be stranded.

Cablings for following equipment shall be fire survival type.

Basement smoke exhaust fan  
Jet fans  
Smoke evacuation fan  
Staircase, lift, lobby pressurization tank  
Make-up air fan for emergency duty

## 15.27 Fire Survival Armoured Cable

Fire Survival armoured cable, LPCB / BRE-GLOBAL / ERDA approved, with class -2, annealed copper / or aluminum conductor having glass mica fire barrier tape extruded with cross linkable low smoke zero halogen insulation. The inner & outer sheath shall be LSZH. The basic design shall be as per BS: 7846 & BS: 5839-1 (Latest edition).

The cable should meet fire performance circuit integrity test as per BS 8434-2 / BS 6387 CWZ.

## 15.28 Fire Survival Un-Armoured Cable

Fire Survival Un-armoured cable, LPCB / BRE-GLOBAL / ERDA approved, with class -2, annealed copper or aluminum conductor having glass mica fire barrier tape extruded with cross linkable low smoke zero halogen insulation. The outer sheath shall be LSZH. The basic design shall be as per BS: 7629 & BS: 5839-1 (Latest edition).

The cable should meet fire performance circuit integrity test as per BS 8434-2 / BS 6387 CWZ.

Cablings shall be of the following sizes as minimum :

- i. From 30 HP to 35 HP motors  
2 nos. 3 x 16 sq. mm aluminium conductor armoured cable.
- ii. From 40 HP to 50 HP motors  
2 Nos. 3 x 25 sq. mm. aluminium conductor armoured cable.

iii.	From 60 HP to 75 HP motors	1 No. 3 x 70 sq. mm aluminium conductor armoured cable.
iv.	100 HP motors	1 No. 3 x 150 sq. mm. aluminium conductor armoured cable
v.	150 HP motor	1 No. 3 x 240 sq. mm. aluminium conductor armoured cable.
vi.	250 HP motor	2 Nos. 3 x 240 sq. mm. aluminium conductor armoured cable.
vii.	400 HP motor	3 Nos. 3 x 240 sq. mm. aluminium conductor armoured cable.
viii.	600 HP motor	3 Nos. 3 x 400 sq. mm. aluminium conductor armoured cable.

HVAC contractor shall submit cable schedule for all equipment for approval.

#### 15.29 Cable Laying

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks.

##### 15.29.1 Laying of Cables on Cable Trays

The relative position of the cables, laid on the cable tray be preserved and the cables not cross each other. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius as recommended by the manufacturer's. All cables be laid with minimum one diameter gap and shall be clamped at every metre to the cable tray. Cables be tagged for identification with aluminum tag and clamped properly at every 20M. Tags be provided at both ends and all changes in directions both sides of wall and floor crossings. All cable be identified by embossing on the tag the size of the cable, place of origin and termination.

All cables passing through holes in floor or walls shall be sealed with fire retardant Sealant and shall be painted with fire retardant paint upto one meter on all joints, terminations and both sides of the wall crossings by "VIPER CABLE RETARD".

##### 15.29.2 Laying of Cables in Ground

The width of trench for laying single cable be minimum 350 mm. Where more than one cable is to be laid in horizontal formation, the width of the trench be workout by providing 200 mm gap between the cables, except where otherwise specified. There shall be clearance of 150 mm between the end cable and the side wall of the trench. The minimum depth of the cable trench no to be less than 750 mm for single layer of cables. When the cables are laid in more than one tier the depth of the trench shall be increased by 300 mm for each additional tier.

Excavation of trenches : The trenches shall be excavated in reasonably straight lines. Wherever there is a change in

direction, suitable curvature shall be provided. Where gradients and changes in depth are unavoidable, these shall be gradual. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench. The bottom of the trench shall be levelled and shall be made free from stone, brick bats etc. The trench then shall be provided with a layer of clean, dry sand cushion of not less than 100 mm in depth. Prior to laying of cables, the cores shall be tested for continuity and insulation resistance. The cable drum be properly mounted on jacks, at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum and the spindle is horizontal. Cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire drum length shall be laid in one stretch. However, where this is not possible the remainder of the cable be removed by 'Flaking' i.e. by making one long loop in the reverse direction. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted off the rollers beginning from one end by helpers standing about 10 meters apart and laid in a reasonably straight line. Cable laid in trenches in a single tier formation have a cover of clean, dry sand of not less than 150 mm. above the base cushion of sand before the protective cover is laid. In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 300 mm shall be provided over the initial bed before the second tier is laid. Finally the cables be protected by second class bricks before back filling the trench. The buried depth of uppermost layer of cable not be less than 750mm.

**Back Filling :** The trenches shall be back filled with excavated earth free from stones or ther sharp edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 300 mm. Unless otherwise specified, a crown of earth not less than 50 mm in the centre and tapering towards the sides of the trench shall be left to allow for subsidence.

### 15.30 Wire & Wire Sizes

1100 volts grade PVC insulated copper conductor wires in conduit shall be used.

For all single phase/ 3 phase wiring, 1100 volts grade PVC insulated copper conductor LSZH wires shall be used. The equipment inside plant room and AHU room shall be connected to the control panel by means of insulated copper conductor wires of adequate size in exposed conduits. Final connections to the equipment shall be through wiring enclosed in galvanized flexible conduits rigidly clamped at both ends and at regular intervals. An isolator shall be provided near each motor/equipment wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated copper conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads be provided at both the ends for easy identification of control wiring.

The minimum size of control wiring shall be 1.5 sq. mm PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

Power cabling shall be of the minimum following sizes:

- |      |   |  |
|------|---|--|
| i.   | Upto 5 HP motors/ 5 KW heaters                      | 3C x 4 sq. mm copper conductor PVC insulated cables.       |
| ii.  | From 6 HP to 10 HP motors<br>6 KW to 7.5 KW heaters | 3 x 6 sq. mm copper conductor PVC insulated cables.        |
| iii. | From 12.5 HP to 15 HP motors                        | 2 Nos. 3 x 6 sq. mm copper conductor PVC insulated cables. |
| iv.  | From 20 HP to 25 HP motors                          | 2 Nos. 3 x 10 sq. mm copper conductor PVC insulated cables |

### Starters

Each motor shall be provided with a starter of suitable rating. Starters be in accordance with relevant IS

Codes. All Star Delta Starters be fully automatic. Motors up to 7.5 HP be provided by Direct On Line (DOL) starter, motors above 7.5 HP and up to 45 HP shall be provided by star/delta starter and motors above 45 HP shall be provided by soft starter. All starters be with Type II coordination for breaker, contactor and over load relay.

All the switches, contactors, push button stations, indicating lamps be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors or as per manufacturer's recommendation.

TYPE OF STARTER CAPACITY	CONTACTOR CURRENT RANGE	OVERLOAD RELAY
5 HP Motors	D O L	16 amps
7.5 HP motors	D O L	16 amps
10 HP Motors	Automatic Star Delta	25 amps
12.5 HP Motors	Automatic Star Delta	16 amps
15 HP Motors	Automatic Star Delta	25 amps
20 HP Motors	Automatic Star Delta	32 amps
25 HP Motors	Automatic Star Delta	32 amps
30 HP Motors	Automatic Star Delta	40 amps
35 HP Motors	Automatic Star Delta	40 amps
40 HP Motors	Automatic Star Delta	40 amps
50 HP Motors	VFD	70 amps
60 HP Motors	VFD	110 amps
75 HP Motors	VFD	110 amps
100 HP Motors	VFD	200 amps
125 HP Motors	VFD	200 amps
150 HP Motors	VFD	200 amps
150 HP Motors	VFD	300 amps
200 HP Motors	VFD	300 amps
250 HP Motors	VFD	400 amps
300 HP Motors	VFD	400 amps
400 HP Motors	VFD	600 amps
600 HP Motors	VFD	900 amps

Two speed motors when specified, be provided with DOL starter irrespective of it rating.

### 15.31 Cable Trays

Ladder and perforated type Cable Trays be of Hot dip Galvanized type and factory fabricated out of CRCA sheet with standard accessories like tee, bends, couplers etc. for different loads and number and size of cables as given below :

Cable trays be galvanized as per Specifications..

- a. 1500 mm wide
  - Runners 25 x 100 x 25 x 3 mm
  - Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
  - Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.
- b. 1200 mm wide
  - Runners 25 x 100 x 25 x 3 mm
  - Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
  - Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI

angle.

1000 mm wide

Runners 25 x 100 x 25 x 3 mm

Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C

Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

750 mm wide

Runners 20 x 75 x 20 x 2.5 mm

Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C

Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

e 600 mm wide

Runners 20 x 75 x 20 x 2.5 mm

Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C

Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI

angle.

450 mm wide

Runners 20 x 75 x 20 x 2.5 mm

Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C

Suspenders 2 Nos. 25 x 25 x 4 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

g. Supply and fixing of perforated type cable trays of the following sizes of pre-galvanized iron.

i. 600 x 40 x 40 x 2 mm thick

i. 450 x 40 x 40 x 2 mm thick

i. 300 x 40 x 40 x 2 mm thick

ii. 150 x 40 x 40 x 2 mm thick

Note : Suitable length of 10 mm dia GI rod suspenders at 1800 mm interval shall be included in the item for perforated type cable tray.

## 16.0 ELECTRIC HOT WATER GENERATOR

### 16.1 SCOPE

This section sets out the general requirements in respect of shell type hot water generators as per ASME Standards.

### 16.2 SHELL TYPE HOT WATER GENERATOR

The hot water generator shall be vertical / horizontal, shell type, designed, constructed and tested for the specified water flow rates and temperatures. The hot water generator shall be suitable for outdoor application (exposed to sky).

### 16.3 MATERIAL DESIGN AND CONSTRUCTION

The shell of the generator shall be made 10 mm thick boiler quality steel sheet and dish of 12mm thick sheet steel with electric fusion welded seams. The shell be designed for 50 degrees centigrade of water circulation, unless specified otherwise in SOQ.

The shell with insulation, shall be mounted inside a cabinet of iron frame with 16 SWG mild sheet steel

covers held with locks / bolts and hinges. The cabinet shall be provided with sufficient louvers and rat proofing to ensure ventilation of heater terminals of boiler. Boiler shell shall be installed above the finished floor on iron frame. The iron frame shall be provided with lifting lugs and pedestals.

#### 16.4 HEATERS

Electric heaters shall be provided in banks of equal capacity distributed on three power phases. Heaters shall be mounted within seamless incoloy sheathed electrically resistant U-tubes. The heaters shall be easily removable externally, without opening terminal plate or disturbing other components. The heater mounting socket shall be made leak proof. Heaters shall be suitable for  $415 \pm 10\%$  volts, 50 cycles, three phase AC supply and shall be in direct contact with water contained in shell.

#### 16.5 CONNECTIONS AND ACCESSORIES

Unless specified otherwise in the schedule of quantities the hot water generator shall be provided with following accessories.

- a. Inter locking of electric panel cover with incoming switch / limit switch.
- b. Flow switch, automatic alarm for low water level and reset type high temperature switch with respective indication lights.
- c. Drain point with GM valve.
- d. Descaling GM valves.
- e. Automatic airvent and automatic high temperature pressure relief valve.
- f. Step control thermostat for individual heater bank and master safety thermostat of fixed setting.
- g. Flanges for water pipe connections.

#### 16.6 PRESSURE TESTING

The shell shall be tested in the factory upto two times the working pressure or 21 Kg/Sq.Cm. gauge, whichever is higher.

#### 16.7 INSULATION

The shell shall be insulated with two layers of 50 mm thick resin bonded fibreglass insulation and covered with 26 SWG aluminium cladding.

#### 16.8 ELECTRIC CONTROL CABINET

The electric control cabinet shall be made as detailed in electrical panels and mounted directly on main frame. All controls and terminals shall be factory wired and tested. The control cabinet shall consist of following major controls of rated capacities:

- a. Incoming MCCB.
- b. ON-OFF toggle switch for individual banks.
- c. Contactors with HRC fuses for individual heaters.

- d. Indicating lights for ON status for individual banks.
- e. Fault indicating lights.
- f. Alarm with manual reset.
- g. Thermostats and Master thermostat.
- h. Cabling and control wiring.
- i. Three phase ammeter and voltmeter with selector switches.
- j. Control cabinet shall be BMS compatible

The panel shall be openable only after switching off the incoming power supply.

## 16.9 PAINTING

The external surface of the shell shall be cleaned, derusted and applied with three coats of primer.

The hot water generator shall be factory finished with durable epoxy paint on outside. Shop coats of paints that have become marred during shipment / erection shall be cleaned off with mineral spirits, then coated with enamel paint to match the finish over the adjoining shop painted surface.

The electrical panel shall be provided with powder coated paint finish of matching colour with hot water generator.

## 17. CLOSED TYPE PRESSURIZED EXPANSION TANK

Expansion, pressurization and de-aeration of the chilled water system to be provided by an integrated unit comprising of Pressure-less expansion tank , Twin pump Pressurization with digital controller.

Vessel volume shall be calculated according to the system expansion volume. Every vessel in the unit shall have the same size. Condensate drain cock shall be installed within the base of the vessel. Efficiency of the vessel volume shall be minimum 80%. The system shall be capable of removing dissolved gases and air bubbles via an automatic air vent installed on the top of the vessel. The expansion vessel(s) shall be fitted with a replaceable butyl rubber bladder in accordance with DIN 4807-3. Maximum continual working temperature of the bladder shall be 70 °C (158 °F). A weight sensor shall be fitted to the vessel to provide vessel content information. Finish shall be with epoxy coating.

The pressure-less expansion vessel(s) shall be cylindrical, welded and comply to EN 13831:2007.

Manufactured and designed in accordance with European Pressure Equipment Directive PED 2014/68/EC.

The pressurization unit shall be sized appropriate to the total system expansion volume and maximum operating pressure.

System pressure shall be regulated within  $\pm 0.2$  bar (2.9 psi) of the set pressure. High and low pressure alarm setting shall be selectable by the user.

Top-up function shall be programmed according to system requirements. The unit shall be fitted with an integral, adjustable flood limiter to shut down the system in the event of a serious leak. Water level in the expansion vessel(s) shall be maintained to a minimum value.

The de-aeration function and pressurization function shall be programmable according to system requirements.

The pressurization unit shall have two pumps (orientation vertical/horizontal) with non-return valve, flow restrictor valve and solenoid valve as well as a safety relief valve for the vessel and a “Y” strainer for system protection.

The controller shall display the vessel contents, system pressure and status of the main operating components in real time on the display. This acts as confirmation that pump(s) or valves are operating and responding as required, while also verifying the system setup.

The controller shall regulate the pump unit to provide duty/standby or parallel/backup operation and shall be selectable in dual pump units.

Controller shall display fault code and generate the alarm in case of any fault situation.

Pressurization unit shall be factory assembled. The product shall be installed according to the manufacturer’s instructions using manufacturer’s approved components.

18. INDOOR AIR QUALITY MONITOR TO CAPTURE REAL TIME DATA

Supply of Indoor Air Quality monitor to measure PM2.5, PM10, PM1.0, CO2, Total VOC, Temperature and Humidity on real time basis. Monitor should be wall mount type with Color Display of parameter. It should be able to transmit data using RS485 port on Modbus RTU protocol and should be able to connect on WIFI and transmit data to cloud monitoring server to store data (for 2 years) and generate reports and send alert through email or SMS in case of any pollutant levels going beyond limits.

Air Quality monitor should be able to operate on 5.0V power supply, power consumption should not be more than 5watts.

Construction of monitoring device should be of ABS material and air quality monitor should be manufactured in INDIA using high quality sensors from Europe/USA/UK.

Measurement range for various pollutants are as mentioned below:

Description	Parameters	Measuring Range	Accuracy
Particle Measurement	PM2.5	0-1000 µg/m3	+10 ug/m3 @ 0-100 ug/m3 +10% @ 101-1000 ug/m3
	PM10	0-1000 µg/m3	+10 ug/m3 @ 0-100 ug/m3 +10% @ 101-1000 ug/m3
	PM1.0	0-999 µg/m3	+10 ug/m3 @ 0-100 ug/m3 +10% @ 101-1000 ug/m3
Carbon Di-oxide	CO2	0-5000 ppm	+ (30ppm +3%)
Total VOC	TVOC	100 - 1500 ppb	15% of Measured Value
Temperature	Temp	-40- 70 Deg C	+ 0.86 Deg C @45 Deg C
Humidity	RH	100 %	+ 3%

Installation and Commissioning:

The scope of work include installation of monitoring device and connecting it to BMS system using RS485 port and hard wiring for data acquisition.

## 19. QUALITY ASSURANCE,INSPECTION, TESTING AND COMMISSIONING

### 19.1 SCOPE

The following quality assurance, inspection, testing and commissioning procedures shall be required to be carried out upon award of work.

- I. Provide quality assurance program (QAP), works quality assurance program (WQAP), field quality assurance program (FQAP) and quality plan.
- II. Tests at manufacturer's works.
- III. Perform site tests and commissioning.

### 19.2 SUBMITTALS

- I. After award of work following information shall be submitted.
  - a. Quality Assurance Program (QAP)
  - b. Works Quality Assurance Programme (WQAP)
  - c. Field Quality Assurance Programme (FQAP)
- II. For inspection and testing, submit inspection and testing procedures, Programme, record sheets applicable at each hold point.
- III. After completion of testing, submit test records, packaging, transportation and storage instructions and methods.
- IV. For site installation and commissioning, submit installation methods or procedures, notification and procedures for pre-commission and commissioning.
- V. After commissioning, submit site test records, as-built drawings, manufacturer's operation maintenance manuals and list of recommended spares and tools.

### 19.3 QUALITY ASSURANCE CONCEPT AND CONTROL

- I. Minimum requirements for establishing and implementing a quality assurance Programme shall be applied to all aspects of the work necessary for carrying out the contract. Quality assurance shall extend to material parts, components, systems and services as a means of obtaining and sustaining the reliability of critical items, operating performance, maintenance and safety.
- II. Acceptance of the Contractor's quality assurance Programme does not relieve the Contractor's obligation to comply with the requirement of the contract document. If the Programme is found to be ineffective, then the Owner's site representative reserves the right to request for necessary revisions of the Programme.
- III. The Contractor is required to produce readily identifiable documentary evidence covering the extent and details of both his own and his sub contractor's quality assurances system as follows :
  - a. Quality Assurance Program (QAP)
  - b. Works Quality Assurance Programme (WQAP)
  - c. Field Quality Assurance Programme (FQAP)
  - d. Quality Plan.
- IV. These documents shall be prepared separately and submitted to the Owner's site representative at the time of starting the work.

V. Quality Plan and Manual shall be prepared by the Contractor for all items and services to be supplied, after the contract has been placed, but before commencement of fabrication, and shall be subject to evaluation and acceptance by the Owner's site representative before start of work.

#### 19.4 QUALITY ASSURANCE MANUAL (QAM)

I. The QAM shall be a general comprehensive document outlining the Contractor's basic organization, policies and procedures. The information to be given in the QAM shall include but not limited to :

- a. Quality Policy.
- b. Quality Assurance Programme
- c. Organisation Structure showing inter relationships.
- d. Functional responsibilities and levels of authority.
- e. Lines of communication.
- f. Customer relations.
- g. Laboratory Facilities.

#### 19.5 WORKS QUALITY ASSURANCE PROGRAMME (WQAP)

I. The WQAP shall identify the Contractor's Quality Assurance Programme at works applicable throughout all phases of Contract performance, including design, procurement, manufacture, inspection and testing. It shall identify each of the Programme elements to be designed, developed, executed and maintained by the Contractor for the purpose of ensuring that all supplies and services comply with this specifications.

II. The information to be given under this Programme shall include but not limited to :

- a. Organization and Responsibility.
- b. Contract Review.
- c. Design and Document Control.
- d. Procurement Control.
- e. Production Control.
- f. Control on Sub-contractors.
- g. In-process Quality Control and Traceability.
- h. Inspection and Testing.
- j. Control of Non-conformances.
- k. Corrective Action.
- l. Control of Inspection, Measuring and Test Equipment.

- m. Handling, Storage, Packaging and Delivery.
- n. Records.
- p. Quality Audits.
- q. After - Sales Servicing.

#### 19.6 FIELD QUALITY ASSURANCE PROGRAMME (FQAP)

I. This Programme shall identify the Contractor's Quality Assurance Programme at site applicable throughout site construction, erection and commissioning. It is the underlying philosophy that the quality built into the product at works shall be maintained throughout the construction and commissioning stages.

II. While, in principle, the FQAP shall include the items discussed in WQAP, it shall, however, be approached differently to take into account site conditions.

III. The FQAP shall include, but not limited to the following information :

- a. Organization and responsibility.
- b. Control of Drawings and Documentation.
- c. Product Checklist.
- d. Control and Traceability of Purchased materials and services.
- e. Receipt Inspection of materials at site.
- f. Material Storage Control.
- g. Inspection and Examination Procedures.
- h. Control of Painting and Insulation Works.
- j. Pre-commissioning.
- k. Commissioning.
- l. Control of Non-conformances.
- m. Corrective Action.
- n. Control of Inspection, Measuring and Test Equipment.
- p. Records.
- q. Complétion Documents.
- r. List of recommended spares and tools.
- s. Personal Training.
- t. Servicing during Defects Liability Period.

#### 19.7 QUALITY PLAN

I. The contractor shall be required to prepare manufacturing and construction/erection quality plans for all equipment items and services. The quality plan shall also define the involvement of Owner's site representative in the inspection and test programs.

II. The Quality Plan shall incorporate as appropriate :

a. Charts indicating flow of materials, parts and components through manufacturing quality control inspection and test to delivery and erection.

b. The charts shall indicate the location of hold points for quality control, inspection and test beyond which manufacture shall not continue until the action required by the hold point is met, and the documentation required is generated.

c. The control documents associated with each hold point, i.e. drawings, material, specification, Works Process Schedule (WPS), Process Quality Records (PQR), quality control methods and procedures and acceptance standards.

#### 19.8 SITE QUALITY CONTROL SECTION

I. The Contractor's Quality Control (Q.C.) section shall be headed by an experienced Quality Control Engineer. He shall be assisted by other supervisors. The section shall be an independent one, reporting to the contractor's Site Manager only on administrative matters, but otherwise under full control by the Contractor's Corporate Quality System Management.

II. The Contractor's Q.C. Section shall liaise closely with the Owner's site representative in charge of Quality Assurance/Quality Control, and to whom it shall give fullest cooperation. It is the underlying principle of this contract document that while the Contractor's Q.C. Engineer implements the Contractor's Quality Programme, the adequacy and effectiveness of that implementation shall be audited by the Owner's site representative whose recommendations on improving or maintaining quality shall be acted upon promptly by the Contractor's Q.C. Section.

#### 19.9 INSPECTION AND TESTING

I. All equipment and components supplied may be subjected to inspection and tests by the Consultant/ Owner's site representative during manufacture, erection/installation and after completion. The inspection and tests shall include but not be limited by the requirements of this contract document. Prior to inspection and testing, the equipment shall undergo pre-service cleaning and protection.

II. Tenderers shall state and guarantee the technical particulars listed in the Schedule of Technical Data. These guarantees and particulars shall be binding and shall not be varied without the written permission of the Owner's site representative.

III. No tolerances shall be allowed other than the tolerances specified or permitted in the relevant approved Standards, unless otherwise stated.

IV. If the guaranteed performance of any item of equipment is not met and / or if any item fails to comply with the specification requirement in any respect whatsoever at any stage of manufacture, test or erection, the Owner's site representative may reject the item, or defective component thereof, whichever he considers necessary; and after adjustment or modification as directed by the Owner's site representative, the contractor shall submit the item for further inspection and /or test.

V. The approval of the Owner's site representative of inspection and/or test results shall not prejudice the right of the Owner's site representative to reject an item of equipment if it does not comply with the contract document when erected, does not or prove completely satisfactory in service.

VI. The Contractor shall be responsible for the timely transmission of the relevant and appropriate sections of the

contract document to manufacturers and sub-contractors for the proper execution of all tests at their works as per contract specifications.

#### 19.10 TESTS AT MANUFACTURER'S WORKS

I. All tests to be performed during manufacture, fabrication and inspection shall be agreed with the Consultant/ Owner's site representative prior to commencement of the work. The Contractor shall prepare the details of the schedule and submit these to the Consultant/ Owner's site representative for approval. It must be ensured that adequate relevant information on the design code/standard employed, the manufacture /fabrication/assembly procedure and the attendant quality control steps proposed are made available to the Consultant/Owner's site representative who will mark in the appropriate spaces his intention to attend or waive the invited tests, or inspections. Contractor shall arrange inspection and factory witness test for centrifugal, screw chiller and vapor absorption chiller.

II. A minimum of twenty-one days' notice of the readiness of equipment for test or inspection shall be provided to the Owner's site representative by the Contractor (whether the tests be held at the Contractor's or Sub-contractor's works). The subject items should remain available for Owner's site representative inspection and test up to a minimum 10 days beyond the agreed date of witnessing the test. Every facility in respect of access, drawings, instruments and manpower shall be provided by the Contractor and sub-contractor to enable the Owner's site representative to carry out the necessary inspection and testing of the Plant.

III. No plant shall be packed, prepared for shipment, or dismantled for the purpose of packing for shipment, unless it has been satisfactorily inspected, all tests called for have been successfully carried out in the presence of the Owner's site representative or approved for shipment, or alternatively inspection has been waived.

IV. Functional electrical, mechanical and hydraulic tests shall be carried out on completed assemblies in the works. The extent of these tests and method of recording the results shall be submitted to, and agreed by, the Owner's site representative in sufficient time to enable the tests to be satisfactorily witnessed, or if necessary for any changes required to the proposed Programme of tests to be agreed.

V. The Consultant/Owner's site representative reserves the right to visit the Manufacturer's works at any reasonable time during fabrication of equipment and to familiarize himself with the progress made and the quantity of the work to date.

VI. Within 30 days of completion of any tests, triplicate sets of all principal test records, test certificates and correction and performance curves shall be supplied to the Owner's site representative.

VII. These test records, certificates and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Owner's site representative or not. The information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificate refers and should also bear the Contract reference title.

VIII. When all equipment has been tested, the test certificates from all works and site tests shall be compiled by the Contractor into volumes and bound in an approved form complete with index and four copies of each volume shall be supplied to Consultant/ Owner's site representative.

IX. Stage wise inspection of equipment in factory is waived.

#### 19.11 PERFORMANCE TESTS AT MANUFACTURER'S WORKS

I. All equipment may be subjected to routine performance tests at the Manufacturer's Works in accordance with the relevant ANSI, ASME, ASTM, BIS standard including operating tests of complete assemblies to ensure correct operation of apparatus and components.

II. Pumps, fans, compressor, and other rotating equipment shall be given full load tests, and run to 15% over speed for 5 minutes to check vibration. Main and auxiliary gear boxes shall be subjected to shock load tests and a six-

hour endurance run at rated speed and maximum torque.

III. The Contractor shall submit single line diagrams including the layout of the Plant together with the location of test instrumentation and the principal dimensions of the layout. All calculations to derive performance data shall be made strictly in accordance with format given in the approved standards. Any alterations or deviations from the approved standard test layout or formulae shall be subjected to the prior approval of the Owner's Site Representative.

IV. The performance test shall be conducted over the full operating range of the pump to a closed valve condition and a minimum of five measurement points covering the full range shall be taken. Curves indicating Quality vs. Head, Quantity vs. Power absorbed, and Quantity vs. Pump efficiency shall be provided. In addition a curve of the NPSH required vs. Quantity shall be provided except when the suction conditions do not require this test. Any proposal for the omission of this test shall be to the approval of the Consultant/ Owner's site representative.

V. On completion of the tests the Contractor shall submit a report showing the test results obtained together with the curves corrected to the site operating conditions.

## 20. TESTING, ADJUSTING AND BALANCING

### 20.1 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 by technical societies and associations including :

ASHRAE : 2011 HVAC Application.

SMACNA : Manual for the Balancing and Adjustment of air distribution system.

### 20.2 PERFORMANCE

- a. Verify design conformity.

Establish fluid flow rates, volumes and operating pressures.

Take electrical power readings for each motor.

Establish operating sound and vibration levels.

Adjust and balance to design parameters.

Record and report results as per the formats specified.

### 20.3 DEFINITIONS

Test :To determine quantitative performance of equipment.

Adjust :To regulate for specified fluid flow rates and air patterns at terminal equipment (e.g. reduce fan speed, throttling etc.)

Balance : To proportion within distribution system (submains, branches and terminals) in accordance with design quantities.

## 20.4 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 contractor shall intimate the PMC about his readiness to conduct the TAB procedures in the format given in these specifications.

## 20.5 DESCRIPTION OF SYSTEM AND REQUIREMENTS

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.

## 20.6 AIR SYSTEMS

### I. Air Handlers Performance

The TAB procedure shall establish the right selection and performance of the AHUs with the following results :

- Air-IN DB and WB temperature.
- Air-OUT DB and WB temperature.
- Dew point air leaving.
- Sensible heat flow.
- Latent heat flow.
- Sensible heat factor.
- Fan air volume.
- Fan air outlet velocity.
- Fan static pressure.
- Fan power consumption.
- 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 utilizing telescoping probes of Electronic Rotating Vane Anemometers and Accubalance for grilles and diffusers.

### 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 :

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 air tight.

Grilles are installed & dampers are fully open.

Provision and accessibility of usage of TAB instruments for traverse measurements are available.

All windows, doors are in position.

Duct system are of proper construction and are equipped with turning vanes and joints are sealed.

h. Test holes and plugs for ducting.

## 20.7 HYDRONIC SYSTEM BALANCING

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.

II. 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 coordinated drawings and approved submittals and system sketch with design water flows specified thereon.

Hydronic system is free of leaks, is hydrostatically tested and is thoroughly cleaned, flushed and refilled.

Hydronic system is vented.

III. The contractor shall confirm completion of the basic procedures and prepare check lists for readiness of system balance.

Check pumps operation for proper rotation and motor current drawn etc.

Confirm that provisions for TAB measurements (Temperature, pressure and flow measurements) have been made.

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 presented to the PMC/Consultants for approval.

## 20.8 READINESS FOR COMMENCEMENT OF TAB

Before starting of any of the tests, the readiness to do so should be recorded as per the prescribed check list.

## 20.9 TAB INSTRUMENTS

I. Air Measuring Instruments

a. For measuring DB and WB temperature, RH and dew point, microprocessor based TSI USA make VelociCalc Plus 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 hermometers from thermo wells 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

Electronic Digital Tachometer.

## IV. Temperature & RH Measuring Instrument

TSI VelociCalc model 8386 / VelociCalc model 8345 or equivalent.

## 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, 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 the PMC.

Sound level readings shall be taken at ten (10) locations in the building as selected by the PMC. The readings shall be taken on an Octave Band nalyzer in a manner acceptable to him. The 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 PMC/Consultant.

SYSTEM READY TO BALANCE  
CHECK LIST

	Ready		Date			Ready		Date
	Yes	No.				Corrected	Yes	
1. HVAC Units (AHU)								
a) General					e) Vibration isolation			
Louvers installed					Springs and compression			
Manual dampers open & locked					Base level and free			
Automatic dampers set properly								
Housing Construction-leakage					2. Duct systems			
Access doors-leakage					a) General			
Condensate drain piping and pan					Manual dampers open & locked			
Free from dirt and debris					Access doors closed and tight			
Nameplate data					Fire dampers open and accessible			
b) Filters					Terminal units open and set			
Type and size					Registers and diffusers open and set			
Number					Turning vanes in square elbows			
Clean					Provisions made for TAB measurements.			
Frame-Leakage					Systems installed as per plans.			
c) Coils (Hydronic)					Ductwork sealed as required			
Size and rows					b) Architectural			
Fin spacing and condition					Windows installed and closed.			
Obstructions and / or debris					Doors closed as required.			
Airflow and direction					Ceiling plenums installed and sealed.			
Piping leakage					Access doors closed and tight			
Correct piping Connections and flow					Air shafts and openings as required			
Valves open or set								
Airvents or steam traps					3. Pumps.			
Provisions made for TAB measurements					a) Motors.			
d) Fans.					Rotation			
Rotation.					Lubrication			
Wheel clearance and balance					Alignment			
Bearing and motor lubrication					Set screws tight			
Drive alignment					Guards in place			
Belt tension.					Tank level and controls.			
Drive set screws tight					Starters and disconnect			

					switches			
Belt guard in place					Electrical service & connections.			
Flexible duct connector alignment					Nameplate data.			
Starters and disconnect switches								
Electrical service & connections.								
Nameplate data								

b) Piping				5. Refrigeration Equipment			
Correct flow				Crankcase heaters energized			
Correct connections				Operating controls and devices.			
Leakage				Safety controls and devices.			
Valves open or set				Valves open			
Strainer clean				Piping connections and flow			
Air vented				Flexible connectors			
Flexible connectors				Oil level and lubrication			
Provisions made for TAB measurements				Alignment and drives.			
c) Bases				Guards in place.			
Vibration isolation.				Vibration isolation.			
Grouting				Starters, contactors and disconnect switches.			
Leveling.				Electrical connectors.			
				Nameplate data.			
4. Hydronic equipment.							
a) Heat Exchangers/HW coil				6. Hydronic Piping systems.			
Correct flow and connections				Leak tested.			
Valves open or set				Fluid levels and make-up			
Airvents or steam traps				Relief or safety valves.			
Leakage				Compression tanks and air vents.			
Provisions made for TAB measurements				Steam traps and connections.			
Nameplate data.				Strainers clean			
				valves open or set			
b) Cooling towers							
Correct flow and connections.				Provisions made for TAB measurements.			
Valves open or set				Systems installed as per plans.			
Leakage							
Provisions made for TAB measurements				7. Controls System			
Sump water level.				Data centers.			
Spray nozzles.				Outdoor return air reset			
Fan/pump rotation.				Economizer			
Motor/fan lubrication.				Static pressure			
Drives and alignment				Room controls.			
Guards in place.				8. Other Checks.			
				a) Other trades or personnel notified of TAB work requirements.			
				b) Preliminary data complete			
				c) Test report forms prepared.			



AIR HANDLING EQUIPMENT TEST REPORT

PROJECT \_\_\_\_\_ SYSTEM / UNIT \_\_\_\_\_

LOCATION \_\_\_\_\_

UNIT	DATA	MOTOR	DATA
Make/Model No.		Make / Frame	
Type/Size		H.P / RPM	
Serial Number		Volts/Phase/cycles	
Arr./Class		F.L amps.	
Discharge		Pully Diam/Bore	
Pully diam/Bore		Pully /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. T1 T2 T2 T3 T3 T1			Filters S.P		
Outside air Cfm					
Return air Cfm					

REMARKS.

TEST DATE \_\_\_\_\_ READINGS BY \_\_\_\_\_

COOLING / HEATING TEST REPORT (AHU)  
 PROJECT \_\_\_\_\_

COIL DATA	COIL NO.	COIL NO.	COIL NO.	COIL NO.
System Number				
Location				
Coil Type				
No. Rows Fins/In				
Manufacturer				
Model Number				
Face Area, Sq.Ft.				

TEST DATA	DESIGN	ACTUAL	DESIGN	ACTUAL	DESIGN	ACTUAL	DESIGN	ACTUAL
Air Qty. CFM								
Air Vel.FPM								
Press.Drop In.								
Out.Air DB/WB								
Ret. Air DB/WB								
Ent.Air DB/WB								
Lvg.Air DB/WB								
Air AT								
Water flow. GPM								
Press.Drop.PSI								
Ent.Water Temp								
Lvg .Water Temp								
Water AT								
Exp.Valve/Refrig								
Refrig.Suction Pr.								
Refrig.Suct.Temp								
Inlet Steam press.								

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 Diam./Bore			
Fan pully Diam./Bore			
No. Belts/ Make/Size			
Pully Distance.			

TEST DATA	DESIG N	ACTUA L	DESIG N	ACTUA L	DESIG N	ACTUA L
CFM						
FAN RPM						
S.P IN/OUT						
TOTAL S.P						
Voltage            T1 T2 T2 T3						
T3 T1						
Amperage        T1 T2 T3						

REMARKS:

TEST DATE: \_\_\_\_\_ READINGS BY \_\_\_\_\_

RECTANGULAR DUCT  
TRAVERSE REPORT

PROJECT \_\_\_\_\_ SYSTEM \_\_\_\_\_

LOCATION / ZONE \_\_\_\_\_ ACTUAL AIR TEMP. \_\_\_\_\_ DUCT S.P. \_\_\_\_\_

DUCT SIZE _____ SQ.FT. _____ —	REQUIRED FPM _____ CFM _____ —	ACTUAL FPM _____ CFM _____ —
--------------------------------------	--------------------------------------	------------------------------------

POSITION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
VELOCITY SUBTOTALS															

REMARKS.

TEST DATE \_\_\_\_\_ READINGS BY \_\_\_\_\_



## 20. PAINTING AND FINISHES

### 20.1 Scope

The scope of this section comprises of colour scheme required for each piece of equipment

### 20.2 Colour Scheme.

Description	Standard Colour & Reference	Lettering Colouring
Exposed Duct Work (other than plant room) instruction	To Architect's	
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 25 mm wide)	
Switchboards - exterior - interior	BS 366 Light Beige White	
Machine Bases, Inertia Bases and Plinths	Charcoal Grey	

## 20. IDENTIFICATION OF SERVICES

### 20.1 SCOPE

The scope of this section comprises of identification of services for each piece of equipment

### 20.2 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.

A wall mounted, glass covered plan to the approval of the Architect / Engineer shall be provided and displayed in each plant room showing the plant layout with pipe work, valve diagram and valve schedule indicating size, service, duty, etc.

### 21.3 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 and ducts, and control points to readily identify the service, but spacing shall not exceed 4.0 metres.

#### 21.3.1 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
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
Central Heating Services :	
Below 100o C	18 E 55/04 D 45/18 E 53
Above 100o 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 Vacuum	Basic Colour only White.
Town Gas : Manufactured Natural	14 E 53 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.

### 21.3.2 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 should 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
Fresh 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
Fresh Air	F
Exhaust Air	E

The colour banding and triangles shall be manufactured from self adhesive cellulose tape, laminated with a layer of transparent ethyl cellulose tape.

## 21. NOISE CONTROL

### 21.1 SCOPE

The scope of this section comprises of the supply, installation, testing and commissioning of noise and vibration control equipment and accessories.

### 21.2 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 : Parts 1-9:1980	Laboratory and Field Measurement of Airborne Sound 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 : Part 2: 1976	Acoustic Testing.
BS 4856 : Part 2: 1976	Acoustic performance without additional ducting of forced fan convection equipment.
Part 5: 1976	Acoustic performance with additional ducting of forced fan

convection equipment.

BS 4857 :  
Par 2:1978 (1983) Acoustic Testing and Rating of High Pressure Terminal Reheat Units.

BS 4954 :  
Par 2:1978 (1987) Acoustic Testing and Rating of Induction Units.

BS 5643 : 1984 Glossary of Refrigeration, Heating, Ventilating and Air Conditioning Terms.

### 21.3 GENERAL

Mechanical services shall generally be designed and installed with provisions to contain noise and the transmission of vibration, generated by moving plant and equipment at source where illustrated on the tender drawings and plant and equipment schedules to achieve acceptable noise rating specified for occupied areas.

In addition to the provisions specified in the Specification, particular attention must be given to the following details at time of ordering plant and equipment and their installation :-

- a. All moving plant , machinery and apparatus shall be statically and dynamically balanced at manufacturers works and certificates issued.
- b. The isolation of moving plant, machinery and apparatus including lines equipment from the building structure.
- c. Where duct work and pipe work services pass through walls, floors and ceilings, or where supported shall be surrounded with a resilient acoustic absorbing material to prevent contact with the structure and minimise the outbreak of noise from plant rooms.
- d. 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.
- e. 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.
- f. All duct connections to fans shall incorporate flexible connections, except in cases where these are fitted integral within air handling units.

Duct work connections to the fan inlets / outlets shall be concentricity aligned so that the flexible connections are not subjected to any strain and not used as a means of correcting base misalignment.

- g. 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.
- h. Where practicable, silencers 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 silencer and the wall subjected to noise infiltration shall be acoustically clad as specified.

- i. Contractor to demonstrate design NC levels in the areas with FFT (Fast Fourier Transform) analyzer.

### 21.4 SILENCERS

At tender stage all silencers as scheduled in the specification or on tender drawings will be selected based on preliminary sound power levels obtained from fan/air handling unit manufacturers or fan duties to achieve a noise rating in the occupied space as specified in “Basis of Design”

All plant attenuators shall be selected to maintain noise criteria given in this Specification.

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 zinc chromet primer paint.

Acoustic splitters shall be formed by channel section pre-galvanised sheet steel framework retaining acoustic fill of a density to attain the required performance. Splitters shall have round nose ends to give smooth entry and exit conditions to minimise air pressure drops.

The acoustic fill shall be protected from the air flow by 22 swg minimum perforated galvanised sheet steel.

All silencers shall be selected against a maximum allowable air pressure drop of 75 a.

It will be the responsibility of the 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.

#### 21.5 ANTI-VIBRATION MOUNTINGS.

All items of rotating and reciprocating plant and equipment shall be isolated from the structure by the use of anti-vibration materials, mountings or spring loaded supports fixed to either concrete bases, inertia blocks or support steels as indicated.

Centrifugal fans and motors within air handling units shall be isolated from the frame of the air handling unit by suitable anti-vibration mountings. Fan discharge air connections shall be fitted with approved flexible connections internally isolating the fan scroll from the air handling unit casing.

Axial flow fans shall be mounted on steel legs as diaphragm plates supported on neoprene in shear anti-vibration mountings, 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 and concrete filled steel upper plinth. The Contractor shall be responsible for issuing the steel upper plinth and mountings to the Contractor for building-in.

Pipe work connections to circulating pumps, chillers, cooler coils and other equipment shall be made with flexible connections as per Specifications.

The construction of the anti-vibration mountings shall generally comply with the following : -

##### Enclosed Spring Mounting ( Caged or Restrained Springs)

Each mounting shall consist of cast or fabricated telescopic top and bottom housing enclosing one or more helical steel springs as the principle isolation elements, and shall incorporate a built- in levelling device.

The springs shall have an outside diameter of not less than 75% of the operating height, and be selected to have at least 50% overload capacity before becoming coil bound.

The bottom plate of each mounting shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

Mountings incorporating snubbers or restraining devices shall be designed so that the snubbing damping or restraining mechanism, is capable of being adjusted to have no significant effect during the normal running of the isolated machine.

Restrained isolator shall be provided on chillers subject to approval by the manufacturers.

#### 21.6 OPEN SPRING MOUNTINGS.

Each mounting shall consist of one or more helical steel springs as the principal isolation elements, and shall incorporate a built-in leveling device. The spring shall be fixed or otherwise securely located to cast or fabricated top and bottom plates, and shall have an outside diameter of not less than 75% of the operating height, and shall be selected to have at least 50% overload capacity before becoming coil-bound.

The bottom plate shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

#### 21.7 NEOPRENE-IN-SHEAR MOUNTINGS.

Each mounting shall consist of a steel top plate and base plate completely embedded in oil resistant neoprene. Each mounting shall be capable of being fitted with a levelling device, and bolt holes in the base plate and tapped holes in the top plate so that they may be bolted to the floor and equipment where required.

#### 21.8 INERTIA BASES FOR PUMPS.

The inertia base shall be an all welded mild steel channel frame the minimum depth of which shall be 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/m<sup>3</sup>.

The inertia base shall be sufficiently large to provide support for all parts of the equipment, including any component which overhang 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 re-enforced for the load of the equipment and base.

Additional reinforcing roads shall be provided at 200 mm. centres to ensure the concrete and frame is adequately stiffened against distortion.

#### 21.9 FLEXIBLE CONNECTIONS

Flexible connections shall be provided on all duct work connections to fans, rotating plant and equipment isolated from structure and anti-vibration materials or mountings. Pipe work and duct work crossing building movement or construction joints shall be installed with flexible connections.

Flexible connections on duct work to fans etc., shall be a minimum / maximum free length of 100 mm. / 200 mm. respectively to minimise noise transmission and noise breakout. They shall be completely free from stress and shall not be required to accept any weight.

Thickness and strength of flexible connection materials shall be suitable to withstand the positive and negative fan pressures to which they will be subjected to and shall not allow perceptible leakage. The materials shall be durable, non flammable having good acoustical quality.

Flexible connections shall be fitted to all pump suction and discharge connections, chillers and other vibrating equipment and where anti-vibration mounts and inertia basis are fitted.

Flexible connections shall be fitted to all cooler coil chilled water pipe work connections.

Flexible connections shall allow freedom of movement of plant in all plans.

Making flanges to pipe work flexible connections shall be of the smooth faced weld-nick type.

Rubber Bellows shall be fitted as close to the source of vibration at practicable. The pipe at the other end of the bellows shall be a fixed point.

Rubber bellows shall be single convolution of multiply reinforced EPDM rubber with wire reinforced cuffs. Flanges shall be able to swivel and be removable. The date of manufacture shall be moulded on the bellows. For traceability membranes shall have an indelible identification showing manufacturer, country of origin, the type and a batch number.

Tie bars with rubber top hat washers shall be used on bellows.

For working temperatures up to 70o C the rubber bellows shall be high tensile synthetic fibre reinforced.

For working temperature between 70oC and 100oC the bellows carcass shall be steel wire mesh reinforced throughout. Steel reinforced bellows shall be manufactured and approved to the Standards.

For temperatures above 100oC bellow shall be multiply stainless steel with Van Stone ends swivel flanges. The overall length shall not exceed 130 mm.

Flexible connections with screwed connections shall be reinforced EPDM rubber hoses and shall have at least one full union to avoid torturing on installation.

Flexible pipe connections on chilled water systems shall be suitable for a working pressure of 10 bar and test pressure of 17 bar.

## 22 BTU METERS

Provide BTU meters as required per the specifications. All BTU meters in the main water plant consisting of Primary Chilled Water Systems, Condenser water System shall be Ultrasonic & non-wearing type with EN/UL approval and shall provided with Optical interference protection as per EN 62056-21:2002 standard

Meter should be a tamper proof meter with Single button design. No tampering can be done on the meter through the keypad. Parameters of the meter can be changed through software only.

Meter should not have any moving part.

The electronic part of the meter should have split mounting arrangement for safety, manual reading and to avoid condensation

Meter should have an integrated flow calculator capable to display readings locally in case of network failure.

Meter should have Self-diagnosis and indication of values, parameters, malfunction and failure messages on the display

The meter Shall have M-bus/ Pulse / RS 485 module to network meters to central station. The flow meter should be pressure rated for minimum PN16.

The meter shall have measuring accuracy of Class 2 or 3 (EN 1434).

Meter shall have an integrated flow calculator capable to display readings locally in case of network failure The electronic part should have split mounting arrangement for safety, manual reading and to avoid condensation

The devices shall properly operate with the specified accuracy and shall not be affected by the media, or by the environment that includes but not limited to low temperatures (5 Deg C), temperature fluctuations and condensation. Control panel enclosures and electronics shall meet the aforementioned requirements or located strategically to ensure proper operation.

Provide insertion type flow meters designed to mount through a fully open, 1 inch full bore ball valve supplied by flow meter manufacturer. Meter flow range shall be 2-40 feet/second for liquid service. Meter linearity shall be +/-1% for a 10:1 range. Repeatability shall be 10%. All wetted parts shall be constructed of stainless steel, bearings shall be tungsten carbide, housing and flange shall be carbon steel.

All meters need to be wet calibrated(temperature sensor and flow meter need to be calibrated together) and calibration certificate to be provided for the BTU meters

Meters need to have an inbuilt battery backup – guaranteed for a minimum of 6 to 16 years. There is no requirement of external Power supply.

No reflector used for detection of flow. This ensure that meters are very robust and don't have any problems even after years of operation. This ensures efficiency of meter and maintenance free years of operation.

The flow sensor needs to be a high capacity flow meter and can take velocities as high as 16 m/s.

One single model for line sizes ranging from 15mm to 700mm.

Meters need to be EN/UL certified and needs to have IP54 Protection

Meter should have the facility to be used as a hot meter as well as a cold meter without any modifications. The meter should have auto switching of Hot/ Cold meters

Accuracy Class	: Class 2
Pressure Drop	: ≤0.025MPa (Normal Flowrate)
Working Pressure	: ≤1.6MPa
Ingress Protection	: Protection IP68 (transducer) / IP 54 (Electronics)
Temp Range oC	: -20 ~95
Output	: Mbus or Pulse or RS485
Static current	: <10uA
Battery type	: Li, 3.6V/2.4Ah
Battery Life	: greater than 6 years Guaranteed
Environmental Class	: A
Enclosure Protection	: IP54
Pt1000 cable length	: 1.5m (longer cable available upon request)
Flow sensor cable length	: 1.2m (longer cable available upon request)
BTU integrator	: Remote with min 2 m cable

Provide supply and return temperature sensors for "Delta-T" calculation of BTU consumption. Monitor total accumulated BTUs, current BTUs, monthly total BTUs, and yearly total BTUs for each location specified or shown.

Provide isolation valve kit (by HVAC vendor) to allow removal and servicing of meter while system is operating.

Supply of Indoor Air Quality monitor to measure PM2.5, PM10, PM1.0, CO2, and Total VOC. Monitor should be table mount or wall mount type with large display of atleast 2.7". It should be able to indicate all above parameter on main screen and show level of pollution based on range on color band, Formaldehyde data should be also be available.

Monitoring device should be CE Certified and shall be able to connect to wifi on 2.4 Ghz and send data to Cloud server and data should be stored for minimum 24 months (on perpetual basis). Various type of report can be downloaded for a specified period

Air Quality monitor should be able to operate on 5.0V power supply and in built battery 1600 mAH to provide battery back-up for minimum One Hour.

Operating range for various pollutants are as mentioned below:

Description	Parameters	Measuring Range
Particle Measurement	PM2.5	0-999 µg/m3 ±10%
	PM10	0-999 µg/m3 ±10%
	PM1.0	0-999 µg/m3 ±10%
Carbon Di Oxide	CO2	0-5000 ppm (+ 50ppm + 5%)
Total VOC	TVOC	0-9.99 mg/m3
Formaldehyde	HCHO	1.7 mg/m3

Installation and Commissioning:

The scope of work include installation of monitoring device and connecting it to Wifi. Create login id and configure all devices under specified login id. Login should allow multiple users under same id.

Generate graphs of the day for various pollutants on real time basis and capture data on graph with 5 minutes frequency.

Auto alert should be generated using SMS or email in the event of any pollutant level going beyond safe limit.

## 24 DRUM SCRUBBER:

The Drum Scrubber shall contain a vertically oriented media bed, shall contain dry chemical media selected for the application and shall be arranged so that the contaminated air shall flow through the inlet plenum then the contaminated air shall flow through pass upward through the media bed. Treated air shall discharge out of the top of the vessel. The system must have fan filter section with MERV 11 dust filter to capture dust before air entering in drum vessel.

Molecular Media consists of 4 mm pellets suitably impregnated to provide an enhanced removal capacity for Ammonia, H2S, So2, VOC and other basic (caustic) contaminants. The Media selection should be as per the specification below and should be regenerative once saturated. The equipment provider must have facility for media regeneration and media testing in India.

The media should be regenerated by in-situ washing with water, drying by air and followed by infusion with 30% by volume of the supplied regenerant. The Media must be regeneratable up to 10 times with minimum 90% efficiency

Drum Scrubber Capacity – For Aeration and MBR Tanks  
 CFM Capacity – 1000 , Quantity 1  
 CFM Capacity – 500, Quantity 1  
 Material construction - SS304 Canister or FRP  
 Media Life Sampling Ports  
 Totally Enclosed Fan Cooled (TEFC) motor  
 High quality blower/motor assembly  
 Adjustable damper (AL)  
 Stainless steel or Rubber latches  
 Fully leakage free lid  
 Flexible coupling at inlet  
 Filled with Standard Media – with below specification

Molecular Media Specification

Media Quantity not exceeding:	250 KG for 500 CFM unit and 500 KG for 1000 CFM unit	Crush
strength:	35-70%	
Abrasion:	4.5% (max)	
Bulk density:	465 Kg/m3 (approx.)	Nominal pellet
Size:	4mm	
Ammonia:	6.8% weight ratio	Hydrogen sulfide
(H2S) 20.0% weight ratio		VOC
14% weight ratio		
Temperature:	-4°C to 51°C	
Humidity:	10 - 95% RH	
Air Speed:	60 - 100 fpm	
Performance:	99.5% (min)initial removal efficiency	
Moisture %:	3.6%	
CTC %:	56.2	
Iodine# %:	1012	
pH	10.4	
Ash Content	4.6%	
Ballpen Hardness	96.2%	

Media to sustain for odor removal for 6 months and to be regenerated after 6 months.

25 VAQ Station

VAQ Station – General

All the VAQ (Variable Air Quality) Station shall be Pressure Independent type with Direct Digital Controls to regulate and monitor the primary air flow rate between the scheduled minimum and maximum values to achieve the specified comfort level and ventilation rates within acceptable noise criteria. A separation shall be made in VAQ Station-SA (Standard VAV Terminals), and VAQ Station-OA (for non-ducted application) as detailed in the schedule. The VAQ Station shall controls air to provide desired zone temperature, and required minimum volume of outdoor air for proper ventilation as per ASHRAE Standard 62. The controller shall measures the pressure, position of the damper blades, and temperature of the air flowing through the damper.

The VAQ Station shall have an air measuring station with an ultra-lowleak, high performance control damper similar to AMCA Class-I leakage. The complete assembly shall be factory assembled and tested to provide effective set point monitoring and adjustment. The unit shall come standard with a pressure transducer, with the output signal proportional to cfm and factory fitted standalone DDC controller.

Overview of VAQ Station-Supply Air (Standard Pressure Independent VAV Terminals)

In this application, an air measuring control damper shall provides the air supply at a constant temperature while individual zone thermostats vary the flow of air to each space maintaining the desired zone temperature. The specific amount of air volume required to maintain a particular zone temperature set-point is dictated by the size of the space and the internal and external heat loads, shall be spanned by Direct Digital Controls.

Overview of VAQ Station-Outdoor Air (For non-ducted application)

In this application, an air measuring control damper shall provide Outdoor, Return and Exhaust air control based on a demand signal. The demand signal shall be determined by a set schedule or by occupancy sensors. Examples of demand signals are carbon dioxide (CO<sub>2</sub>) concentration, a binary signal from a motion detector, or a manual switch.

#### Construction

The casing shall be single skin made out of galvanized sheet steel with acoustic lining from inside. Casing leakage rate shall be similar to AMCA class I leakage. All VAQ Station shall have rectangular duct connection with 25 mm. flange connections at the outlet of the station.

The VAQ Station shall have a air-flow straightener of 3" deep hexagonal pattern at the inlet of the station to provide necessary laminar air flow suitable for measurement, and a multi-leaf opposed blade damper with aluminum, aero foil blade construction, width 100 mm., and exposed gear driven. The damper spindle shall be made of steel (10 mm. diameter), rotating in self-lubricating Nylon bearings.

Each VAQ Station, shall be factory fitted with a multipoint, averaging air flow sensor in the inlet of the terminal. This air flow sensor shall amplify the air pressure signal linearly with an amplification factor of at least 3.0. The air flow sensor shall contain not less than 2x8 sensing points, which shall be arranged as per LOG-TCHEBYCHEFF rule. The signal shall be averaged and measured from the center of the sensor. And the accuracy shall be within 5% even with irregular duct approach.

#### Controls

##### Controller

Controller shall be DDC Advanced Application Controller that communicates on direct digital control using point 2 point analog controls and compatible with existing or future BMS system.

##### Actuator

Actuator shall have a pressure sensor, digital VAV controller and damper actuator all in one, providing a Compact solution with a communications capability for Pressure-independent VAV and CAV systems in the comfort zone. It should also have a connection facility for commissioning Diagnostic socket for operating devices.

##### CO<sub>2</sub> Sensor/Thermostat

CO<sub>2</sub> sensor/Thermostat shall have voltage proportional signal i.e.0-10 vdc & should be capable of measuring 0-2000 ppm of CO<sub>2</sub> Concentration with a resolution of maximum 50 ppm

ANNEXURE - V  
Technical data Sheets

SCHEDULE OF TECHNICAL DATA

Contractor should furnish the detailed computerized performance sheet for chillers along with details listed below. In absence of the same, the bid shall be considered invalid.

3. AIR HANDLING UNIT
  - 3.1 General
    - a. Manufacturer
    - b. Material and thickness of casing
    - c. Material and thickness of drain pan.
    - d. Type of vibration isolator
  - 3.2 Fan Section
    - a. Manufacturer.
    - b. Type of fan
    - c. Type of bearings.
    - d. Fan RPM
  - 3.3 Motor
    - a. Manufacturer
    - b. Type
    - c. Motor speed (RPM)
    - d. Motor Efficiency
    - e. Class of Insulation
  - 3.4 Cooling Coil.
    - a. Manufacturer
    - b. Material of tubes
    - c. Material of fins
    - d. No of fins/inch
  - 3.5 Air Filters

- a. Manufacturer
- b. Type of filters
- c. Filter medium
- d. Pressure drop across filters (mm. of water) / Clean & Dirty
- e. Efficiency

3.6 Operating Data

-----  
 AHU NO.  
 -----

-----  
 AIR QTY (CFM)  
 -----

-----  
 TOTAL SP (mmWg)  
 -----

-----  
 FAN ABSORBED POWER (BHP/BkW)  
 -----

-----  
 FAN SPEED (RPM)  
 -----

-----  
 FAN OUTLET VELOCITY (FPM or m/s)  
 -----

-----  
 FAN MOTOR (HP/kW)  
 -----

SOUND POWER LEVEL (DB re 10-12W)

Mid Freq.	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz
SWL(dB)								

-----

SOUND PRESSURE LEVEL(dBA) at fan outlet

Mid Freq.	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz
SPL(dB)								

-----  
COIL FACE AREA (Ft<sup>2</sup>)

-----  
COIL FACE VEL (FPM)

-----  
AIR SIDE PRESSURE DROP ACROSS COOLING COIL (mmWg)

-----  
WATER SIDE PRESSURE DROP IN COOLING COIL (Kg/cm<sup>2</sup>)

-----  
NUMBER OF ROWS

-----  
WATER VELOCITY IN TUBES (m/s)

-----  
TYPE OF FILTERS

-----  
FILTER FACE VELOCITY (FPM or m/s)

-----  
FILTER EFFICIENCY (%) & PARTICLE SIZE (µm)

-----  
AIR PRESSURE DROP IN CLEAN & DIRTY CONDITIONS (mmWg)

-----  
OVERALL DIMENSIONS  
LXWXH (METRES)

---

## OPERATING WEIGHT

---

4. DEDICATED OUTDOOR AIR SYSTEMS
  - a. Manufacturer
  - b. Make
  - c. Recovery Efficiency Total Sensible
  - d. Latent
  - e. Substrate type
  - f. Desiccant
  - g. Desiccant type
  - h. Vertical run /m of Dia
  - i. Radial run /m of Dia
  - j. Supply Air flow to conditioned space
  - k. Return air flow from conditioned space
  - l. Face Velocity-fpm
  - m. Certified as per DIN EN ISO 846 or Equivalent
  - n. NFPA certification for 0% flame spread
  - o. Pressure drop per 100 FPM face velocity or part thereof  
At minimum recoveries specified:

5. FAN COIL UNITS

- a. Manufacturer
- b. Model No
- c. Country of Origin

Unit size

Rows of cooling coil

Air side & water side pressure drops

- f. Type of filter

- g. Motor make
- h. Type of vibration isolators

6. CENTRIFUGAL FANS

- a. Manufacturer
- b. Fan Size and Model
- c. Fan speed

Fan efficiency

Soundlevel

Casing Material

Impeller Material

Motor manufacturer

Motor efficiency and class of insulation.

Type of starter & manufacturer

7. AXIAL FANS

- a. Manufacturer
- b. Fan Size and Model
- c. Fan speed

Fan efficiency

Sound level

Casing Material

Impeller Material

Motor manufacturer

Motor efficiency and class of insulation.

Type of starter & manufacturer

8. PROPELLER FANS

- a. Manufacturer
- b. Motor HP

- c. Capacitors provided.
- d. Speed Regulator for single phase fans
- e. Gravity louvers
- f. Single phase preventor for 3 phase fans
- g. Back draft damper.
- h. Bird Screen

Wire guard

## 9. VARIABLE FREQUENCY DRIVES

Make

Country of Origin

Interface with BAS.

Harmonic filter

Fault Indication.

- f. Dimensions (mm)

## 10. PIPING

- a. Make of pipes / class of pipes
- b. Pipe Wall thickness
- c. VALVES & STRAINER

MAKE

MATERIAL

- i. Butterfly valves
- ii. Gate valve
- iii. Globe valve
- iv. Check valve
- v. Ball valve
- vi. Ball valve with strainer

Balancing valve

- viii. Pot Strainer
- ix. Y-Strainer

- d. Pressure Gauge
  - i. Make
  - ii. Range
  - iii. Dial Size
- e. Thermometer (Make/Type & Range)

11. GALVANISED STEEL SHEETS

- a. Make
- b. Thickness/Gage
- c. Class of Galvanizing

12. GRILLES / DIFFUSERS / DAMPERS

Make, material and gauge of the following :

- a. Fire damper, rating, make of damper motor
- b. Smoke damper, rating, make of damper motor
- c. Grilles/Diffuser

Slot Diffuser

Duct Damper

- f. FA Damper
- g. Access Panel.

13. INSULATION

- a. Manufacturer
- b. Duct acoustic lining material & density
- c. Duct insulation material & density
- d. Pipe insulation material & density

14. ELECTRICAL TECHNICAL DATA SHEETS

For MCC ( To be filled by the bidders)

S.No.	Description	Recommended Specification	Confirmation by the Bidders
1	Type of Panel	a. MCC non drawout type compartmentalized.  b. AHU Panels non drawout type, non compartmentalized	
2	Type of Mounting	Free standing Floor Mounted	
3	Fault kA	50kA -1 Sec for MCC 25kA – 1 Sec for AHU Panels	
4	Thickness of CRCA sheets		
a	Structural members	3mm	
b	Covers and doors	2mm	
c	Base channel	MCC - ISMC 100	
d	Gland plate	3mm	
5 a	Painting/ Process	Synthetic Enamel Paint As per seven tank process Oven baked.	
B	Paint shade;		
a.	Inside	RAL – 7032	
b.	Outside	RAL - 7032	
6	Details of busbars	Electrolytic grade Copper of specified rating for details see constructional features mentioned in specifications	
7	Cable Entry	For MCC & AHU Panels Top or Bottom depending upon location of Panel.	
8	Enclosure Protection/ Ventilation	For MCC – IP -52 with louvers for Ventilation.	
9	Control Wiring/ Power Wiring	Insulated 660Volts Cu wire.	
a.	Voltage Circuit	1.5 sq mm	
b.	Current Circuit	2.5 sq mm	
c.	Minimum size of Power wiring CKt	16 sq mm	
10	Maximum Operating Height	2100	
11	Mounting height of Relays/Meters	Range 350mm to 1900mm	

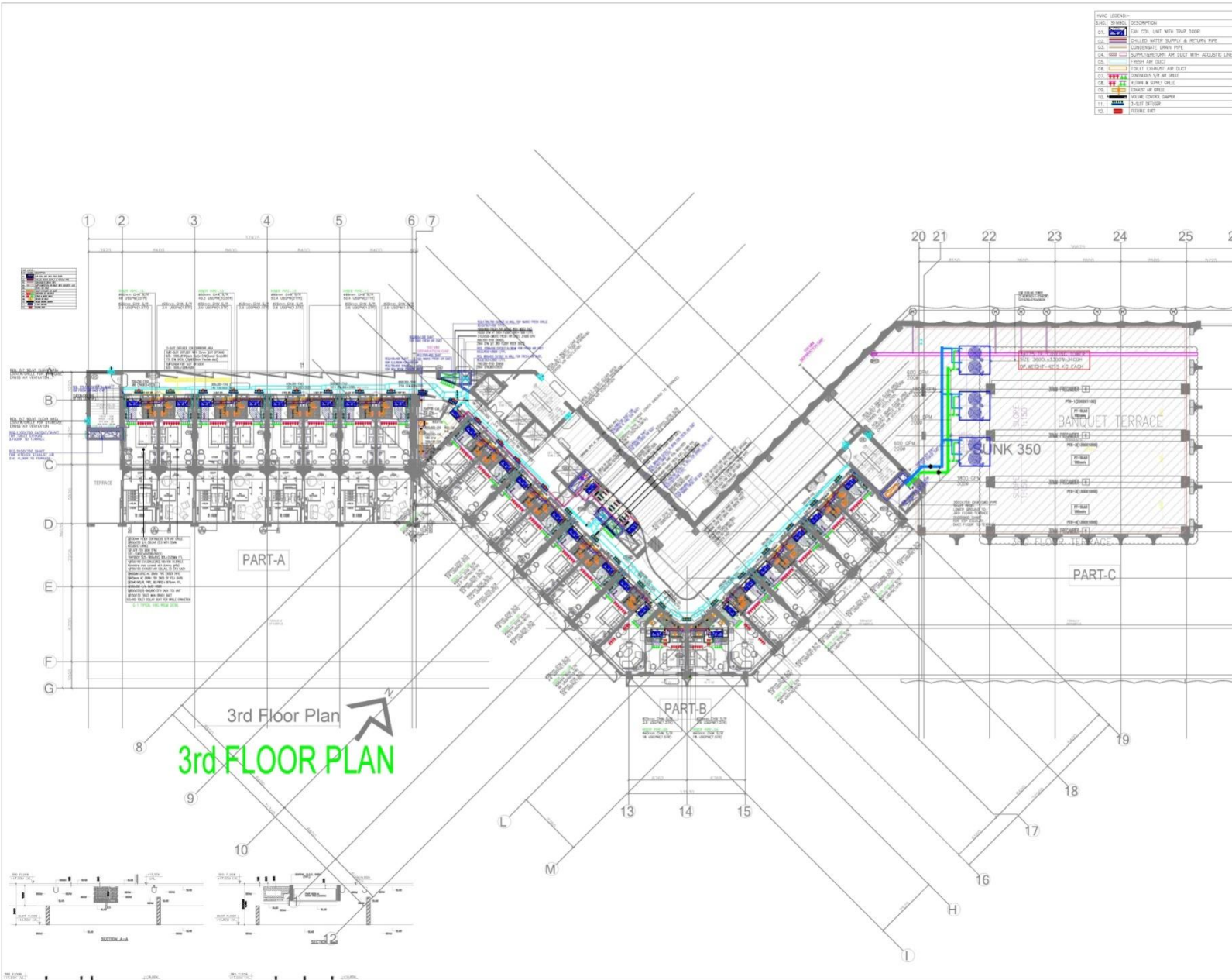
	Control Switches		
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Constructional Features for MCC

S.No.	Description	Recommended Specification	Confirmation by the Bidders
1	MCC		
a.	Busbar Chamber	400mm ht	
b.	Metering Chamber	400mm ht	
c.	Incoming Compartment	1000mm wide Module Single Tier	
d.	Overall Height	2100 mm	
e.	Overall Depth	1300 & 900 mm	
f.	Overall Length	( To be indicated by the bidder)	
g.	Construction	IP-52 with louvers for ventilation	
h.	Current Density	1.25 Amp / Sq.mm	
i.	Main Bus	1.75 Amp / Sq.mm	
ii.	Branch Bus Rating	75% of aggregate Switches connected. 1.25 Amp / Sq.mm Density	
iii.	Neutral Bus	Half of the size of phase bus	
iv.	Earth Bus	Half of the size of phase bus	
j.	Incoming and outgoing feeders.	As per SLD	
2	AHU Panels		
a.	Accessibility	front accessible only	
b.	Overall Depth	300 mm	
c.	Overall Height	700 mm	
d.	Incoming compartment	Individually one module of 600mm wide with direct entry of incoming cables with cable bus bars for terminating multiple incoming cable. incoming metering units and outgoing cables as per SLD.	

The contractor shall refer the tender drawings attached in this section.

Sr. No.	Drawing Title (GFCs)	Drawing No. (If any)
1	LOWER GROUND FLOOR HVAC LAYOUT	AEON/AC/T-01
2	GROUND FLOOR HVAC LAYOUT	AEON/AC/T-02
3	1st FLOOR HVAC LAYOUT	AEON/AC/T-03
4	2nd FLOOR HVAC LAYOUT	AEON/AC/T-04
5	DUCT FLOOR HVAC LAYOUT	AEON/AC/T-05
6	3rd FLOOR HVAC LAYOUT	AEON/AC/T-06
7	4th - 7th FLOOR HVAC LAYOUT	AEON/AC/T-07
8	8th & 9th FLOOR HVAC LAYOUT	AEON/AC/T-08
11	TERRACE FLOOR HVAC LAYOUT	AEON/AC/T-09
12	GROUND FLOOR BOH / KITCHEN LAYOUT	AEON/AC/T-K-02
13	1st FLOOR BOH / KITCHEN LAYOUT	AEON/AC/T-K-03
14	8th FLOOR KITCHEN LAYOUT	AEON/AC/T-K-08



3rd Floor Plan  
**3rd FLOOR PLAN**

**HVAC LEGEND:**

SYMBOL	DESCRIPTION
[Symbol]	FAN COIL UNIT WITH TRIP DOOR
[Symbol]	CHILLED WATER SUPPLY & RETURN PIPE
[Symbol]	CONDENSATE DRAIN PIPE
[Symbol]	SUPPLY/AIR SUPPLY AIR DUCT WITH ACOUSTIC LINING
[Symbol]	FRESH AIR DUCT
[Symbol]	EXHAUST AIR DUCT
[Symbol]	CONDENSATE TRIP OFF PIPE
[Symbol]	RETURN & SUPPLY DUCT
[Symbol]	DOORWAY AT GRILL
[Symbol]	TRAP
[Symbol]	TRAP
[Symbol]	TRAP
[Symbol]	TRAP

**GENERAL NOTES:**

1. All dimensions are in meters unless otherwise specified.
2. The contractor shall be responsible for the correct installation of all equipment and materials.
3. The contractor shall be responsible for the correct installation of all equipment and materials.
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10. The contractor shall be responsible for the correct installation of all equipment and materials.

**GENERAL NOTE:**

1. The contractor shall be responsible for the correct installation of all equipment and materials.

**REVISIONS:**

NO.	DATE	REVISIONS
01	14/12/2023	ISSUED FOR BIDDING
02	14/01/2024	ISSUED FOR APPROVAL

**GENERAL ARCHITECTS:**

**NPAAE BANGKOK**

**ARKITECHNO**

**MEP CONSULTANTS:**

**SACPL**

**ARCHITECTS:**

**DENCITY**

**PROJECT:** GOPALPUR PALM RESORT

**OWNER / PROVIDER:**

**SWOSTI PREMIUM LIMITED**

**DRAWING TITLE:** 3RD FLOOR HVAC LAYOUT

**DRAWING STATUS:** FOR TENDER

**PROJECT NO.:** 24/0241

**DATE OF FIRST ISSUE:** 14/12/2023

**SCALE:** 1:500

**DESIGNER:** AEON/EL/T-06



5th Floor Plan  
**5th FLOOR PLAN**



7th Floor Plan  
**7th FLOOR PLAN**

SYMBOL	DESCRIPTION
01	FAN COIL UNIT WITH TRIP DOOR
02	CHILLED WATER SUPPLY & RETURN PIPE
03	CONDENSATE DRAIN PIPE
04	FLEXIBLE INSULATION AIR DUCT WITH ACOUSTIC LINER
05	FRESH AIR DUCT
06	TOILET EXHAUST AIR DUCT
07	EXHAUST OF V&R DRILL
08	RETURN & SUPPLY DRILL
09	CONDENSATE DRAIN
10	WATER CONTROL VALVE
11	TRIP DOOR
12	TRIP DOOR



**GENERAL REVISIONS SHOULD BE FOLLOWED BY A NEW WORK SHEET IN THIS DRAWING**

1. All dimensions shall be in millimeters unless otherwise specified.
2. All dimensions shall be taken from the center line of the duct or pipe unless otherwise specified.
3. All dimensions shall be taken from the center line of the duct or pipe unless otherwise specified.
4. All dimensions shall be taken from the center line of the duct or pipe unless otherwise specified.
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20. All dimensions shall be taken from the center line of the duct or pipe unless otherwise specified.

**REVISIONS**

NO.	DATE	REVISION	BY
01	16-12-2023	DRWG REVISION ALL PER COMMENTS	
02	16-12-2023	DRWG REVISION ALL PER APPROVAL	

**CLIENT**  
 NPAAE BANGKOK  
 1000 Sukhumvit Rd, Bangkok, Thailand

**PROJECT MANAGER**  
 ARKITECHNO  
 1000 Sukhumvit Rd, Bangkok, Thailand

**ARCHITECTS**  
 DENCITY  
 Architects | Interiors | Turnkey

**OWNER / PROJECT**  
 SWOSTI PREMIUM LIMITED  
 P-1, JAYDEV VIHAR  
 BHUBANESHWAR, ODISHA - 751013

**DRAWING TITLE**  
 4TH - 7TH FLOOR  
 HVAC LAYOUT

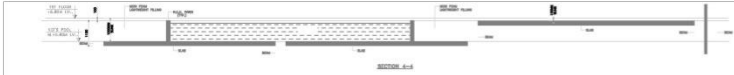
**DRAWING STATUS**  
 FOR TENDER

**PROJECT NO.** 24/CD241  
**DATE OF FIRST ISSUE** 16-12-2023  
**SCALE** 1:200  
**DRG NO.** AEON/EL/T-07

**CHECKED BY** P10PPO  
**DRAWN BY** A.E.





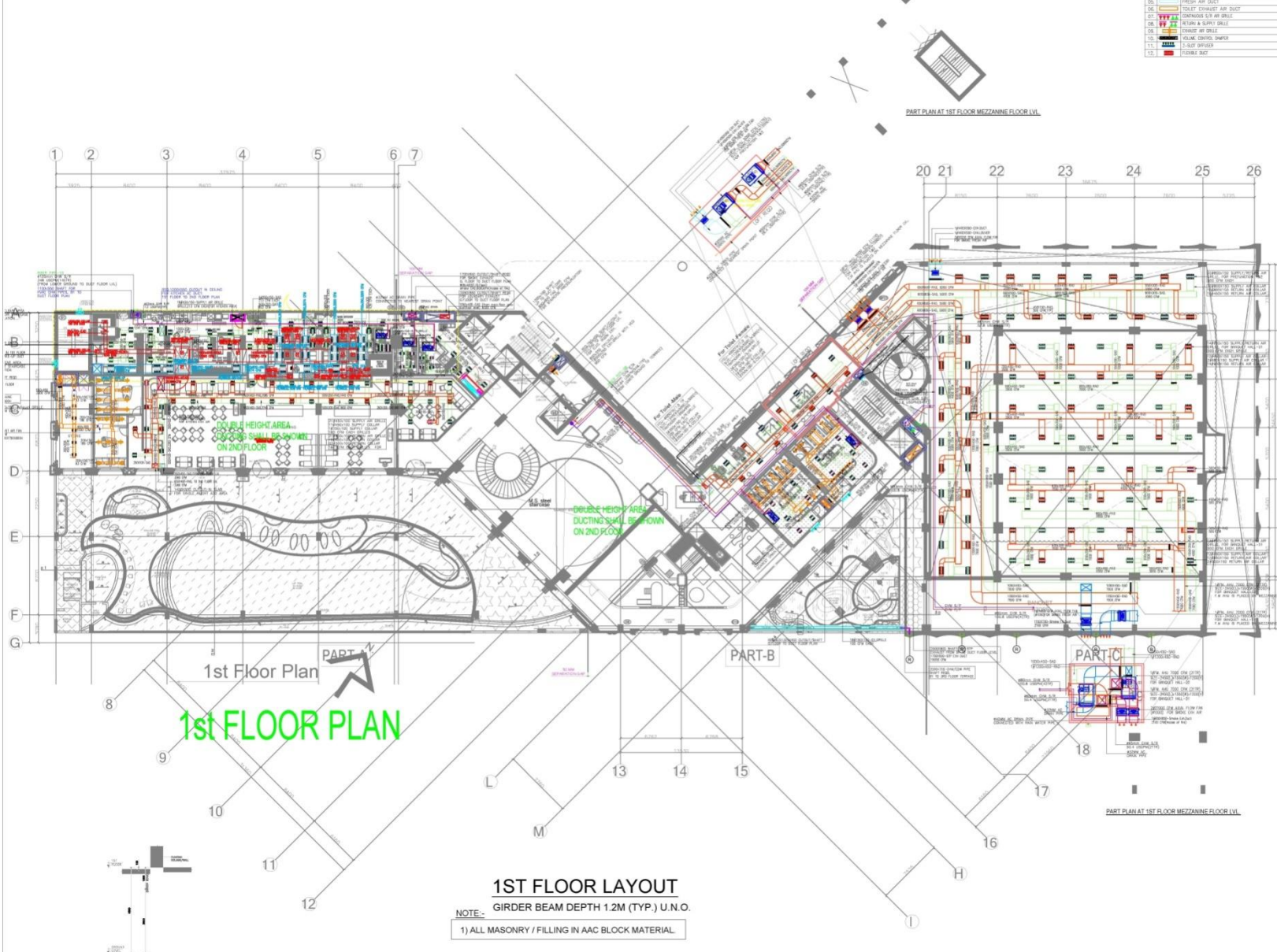


SL. NO.	SYMBOL	DESCRIPTION
01	[Symbol]	FAN COIL UNIT WITH TRAP DOOR
02	[Symbol]	CHILLED WATER SUPPLY & RETURN PIPE
03	[Symbol]	CONDENSATE DRAIN PIPE
04	[Symbol]	SUPPLY/RETURN AIR DUCT WITH ACoustic LINING
05	[Symbol]	FRESH AIR DUCT
06	[Symbol]	TOILET EXHAUST AIR DUCT
07	[Symbol]	CONDENSATE TRAP
08	[Symbol]	MECH & SERV. DRILL
09	[Symbol]	CONDENSATE TRAP
10	[Symbol]	MECH. CHASING, DUCT
11	[Symbol]	2-SLOT DIFFUSER
12	[Symbol]	TRIMMED ROOF



**GENERAL TECHNICAL NOTES TO BE FOLLOWED AT SITE WHICH MAY NOT BE FULLY COVERED BY THIS DRAWING:**

1. All work shall be done in accordance with the approved drawings and specifications.
2. All work shall be done in accordance with the approved drawings and specifications.
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**1ST FLOOR LAYOUT**

NOTE:- GIRDER BEAM DEPTH 1.2M (TYP.) U.N.O.

1) ALL MASONRY / FILLING IN AAC BLOCK MATERIAL.

**GENERAL NOTE:**

1. All work shall be done in accordance with the approved drawings and specifications.
2. All work shall be done in accordance with the approved drawings and specifications.
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REV. NO.	DATE	DESCRIPTION	BY
01	18-12-2020	OWG REVISED AS PER COMMENTS	

PRINCIPAL ARCHITECTS  
**NPA&E**  
BANGALURU

PROJECT MANAGER  
**ARKITECHNO**  
BANGALURU

M E P CONSULTANTS  
**SWOSTI PREMIUM LIMITED**  
BANGALURU

STRUCTURAL CONSULTANTS  
**SACPL**  
BANGALURU

ARCHITECTS  
**DENCITY**  
BANGALURU

PROJECT  
**GOPALPUR PALM RESORT**  
Udayapur, Gopalpur - on-Sea, Ganjam, Odisha

OWNER / PROMOTER  
**SWOSTI PREMIUM LIMITED**  
BANGALURU

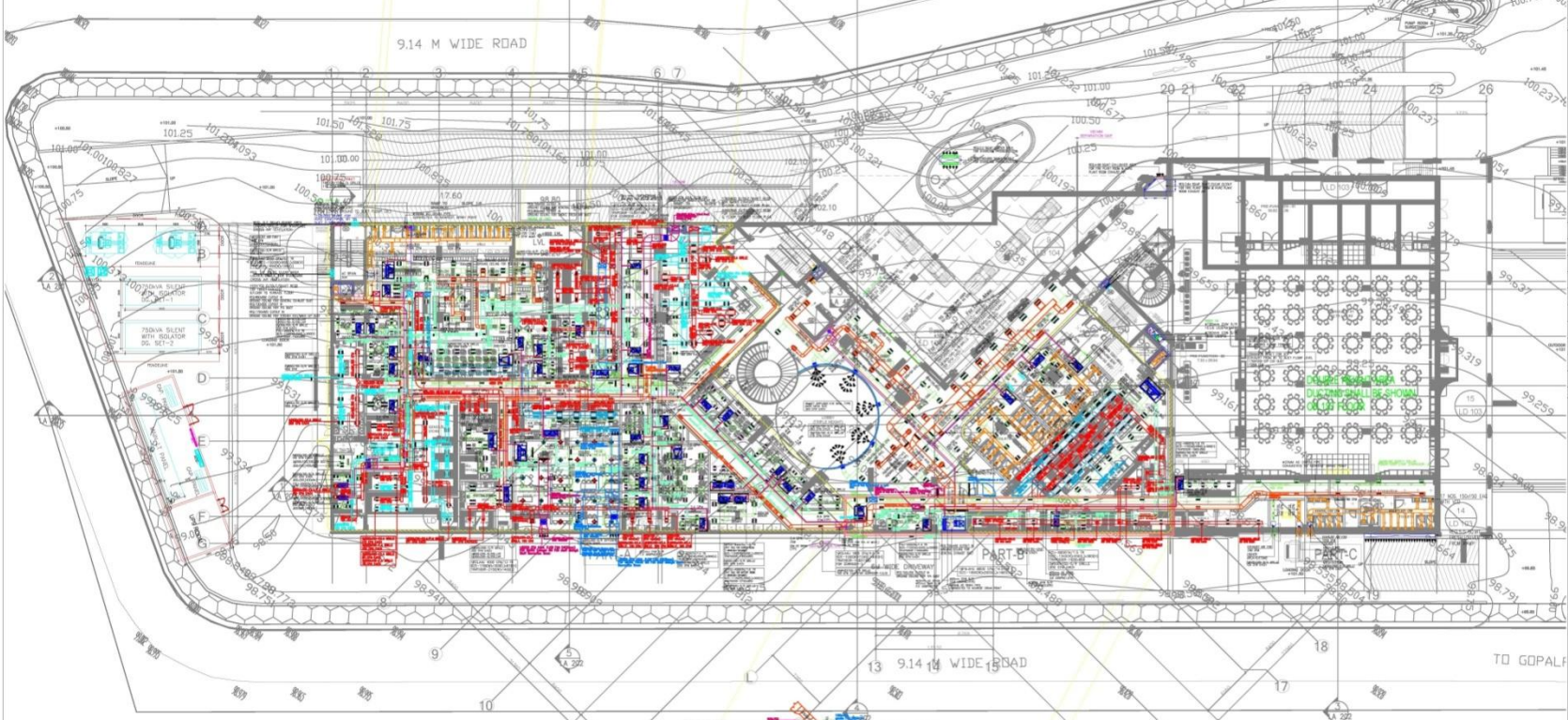
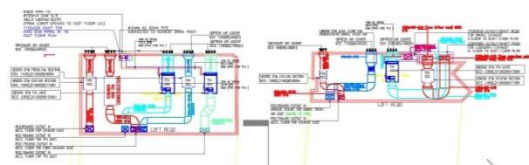
DRAWING TITLE  
**1ST FLOOR HVAC LAYOUT**

FOR TENDER  
PROJECT NO.: 20/2021  
DATE OF THIS DRAWING: 18-12-2020

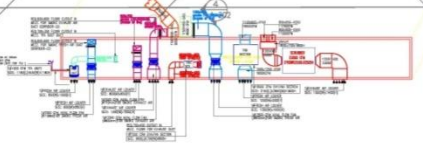
SCALE	REVISED	DATE	BY
1:500	01	18-12-2020	AE

HVAC LEGEND	SYMBOL	DESCRIPTION
01	[Symbol]	FAN COIL UNIT WITH TRIP ROOF
02	[Symbol]	COLLECT WINDY SUPPLY & RETURN PIPE
03	[Symbol]	CONDENSATE DRAIN PIPE
04	[Symbol]	SUPPLY/RETURN AIR DUCT WITH ACOUSTIC LINE
05	[Symbol]	TRIP OF DUCT
06	[Symbol]	TOILET EXHAUST AIR DUCT
07	[Symbol]	CONDENSATE OF AIR GRILL
08	[Symbol]	RETURN & SUPPLY GRILL
09	[Symbol]	TOILET AIR GRILL
10	[Symbol]	TOILET EXHAUST DRAIN
11	[Symbol]	T-ROOF DRAIN
12	[Symbol]	TOILET ROOF

PART PLAN AT GROUND FLOOR MEZZANINE FLOOR LVL



GROUND FLOOR PLAN



NOTES TO BE FOLLOWED AT SITE WORK

1. All work shall be done as per approved drawings.
2. All work shall be done as per approved drawings.
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REV. NO.	DATE	DESCRIPTION	BY
01	15/12/20	DRG REVISED AS PER COMMENTS	
02	16/12/20	DRG ISSUE FOR APPROVAL	

**NPAAE BANGLAKA**  
 NPAAE BANGLAKA CONSULTANTS LTD.  
 300B International Centre for Planning, Bangalore, India

**ARKITECHNO**  
 ARCHITECTURE & INTERIOR DESIGN CONSULTANTS  
 1/12, Sector 13E, Gurgaon - 122001, India

**SACPL**  
 SACPL CONSULTANTS  
 1/12, Sector 13E, Gurgaon - 122001, India

**DENCITY**  
 Architecture | Interiors | Turnkey  
 3rd Floor, Argus Tower, Plot No. 19/20/21, Sector 13E, Gurgaon - 122001, India

**PROJECT: GOPALPUR PALM RESORT**  
 Udayapur, Gopalpur-on-Sea, Ganjam, Odisha

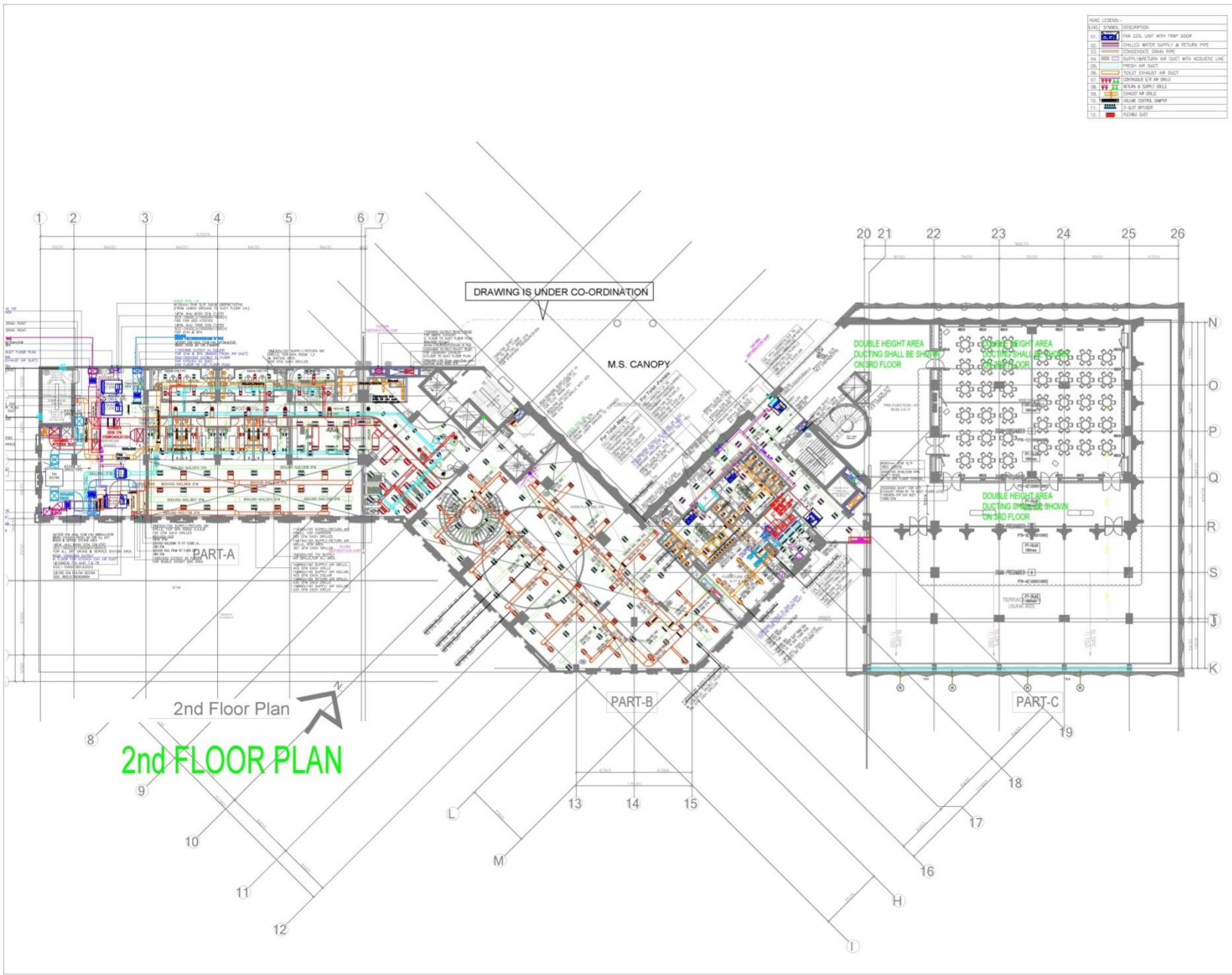
**OWNER / PROVIDER: SWOSTI PREMIUM LIMITED**  
 P-1, JAYDEV SHAH BHUBANESWAR, ODISHA - 751013

**DRAWING TITLE: GROUND FLOOR HVAC LAYOUT**

**DRAWING STATUS: FOR TENDER**

PROJ.ECT.NO. - 24/C241  
 DATE OF FIRST ISSUE - 16/12/2020  
 SCALE - 1:200  
 ORG.NO. - AEON/AC/T-02

CHECKED BY - P.JOYDIP  
 DRAWN BY - A.E.



SYMBOL	LEGEND- SYMBOL DESCRIPTION
(Symbol)	TRAP COL UNIT WITH TRAP DOOR
(Symbol)	CHILLED WATER SUPPLY & RETURN PIPE
(Symbol)	CONDENSATE DRAIN PIPE
(Symbol)	SUPPLY/RETURN AIR DUCT WITH ACOUSTIC LINING
(Symbol)	FRESH AIR DUCT
(Symbol)	TOILET EXHAUST AIR DUCT
(Symbol)	EXHAUST AIR PIPE
(Symbol)	RETURN & SUPPLY GRILLE
(Symbol)	TOILET AIR GRILLE
(Symbol)	FLUKE CONTROL NUMBER
(Symbol)	TRAP UNIT
(Symbol)	TRAP UNIT
(Symbol)	TRAP UNIT



**GENERAL TECHNICAL NOTES TO BE FOLLOWED AT SITE MINDFULLY**

1. All dimensions are in meters unless otherwise specified.
2. All dimensions are to center line unless otherwise specified.
3. All dimensions are to be checked on site.
4. All dimensions are to be checked on site.
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**GENERAL NOTE**

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REV. NO.	DATE	REMARKS	BY
01	14-12-2024	ISSUED FOR APPROVAL	
02	14-12-2024	ISSUED FOR APPROVAL	
03	14-12-2024	ISSUED FOR APPROVAL	
04	14-12-2024	ISSUED FOR APPROVAL	
05	14-12-2024	ISSUED FOR APPROVAL	
06	14-12-2024	ISSUED FOR APPROVAL	
07	14-12-2024	ISSUED FOR APPROVAL	
08	14-12-2024	ISSUED FOR APPROVAL	
09	14-12-2024	ISSUED FOR APPROVAL	
10	14-12-2024	ISSUED FOR APPROVAL	
11	14-12-2024	ISSUED FOR APPROVAL	
12	14-12-2024	ISSUED FOR APPROVAL	
13	14-12-2024	ISSUED FOR APPROVAL	
14	14-12-2024	ISSUED FOR APPROVAL	
15	14-12-2024	ISSUED FOR APPROVAL	
16	14-12-2024	ISSUED FOR APPROVAL	
17	14-12-2024	ISSUED FOR APPROVAL	
18	14-12-2024	ISSUED FOR APPROVAL	
19	14-12-2024	ISSUED FOR APPROVAL	
20	14-12-2024	ISSUED FOR APPROVAL	
21	14-12-2024	ISSUED FOR APPROVAL	
22	14-12-2024	ISSUED FOR APPROVAL	
23	14-12-2024	ISSUED FOR APPROVAL	
24	14-12-2024	ISSUED FOR APPROVAL	
25	14-12-2024	ISSUED FOR APPROVAL	
26	14-12-2024	ISSUED FOR APPROVAL	

2nd Floor Plan  
**2nd FLOOR PLAN**

**PROJECT MANAGER**  
**ARKITECHNO**  
 P/2, JAYDEVI SWASTI, BHUBANESHWAR, ODISHA 751013

**ARCHITECTS**  
**DENCITY**  
 Architects | Interiors | Landscapes

**PROJECT**  
**GOPALPUR PALM RESORT**  
 Gopalpur-on-Sea, Ganjam, Odisha

**OWNER / PROMOTER**  
**SWOSTI PREMIUM LIMITED**  
 P-2, JAYDEVI SWASTI, BHUBANESHWAR, ODISHA - 751013

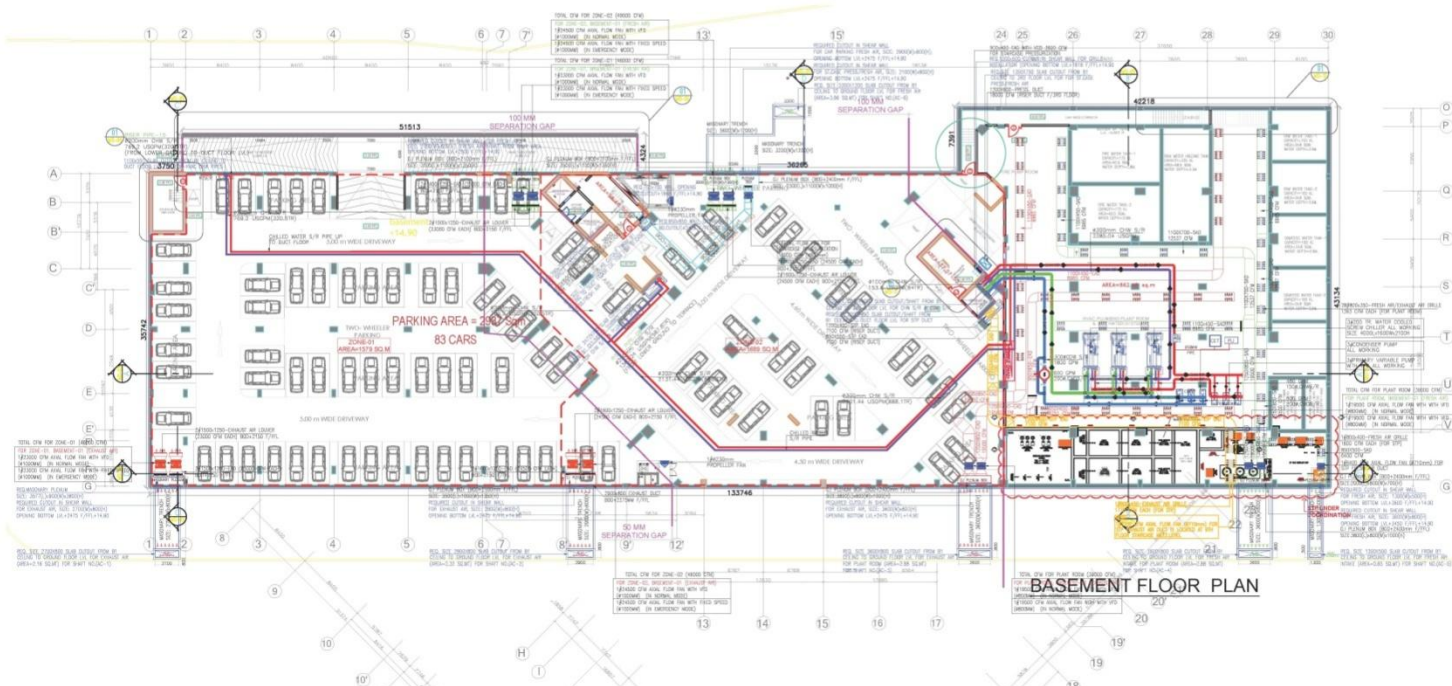
**DRAWING TITLE**  
**2ND FLOOR HVAC LAYOUT**

**DRAWING STATUS**  
**FOR TENDER**

**PROJECT NO.** - 24/024  
**DATE OF FIRST ISSUE** - 14-12-2024  
**SCALE** - 1:50  
**DRG. NO.** - AEON/JAC/T-04

**CHECKED BY**  
**P. JAYDEVI**  
**DATE** - 14-12-2024  
**SCALE** - 1:50  
**DRG. NO.** - AEON/JAC/T-04





**BASEMENT FLOOR PLAN**

SYMBOL	DESCRIPTION
[Symbol]	ACQUATIC TUBE
[Symbol]	CLEARING
[Symbol]	DUCT EXPANSION
[Symbol]	TRAP
[Symbol]	AIR SEPARATOR
[Symbol]	PRESSURIZATION UNIT
[Symbol]	CONDENSATE WATER
[Symbol]	SUPPLY/RETURN PIPE
[Symbol]	TRAP
[Symbol]	SUPPLY/RETURN PIPE

HVAC LEGEND	
[Symbol]	FRESH/SUPPLY AIR DUCT
[Symbol]	EXHAUST AIR DUCT
[Symbol]	FRESH AIR DUCT
[Symbol]	EXHAUST AIR DUCT
[Symbol]	PRESSURIZATION AIR DUCT
[Symbol]	STP EXHAUST AIR DUCT
[Symbol]	FRESH AIR EXHAUST AIR AXIAL FLOW FAN
[Symbol]	HVAC SHAFT
[Symbol]	HVAC WISBAY TRENCH

**NORTH DIRECTION**

**GENERAL TECHNICAL NOTES TO BE FOLLOWED AT ALL INSTANCES**

**1. SITE & SUBMISSIONS**

The site is to be located along Sector 14, Township 24 North, Range 18 East, and Range 19 North in the City of Bangalore, Karnataka. The site is bounded by Sector 14 to the North, Range 18 East to the East, and Range 19 North to the South. The site is situated in a residential area. The site is bounded by Sector 14 to the North, Range 18 East to the East, and Range 19 North to the South. The site is situated in a residential area.

**2. DESIGN**

The design is to be prepared as per the attached drawings and specifications. The design is to be prepared as per the attached drawings and specifications. The design is to be prepared as per the attached drawings and specifications. The design is to be prepared as per the attached drawings and specifications.

**3. MATERIALS**

All materials to be used in the construction shall be of the highest quality and shall conform to the specifications of the Indian Standards. All materials to be used in the construction shall be of the highest quality and shall conform to the specifications of the Indian Standards.

**4. CONSTRUCTION**

The construction shall be carried out in accordance with the approved drawings and specifications. The construction shall be carried out in accordance with the approved drawings and specifications. The construction shall be carried out in accordance with the approved drawings and specifications.

**5. MAINTENANCE**

The owner shall be responsible for the maintenance and repair of the building. The owner shall be responsible for the maintenance and repair of the building. The owner shall be responsible for the maintenance and repair of the building.

**6. OTHER NOTES**

The drawings are to be read in conjunction with the specifications. The drawings are to be read in conjunction with the specifications. The drawings are to be read in conjunction with the specifications.

**REVISIONS**

NO.	DATE	DESCRIPTION
01	24/12/20	ISSUED AS PER NEW ARCHITECT LAYOUT
02	15/01/21	ISSUED FOR APPROVAL

**PREPARED BY:** ARCHITECT

**CHECKED BY:** ARCHITECT

**PROJECT MANAGER:** ARCHITECT

**CLIENT:** SWOSTI PREMIUM LIMITED

**PROJECT:** GOPALPUR PALM RESORT

**OWNER/PROJECTOR:** SWOSTI PREMIUM LIMITED

**DRAWING TITLE:** BASEMENT FLOOR PLAN HVAC LAYOUT

**DRAWING STATUS:** TENDER DRAWING

**PROJECT NO.:** 34/2021

**DATE OF FIRST ISSUE:** 24/12/2020

**SCALE:** AS SHOWN

**CHECKED BY:** ARCHITECT

**SECTION-4-FINANCIALPROPOSALSUBMISSIONFORM**

**(To be submitted in separate sealed Envelop)**

{Location,Date}

To

The General Manager (Communications)  
Swosti Premium Ltd.  
Gopalpur Palm Resort Project  
Email: [gm.communications@swostihotels.com](mailto:gm.communications@swostihotels.com)

Dear Sirs:

We, the undersigned, offer to provide the construction services for "Construction of B+G+9 Storied Gopalpur Palm Resort – Supply, Installation, Testing & Commissioning of HVAC-Low Side and Allied Works at Gopalpur Palm Resort for Swosti Premium Ltd., Gopalpur, Ganjam, on a Item Rate Contract Basis", in accordance with your Request for Proposal dated \_\_\_\_\_ and our Technical Proposal.

"We here by certify that we have taken steps to ensure that no person acting for us or on our behalf will engage in bribery. We undertake that, in competing for (and, if the award is made to us,in executing) the above contract, we will strictly observe the laws against fraud and corruption in force in India namely "Prevention of Corruption Act,1988(as updated from time to time)."

Our attached Financial Proposal is for the amount of {Indicate the corresponding to the amount(s) currency(ies)}{Insert amount(s) in words and figures}, "excluding" of all indirect local taxes as in the Data Sheet. The estimated amount of local indirect taxes is {Insert currency} {Insert amount in words and figures} which shall be confirmed or adjusted, if needed, during ne gotiations. {Please note that all amounts shall be the same as indicated above.

Our Financial Proposal shall be binding upon us subject to the modifications resulting from Contract negotiations, up to expiration of the validity period of the Proposal, i.e. before the date indicated in the Data Sheet.

We understand you are not bound to accept any Proposal you receive.

We remain,

Yours sincerely,

Authorized Signature {In full and initials}:\_\_\_\_\_ Name and Title of Signatory:\_\_\_\_\_

In the capacity of:\_\_\_\_\_

Address:\_\_\_\_\_

E-mail:

**DETAILED BOQ FOR HVAC –LOWSIDE COMPONENT & INSTALLATION & Allied Services**

S. No.	Description of Items	Unit	Qty	Rate (INR)	Amount (INR)
<b>A.</b>	<b>EQUIPMENT</b>				
1	Supplying, installing, testing and commissioning of 50 mm thick double skin construction <b>Eurovent/ AHRI certified Air Handling Units</b> comprising of following: <b>(Floor Mounted )</b>				
	EC fan section shall be equipped with a Single Inlet Centrifugal Impeller with High Efficiency Backward curved blades (Plug Fan) and external rotor EC (Electronically Commutated) motor, energy optimized for operation without spiral housing for high efficiency and favorable acoustic behavior. Impeller: The high efficiency backward curved impeller made of welded aluminium sheet/ high performance composite material, with external rotor motor balanced together statically and dynamically according to DIN ISO 1940. The EC fan should be capable of being fitted in horizontal or vertical position in the AHU, depending on the application.				
	Pre filter (MERV 8) and fine filter (MERV-14) on independent frame at supply air stream. Velocity across filter section shall not exceed 500 FPM.				
	All AHU with 6 row deep cooling coil unless specified otherwise. SS 304 construction end plates to be provided. UVGI space provision to be provided across the coil, necessary space, power provision shall be provided so that later can install UVGI as per requirement. Coil shall be provided with hydrophilic coating.				
	The minimum efficiency class of the motor shall be equivalent to IE-4. The motor shall be Permanent magnet external rotor motor with integrated electronics and suitable for continuous operation. The speed of the motor shall be varied with an external 0-10V/ PWM control signal. The fan in totality shall be of most efficient type so that the power Consumption and noise level is minimal. The motor shall be minimum IP54 protection class.				
	DDC Controller module <b>(Digital display- HDMI 7 Inch Touch Screen)</b> with RS 485 port compatible with BMS, on board protocol following 1. EC fan operation status 2. Chilled water valve operation status 3. AHU Airflow ( CFM) to monitor the fan status 4. AHU power consumption 5. EC Fan On/Off status 6. EC Fan parameters 7. Controller shall also have fire trip alarm to shut AHU incase of signal from fire panel 8. UVC Status				

	<p>Instrumentation Kit to be provided to give out the following option</p> <ol style="list-style-type: none"> <li>1. Supply air temperature sensor</li> <li>2. Return air temperature &amp; RH Sensor</li> <li>3. Chilled water in temperature</li> <li>4. Chilled water out temperatue</li> <li>5. DP switch across filter for filter clog</li> <li>6.CO2 measuremnt sensor in return air temp.</li> <li>7.AHU Chilled Water Control</li> <li>8. 2 way chilled water modulating control</li> </ol>				
	<p>Minimum 40 mm (WC) external static pressure shall be considered. However, actual total static pressure shall be calculated and confirmed by the vendor at the time of bidding.The Maximum Static not more than 70 mm WG and AHU sound level not exceed 60 dba @1 mtr. Contractor to add sound attenuator in the supply/return air duct incase the desired sound criteria is not met and can propose thermo acoustic panel if required. Fan outlet velocity not exceeding 10 mps.</p>				
	<p>From electrical panel there shall be single input to Single AHU terminal box. All necessary internal wiring from Terminal Box to multiple direct drive motors provided by AHU vendor. Electrical panel shall be provided on the AHU casing as per the specifications.</p>				
	<p>AHU's shall be provided with mixing box with thermal brake profile as per listed below</p>				
	<p>Unit shall be certified as per AHRI 1350. Following is mandatory.</p> <ol style="list-style-type: none"> <li>1) Leakage Class - CL1</li> <li>2) Thermal Class - CT2</li> <li>3) Thermal bridge - CB2</li> <li>4) Casing deflection - CD4</li> </ol>				
	<p>Supply and Installation of 19 mm thick Neoprene Rubber Waffle Type Pads to be installed between the floor and the Air Handling Units. The neoprene pads shall be in accordance with the manufacturer's instructions for the size and weight distribution of the equipment supported.</p> <p>Supply and Installation of Fire Resistant Fabric Flexible Connection to be installed between the Fans and the ducting to provide flexibilty of movement in case of a seismic event and to prevent transmission of vibration from the unit to the duct. The fabric should be of glassfiber with a silicon silicon coating and extruded metal flanges. The fabric should conform to BS 476 Part 7 Class 1 and NFPA 701.</p>				
	<p>Smart AHU built in electrical shall be provided by AHU OEM. Following is required from the Contractor</p> <ol style="list-style-type: none"> <li>1. Incomer &amp; terminating into Electrical Panel with suitable cables, earthings, cable trays shall be provided by Main Electrical Contractor.</li> <li>2. Control wiring from unit mounted Panel to fire damper actuators/ damper panel with suitable incoming/ outgoing MCB/MCCB.</li> </ol>				

3. Wiring with transformer for suitable output to 2 way modulating valve													
The desired rating of AHU shall be as follows:													
	AH U Tag	Area of Operation	Floor	CFM	TR	Staic Pressure (MM WG)	Recom mende d mini motor ( kW)	Mixing Box with TBF					
i	FM AH U-1	Lobby, Corridor	Ground Floor	8000	14	50-55	11	Yes	No	1			
ii	FM AH U-2	Banquet1	First Floor	7000	21	50-55	3.7	Yes	No	1			
iii	FM AH U-3	Banquet2	First Floor	7000	21	50-55	3.7	Yes	No	1			
iv	FM AH U-4	Prefunction 1	First Floor	5000	11	50-55	3.7	Yes	No	1			
v	FM AH U-5	Prefunction 2	First Floor	5000	11	50-55	3.7	Yes	No	1			
vi	FM AH U-6	Kids Play Corridor Lobby (triple height), Banquet Office	First Floor	7500	19	50-55	5.5	Yes	No	1			
vii	FM AH U-7	Service Station, All Dining	First Floor	9000	27	50-55	3.7	Yes	No	1			
viii	FM AH U-8	Main Kitchen	First Floor	6500	13	50-55	3.7	Yes	No	1			
ix	FM AH U-9	Gym & Spa	Seco nd Floor	7000	12	50-55	3.7	Yes	No	1			
x	FM AH U-10	Meetin g Room	Seco nd Floor	3500	13	50-55	2.2	Yes	No	1			
xi	FM AH	Meetin g Room	Seco nd	3500	13	50-55	2.2	Yes	No	1			

	U-11		Floor									
xii	FM AH U-12	Prefunction	Second Floor	15000	25	50-55	11	Yes	No	1		
2	Supplying, installing, testing and commissioning of <b>48±2 mm thick</b> double skin construction Air Handling Units comprising of following: <b>(Ceiling Mounted)</b>											
	The housing shall be so made that it can be delivered at site in total/semi- knocked down conditions depending upon the requirements. The main framework shall be extruded aluminum structural sections with 48 + 2mm thick Thermo-acoustic panel. Thermo-acoustic panel shall be comprising of 23+ 2mm thick thermal insulation of 40 Kg/Cu.M density PU foam injected between 0.6 mm pre-coated GI outer sheet & 0.6mm plain GI intermediate sheet, followed by laminated tissue paper glass wool insulation of 25+2 mm thickness having 70-80 Kg/Cu.M density sandwiched between intermediate sheet and inner skin of 0.8mm perforated GI sheet. The entire framework shall be assembled using mechanical joints to make a sturdy and strong framework for various sections. Entire framework shall be made of extruded aluminum profile.											
	EC fan section shall be equipped with a Single Inlet Centrifugal Impeller with High Efficiency Backward curved blades (Plug Fan) and external rotor EC (Electronically Commutated) motor, energy optimized for operation without spiral housing for high efficiency and favorable acoustic behavior. Impeller: The high efficiency backward curved impeller made of welded aluminium sheet/ high performance composite material, with external rotor motor balanced together statically and dynamically according to DIN ISO 1940. The EC fan should be capable of being fitted in horizontal or vertical position in the AHU, depending on the application.											
	Pre filter (MERV 8) and fine filter (MERV-14) on independent frame at supply air stream. Velocity across filter section shall not exceed 500 FPM.											
	All AHU with 4 row deep cooling coil unless specified otherwise. SS 304 construction end plates to be provided. UVGI space provision to be provided across the coil, necessary space, power provision shall be provided so that later can install UVGI as per requirement.. Coil shall be provided with hydrophilic coating.											
	The minimum efficiency class of the motor shall be equivalent to IE4. The motor shall be Permanent magnet external rotor motor with integrated electronics and suitable for continuous operation. The speed of the motor shall be varied with an external 0-10V/ PWM control signal. The fan in totality shall be of most efficient type so that the power Consumption and noise level is minimal. The motor shall be minimum IP54 protection class.											

<p>DDC Controller module (<b>Digital display- HDMI 7 Inch Touch Screen</b>) with RS 485 port compatible with BMS, on board protocol following</p> <ol style="list-style-type: none"> <li>1. EC fan operation status</li> <li>2. Chilled water valve operation status</li> <li>3. AHU Airflow ( CFM) to monitor the fan status</li> <li>4. AHU power consumption</li> <li>5. EC Fan On/Off status</li> <li>6. EC Fan parameters</li> <li>7. Controller shall also have fire trip alarm to shut AHU in case of signal from fire panel</li> <li>8. UVC Status</li> </ol>				
<p>Instrumentation Kit to be provided to give out the following option:</p> <ol style="list-style-type: none"> <li>1. Supply air temperature &amp; RH Sensor</li> <li>2. Return air temperature &amp; RH Sensor</li> <li>3. Chilled water in temperature</li> <li>4. Chilled water out temperature</li> <li>5. DP switch across filter for filter clog</li> <li>6. CO2 measurement sensor in return air temp.</li> <li>7. AHU Chilled Water Control</li> <li>8. Motorized fresh air damper command</li> <li>9. 2 way chilled water modulating control</li> </ol>				
<p>All AHU are ceiling suspended type complete with , vibration isolation &amp; hanging arrangement with height of unit not exceeding 500-550 mm.</p>				
<p>All AHU are ceiling suspended type complete with vibration isolation &amp; hanging arrangement with height of unit not exceeding 500-550 mm. Mixing box shall be required in below indicated units.</p>				
<p>Minimum 20 mm (WC) external static pressure shall be considered. However, actual total static pressure shall be calculated and confirmed by the vendor at the time of bidding. The Maximum Static not more than 40 MMWG and AHU sound level not exceed 60 dba @1 mtr. Contractor to add sound attenuator in the supply/return air duct in case the desired sound criteria is not met and can propose thermo acoustic panel if required. Fan outlet velocity not exceeding 10 mps.</p>				
<p>Unit shall be certified as per AHRI 1350. Following is mandatory.</p> <ol style="list-style-type: none"> <li>1) Leakage Class - CL1</li> <li>2) Thermal Class - CT2</li> <li>3) Thermal bridge - CB2</li> <li>4) Casing deflection - CD4</li> </ol>				
<p>From electrical panel there shall be single input to Single AHU terminal box. All necessary internal wiring from Terminal Box to multiple direct drive motors provided by AHU vendor. Electrical panel shall be provided on the AHU casing as per the specifications.</p>				

<p>Supply and Installation of spring hangers for all above mention CS AHU. The hangers should consist of a free-standing, laterally stable steel spring and elastomeric washer in series, assembled in a stamped or welded steel bracket with a Neoprene element at the top . The hanger bracket shall be designed to carry five times overload without failure and shall allow up to 30 degree rod misalignment without metal to metal contact. The spring should have a minimum deflection of 25 mm and Neoprene element minimum 4mm deflection.</p> <p>Supply and Installation of Fire Resistant Fabric Flexible Connection to be installed between above mention all the Fans and the ducting to provide flexibility of movement in case of a seismic event and to prevent transmission of vibration from the unit to the duct. The fabric should be of glassfiber with a silicon silicon coating and extruded metal flanges. The fabric should conform to BS 476 Part 7 Class 1 and NFPA 701.</p>												
<p>Smart AHU built in electrical shall be provided by AHU OEM. Following is required from the Contractor</p> <ol style="list-style-type: none"> <li>1. Incomer &amp; terminating into Electrical Panel with suitable cables, earthings, cable trays shall be provided by Main Electrical Contractor.</li> <li>2. Control wiring from unit mounted Panel to fire damper actuators/ damper panel with suitable incoming/ outgoing MCB/MCCB.</li> <li>3. Wiring with transformer for suitable output to 2 way modulating valve</li> </ol>												
The desired rating of AHU shall be as follows:												
	AH U Tag	Area of Operation	Floor	CFM	Mixing Box	TR	Static Pressure MMWG	Recommended mini motor (kW)				
i	CS-AH U 1	Male/Female Locker room	Ground Floor	3000	No	7	40	5.5	No	1		
ii	CS-AH U 2	Staff Reception/Staff Dining	Ground Floor	4000	No	13	40	3.75	No	1		
iii	CS-AH U 3	Corridor 1,2	Ground Floor	1800	No	4	40	1.1	No	1		
iv	CS-AH U 4	Corridor 3	Ground Floor	1800	No	4	40	1.1	No	1		
v	CS-AH U 5	Training Room	Ground Floor	1500	No	6	40	1.1	No	1		
vi	CS-AH	laundry	Ground	2500	No	5	40	1.1	No	1		

	U 6		Floor									
vii	CS-AH U 7	Banquet kitchen	Ground Floor	4500	No	8	40	1.1	No	1		
viii	CS-AH U 8	Corridor	Second Floor	2000	No	4	40	1.1	No	1		
ix	CS-AH U 9	Food Prep Area	Second Floor	1600	No	2.5	40	1.1	No	1		
3												
Supply, installation, testing and commissioning of double skin construction with 50 mm thick panel <b>Dedicated Outdoor Air System ( DOAS)</b> comprising of following :												
Unit shall be certified as per AHRI 1350. Following is mandatory.												
1) Leakage Class - CL1												
2) Thermal Class - CT2												
3) Thermal bridge - CB2												
4) Casing deflection - CD4												
<b>A. Supply air Section</b>												
Pre filter (G 4) washable type, ESP FILTER (Merv 14) in supply air stream . Filters shall be sized for air velocity of 500 fpm. UVGI lamp downstream of cooling coil.												
EC fan section shall be equipped with a Single Inlet Centrifugal Impeller with High Efficiency Backward curved blades (Plug Fan) and external rotor EC (Electronically Commutated) motor, energy optimized for operation without spiral housing for high efficiency and favorable acoustic behavior. Impeller: The high efficiency backward curved impeller made of welded aluminium sheet/ high performance composite material, with external rotor motor balanced together statically and dynamically according to DIN ISO 1940. The EC fan should be capable of being fitted in horizontal or vertical position in the AHU, depending on the application.												
Enthalpy wheel for heat recovery placed between outdoor air and exhaust air streams with total efficiency>75%. Enthalpy wheel velocity shall not exceed 700 FPM on supply air volume.												
8 row deep cooling coil sized for air velocity of 500 fpm & 3 row deep heating coil, SS 304 construction end plates to be provided												
Minimum 30 mm (WC) external static pressure shall be considered. However, actual total static pressure shall be calculated and confirmed by the vendor at the time of bidding.The Maximum Static not more than 80 mm in Supply air side and 50mm in exhaust air side.												
<b>B. Return air Section</b>												
Pre filter (MERV 8) in return air stream and sized for air velocity of 500 fpm.												

<p>EC fan section shall be equipped with a Single Inlet Centrifugal Impeller with High Efficiency Backward curved blades (Plug Fan) and external rotor EC (Electronically Commutated) motor, energy optimized for operation without spiral housing for high efficiency and favorable acoustic behavior. Impeller: The high efficiency backward curved impeller made of welded aluminium sheet/ high performance composite material, with external rotor motor balanced together statically and dynamically according to DIN ISO 1940. The EC fan should be capable of being fitted in horizontal or vertical position in the AHU, depending on the application.</p>				
<p>Minimum 30 mm (WC) external static pressure shall be considered. However, actual total static pressure shall be calculated and confirmed by the vendor at the time of bidding. The Maximum Static not more than 80 mm in Supply air side and 50mm in exhaust air side.</p>				
<p>The minimum efficiency class of the motor shall be equivalent to IE3. The motor shall be Permanent magnet external rotor motor with integrated electronics and suitable for continuous operation. The speed of the motor shall be varied with an external 0-10V/ PWM control signal. The fan in totality shall be of most efficient type so that the power Consumption and noise level is minimal. The motor shall be minimum IP54 protection class.</p>				
<p>DDC Controller module (<b>Digital display- HDMI 7 Inch Touch Screen</b>) with RS 485 port compatible with BMS, on board protocol following</p> <ol style="list-style-type: none"> <li>1. EC fan operation status</li> <li>2. Chilled water valve operation status</li> <li>4. DOAS Airflow ( CFM) to monitor the fan status</li> <li>5. DOAS power consumption</li> <li>6. EC Fan On/Off status</li> <li>7. EC Fan parameters</li> <li>8. Controller shall also have fire trip alarm to shut DOAS in case of signal from fire panel</li> <li>9. UVC Status</li> <li>10 HRW status</li> </ol>				
<p>Instrumentation Kit to be provided to give out the following option</p> <ol style="list-style-type: none"> <li>1. Supply air temperature sensor</li> <li>2. Return air temperature &amp; RH Sensor</li> <li>3. Chilled water in temperature</li> <li>4. Chilled water out temperature</li> <li>5. DP switch across filter for filters clog</li> <li>6. CO2 measurement sensor in return air temp.</li> <li>7. AHU Chilled Water Control</li> <li>8. 2 way chilled water modulating control</li> </ol>				
<p>Smart DOAS built in electrical shall be provided by DOAS OEM. Following is required from the Contractor</p> <ol style="list-style-type: none"> <li>1. Incomer &amp; terminating into Electrical Panel with suitable cables, earthings, cable trays shall be provided by Main Electrical Contractor.</li> </ol>				

	2. Control wiring from unit mounted Panel to fire damper actuators/ damper panel with suitable incoming/ outgoing MCB/MCCB. 3. Wiring with transformer for suitable output to 2 way modulating valve											
<b>C.</b>	<b>General</b>											
	The DOAS shall be designed for receiving exhaust air temperature of 77 F DBT & 60% RH during summer & monsoon conditions. For ambient air conditions, refer Design basis in tender specifications.											
	The rating shall be as follows:											
	<b>Eq uip me nt Tag</b>	<b>Space</b>	<b>Equip ment Locat ion</b>	<b>SA CFM</b>	<b>RA CF M</b>	<b>TR</b>	<b>SP(MM )</b>	<b>Motor Rating Supply/ Return</b>				
i	DO AS	4th to 9th Floor	Terra ce	1400 0	450 0	147	70/60	22.2 KW/3.7 KW	No	1		
ii	DO AS	4th to 9th Floor	Terra ce	1270 0	450 0	134	70/60	22.2 KW/3.7 KW	No	1		
<b>4</b>	Supplying, installing, testing and commissioning of vertical / horizontal blow through type Eurovent/ AHRI certified <b>Fan Coil Units (2 Pipe)</b> withwith 3 row deep chilled water coil and 2/1 row deep heating water coil , 3-speed, BLDC motor, centrifugal fans, cleanable fabric filters, main condensate drain pans duly extended to over valve assembly, acoustically lined casing, wiring, control wiring in conduit upto thermostat boxes. All fan coil units shall be suitable for 220 ± 6% volts, 50 cycles, single phase power supply. Fan Coil Units shall be of following refrigeration capacities as listed.											
	Following to be included											
	a)External Static pressure shall be 50Pa as per site requirement.											
	b) Return air temp to be considered as 23+ 1 Deg C. FCU coil to be selected accordingly. Capacity of FCU are actual requirement, Contractor to quote the price accordingly.											
	c) Chilled water circuit-FCUs shall be provided with Valve station comprising of 3 No. Ball valve, Y Strainers with drain cock, modulating type two way pressure independent dynamic control& balancing valve with spring return feature, Set of flexible connectors mini 500mm long. FCU Kit should have minimum 3 Years of warranty. All additional items required for such modulating actuator functionality shall be part of this scope.											
i	1.0 TR refrigeration capacity								No	36		
ii	1.5 TR refrigeration capacity								No	146		
iii	2.0 TR refrigeration capacity								No	2		
iv	2.5 TR refrigeration capacity								No	16		
v	3.0 TR refrigeration capacity								No	1		

9	Supplying, installing, testing and commissioning of <b>Smoke extractionAxial fans</b> as per specifications. Fan shall be with direct driven Tube axial fan. The fan shall be equipped with mounting bracket, fire rated flexible connection. Cost of spring isolators for the installation of the fans needs to be included.										
	The motor shall be Class H rating and suitable for 415±10% volts 3 phase 50 cycles, AC supply. The motor selected shall be IE3 efficiency at full load. Fan shall be selected for minimum efficiency of 65-70%.										
	Fan and casing shall be suitable for normal & smoke exhaust application. Motor shall be mounted inside the fan casing & thermally rated for 250 Deg C for 2 hour as per [BS-7346 Part-2 : 1090]										
	Total static pressure shall be check by vendor. Fan shall be AMCA certified for sound and air performanance.										
	Fan shall be selected for lower noise level and shall not exceed 70 DB (A) at 3m distance from the fan. Required size sound attenuator to be provided to achieve desired noise level.										
	Fan used in case of fire can be selected for higher outlet velocity as sound is not criteria while selecting.										
	STP exhaust fan motor shall be spark proof.										
	The fan capacities shall be as follows:										
	<b>Eq uip me nt Tag</b>	<b>Space</b>	<b>Loca tion</b>	<b>CF M</b>	<b>Stati c Pres s. MM WG</b>	<b>Motor kW</b>	<b>VFD( Yes /No)</b>				
i	EA 1	Pre-function1 & 2	Seco nd Floor	150 00	25	7.5	Yes	No.	1		
ii	EA 3	Lobby & kids Play	Seco nd Floor	300 00	25	15	Yes	No.	1		
iii	EA 5	Meeting Room	Seco nd Floor	170 00	25	11	Yes	No.	1		
iv	EA 6	GYM & SPA	Seco nd Floor	105 00	25	5.5	Yes	No.	1		
v	EA 7	All dining & service Area	First Floor	175 00	25	11	Yes	No.	1		
vi	EA 8	PreFunction -1 & 2	Grou nd Floor	210 00	25	11	Yes	No.	2		
vii	EA 9	PreFunction -1 & 2	Grou nd Floor	162 50	25	11	Yes	No.	2		
viii	EA	Staff dining	Grou	550	20	3.5	Yes	No.	1		

	10	&recreation room	nd Floor	0							
ix	EA 11	Corridor	Grou nd Floor	600 0	20	3.5	Yes	No.	1		
x	EA 12	Corridor	Grou nd Floor	700 0	20	3.5	Yes	No.	1		
xi	EA 13	Corridor	Grou nd Floor	135 00	25	7.5	Yes	No.	1		
xii	EA 13	Corridor	Terra ce	240 00	25	15	Yes	No.	1		
xiii	EA 13	Corridor	Terra ce	410 00	25	22	Yes	No.	1		
10	Supply, installation, testing & commissioning of <b>Axial Flow Fans</b> suitable for installing in both Horizontal or vertical position as per site requirement and complete with totally enclosed fan cooled motor direct drive, multi sheaved pulley, belt guard, motor mount, fire rated flexible connection and vibration isolators. The fan shall be equipped with mounting bracket. Fan capacity shall be as follows										
	Fan shall be selected for lower noise level and shall not exceed 70 DB (A) at 3m distance from the fan. Required size sound attenuator to be provided to achieve desired noise level. Fan shall be selected for minimum efficiency of 70% and also these fan will operate through VFD Fan used in case of fire can be selected for higher outlet velocity as sound is not criteria while selecting.										
	The motor shall be suitable for 415±10% volts 3 phase 50 cycles, AC supply. The motor selected shall be IE 3 efficiency .										
	Total static pressure shall be check by vendor. Fan shall be AMCA certified for sound and air performance.										
	The fan capacities shall be as follows:										
	<b>Eq uip me nt Tag</b>	<b>Space</b>	<b>Loca tion</b>	<b>CF M</b>	<b>Stati c Pres s. MM WG</b>	<b>Motor kW</b>	<b>VFD( Yes /No</b>				
i	AXF 1	Pre-function1 & 2	Seco nd Floor	150 00	25	7.5	Yes	No.	1		
ii	AXF 2	Lobby & kids Play	Seco nd Floor	300 00	25	15	Yes	No.	1		
iii	AXF 3	Meeting Room	Seco nd Floor	170 00	25	11	Yes	No.	1		
iv	AXF 4	GYM & SPA	Seco nd	105 00	25	5.5	Yes	No.	1		

			Floor									
v	AXF 5	All dining & service Area	First Floor	17500	25	11	Yes	No.	1			
vi	AXF 6,7	PreFunction -1 & 2	Ground Floor	21000	25	11	Yes	No.	2			
vii	AXF 8,9	PreFunction -1 & 2	Ground Floor	16250	25	11	Yes	No.	2			
viii	AXF 10	Staff dining & recreation room	Ground Floor	5500	25	11	Yes	No.	1			
ix	AXF 11	Corridor	Ground Floor	6000	25	3.5	Yes	No.	1			
x	AXF 12	Corridor	Ground Floor	7000	25	3.5	Yes	No.	1			
xi	AXF 13	Corridor	Ground Floor	13500	25	7.5	Yes	No.	1			
xii	AXF 14	Corridor	Terrace	24000	25	15	Yes	No.	1			
xiii	AXF 15	Corridor	Terrace	41000	25	22	Yes	No.	1			
xiv	AXF 16, 17	STP	Lower Ground Floor	7500	25	3.5	Yes	No.	2			
xv	AXF 18	Plumbing Pump Room	Lower Ground Floor	9500	25	5.5	Yes	No.	1			
xvi	AXF 19	HVAC Plant Room	Lower Ground Floor	24500	25	15	Yes	No.	1			
xvii	AXF 20, 21	Staircase2 & 3	Lower Gr Floor to Duct Floor	18000	25	11	Yes	No.	2			
xviii	AXF 22, 23	Service lift well 3 & Guest Lift Well 3	Ground Floor to Duct	12000	25	7.5	Yes	No.	2			

			Floor								
xix	AXF 24, 25, 26, 27	Service lift well 1 & 2, Guest Lift Well 1 & 2	1st Floor to Terra ce	165 00	25	11	Yes	No.	4		
xx	AXF - 29, 30	Ventilation Basement	Base ment	230 00	25	11	Yes	No.	4		
xx	AXF - 31, 32	Ventilation Basement	Base ment	245 00	25	11	Yes	No.	4		
13	Supply, installing, testing and commissioning of <b>VFD</b> suitable for HVAC application <b>with minimum IP 20</b> enclosures complying with the tender specifications and shall be complete in all respects and suitable for following motor rating and shall meet the following specifications :										
	a) The VFD shall have a dual 5% impedance DC link reactor (Harmonic filters) on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating.										
	b) All the VFD's should have factory fitted IP20 enclosure protection										
	c) EMC filters, C1/C2 Category, Drive should support at least 3/2 PID loops are required										
	d) Panel space and wiring shall be included under Electrical Panel section										
	e) Temperature sensor and wiring shall be included in the cost (for the VFDs to be used in the Plant rooms)										
	<b>Description</b>						<b>Motor kW</b>				
	Axial Fans For Fresh Air & Exhaust						22.5	No.	2		
							15	No.	5		
i							11	No.	11		
ii							7.5	No.	5		
iii							5.5	No.	3		
iv							3.7	No.	6		
v							2.2	No.	R/o		
vi							1.1	No.	R/o		
vii	DOAS						22.2	No.	2		
viii							18.5	No.	2		
xi	Cooling Tower						7.5	No.	3		

15	Supplying, installing, testing and commissioning of double skin construction <b>Fan sections</b> (made out of 25mm thick panel) complete with internally mounted motor, fan belt drive, flexible connection, vibrations isolators and complete with following:										
	TEFC Motors suitable for 415 ± 10% volts, 50 Hz, AC supply and IE 3 efficiency. The maximum rating is specified below and contractor can select a lower rating motor incase the desired performance is being met.										
	Forward curved fan inside double skin housing with efficiency not less than 70%.										
	Minimum 15-20 mm (WC) external static pressure shall be considered. However, actual total static pressure shall be calculated and confirmed by the vendor at the time of bidding. Height of the unit shall not exceed 550mm, contractor to select the no. of fans accordingly. Fresh air Fan shall be provided with pre filters of MERV-8. Fan used for fire shall motor outside the smoke stream, fire rating to be accounted.										
	FA : Fresh Air Fan , EA : Exhaust Air Fan										
	The rating of fan sections shall be as follows:										
	<b>Fan Tag</b>	<b>Space</b>	<b>Location</b>	<b>CFM</b>	<b>Total SP (mmwg)</b>	<b>Motor kW</b>	<b>Fire Rated</b>				
i	FA 01	Staff Kitchen	Ground Floor	3500	25	2.2	No	No.	1		
ii	FA 02	Bankquet Kitchen	Ground Floor	1950	25	11	No	No.	1		
iii	FA 03	Main Kitchen	First Floor	1450	25	7.5	No	No.	1		
iv	FA 05	Setelite Kitchen	Second Floor	3000	25	2.2	No	No.	1		
v	FA 06	Roof top Kitchen	Roof Floor	5500	25	3.7	No	No.	1		
vi	EA 07	Toilet Exhaust	Gr, 1st & 2nd Floor	7000	25	3.75	No	No.	1		
vii	EA 09	BOH Exhaust	Ground Floor	5000	25	3.75	No	No.	1		
viii	EA 09	BOH Exhaust	Ground Floor	2000	25	2.2	No	No.	1		
ix	EA	laundar	Grou	6000	25	3.75	No	No.	1		

	09	y	nd Floor							
16	<p>Supplying, installing, testing and commissioning of <b>SILENT MIXED FLOW INLINE FANS</b> suitable for installing in any position in vertical or horizontal ducts. Constructed with sheet steel with epoxy polyester paint, acoustic insulation within the outer shell. Two speed motor (IP 44 Rated) with removable fan body with two speed motor, single phase speed controllable class F external rotor motor with capacitor and thermal protection. All units shall be complete with duct flexible connector, speed regulator (with wiring of 3 m included between fan &amp; regulator) and volume control damper and static pressure or to suit the system, shall be as follows:</p>									
	<p>The sound level shall be measured at three metre distance. Actual static to be checked by the vendor during the shop drawings</p>									
	<b>CFM</b>		<b>Noise Level (dB) A</b>		<b>SP MM WG</b>					
i	501-800		35-40		15-20			No.	2	
ii	801-1000		35-40		15-20			No.	1	
iii	1201-1600		35-40		15-20			No.	4	
	<p>Supply, Installation, Testing and Commissioning of <b>Dry Scrubber</b> each comprising of extract air intake section, electrostatic precipitation technology, dry type air cleaner to remove oil, smoke and fumes from exhaust air, as per the Specifications :</p>									
	<p>The unit shall be integrated &amp; connected with centrifugal fan for kitchen including all necessary accessories to complete the installation.</p>									
	<p>Supply, Installation, Testing and Commissioning of Kitchen ventilation system comprising of following items :</p>									
	<p>SISW class I backward curved centrifugal fans for ventilation system. Each fan shall be complete with totally enclosed fan cooled motor, belt drive, pulley mounted on motor (IE3) &amp; fan shaft, belt guard, motor mount and vibration isolators. The motor shall be suitable for 415±10% volts 3 phase 50 cycles, AC supply. The motor selected shall be energy efficient having efficiency at full load ranging between 82.5% to 92% in accordance with motor rating as per specification. External static pressure shall be 25-30 mm (WC) minimum and Total static pressure shall be check by vendor.</p>									
	<p>Dry Scrubber each comprising of extract air intake section, electrostatic precipitation technology, dry type air cleaner to remove oil, smoke and fumes from exhaust air, as per the Specifications :</p>									

The unit shall be integrated & connected with centrifugal SISW fan for kitchen including all necessary accessories to complete the installation. Fan capacities shall be as follows:									
Fan capacities shall be as follows:									
	Equip ment Tag	Space	Equipme nt Location	CFM	Motor kW				
i	SC-01	Kitchen	Ground Floor	4100	2.2	No	1		
ii	SC-02	Bankqu et Kitchen	Ground Floor	23000	11	No	1		
iii	SC-03	Kitchen	First Floor	17000	7.5	No	1		
iv	SC-05	Kitchen	Second Floor	3600	2.2	No	1		
v	SC-06	Kitchen	Roof Floor	6400	3.7	No	1		
<b>TOTAL CARRIED TO SUMMARY</b>									
<b>B</b>	<b>Piping- Chilled Water</b>								
1	Providing & fixing the following factory rolled MS pipes with specified wall thickness cut to required lengths and installed with all welded / grooved joints, providing and fixing in position necessary fittings like bends, elbows, tees, reducers, mating flanges & sockets for BAS, fabricated to size and shape in workshop or brought out ready made where available of acceptable quality.								
	Note:- The Pipes of sizes 150mm & below shall be M.S. 'C' class as per IS : 1239 and pipes size above 150mm shall be welded black steel pipe heavy class as per IS: 3589, from minimum 7 mm thick M.S. Sheet for pipes upto 150 mm dia. and from minimum 8 mm thick MS sheet for pipes of 200 mm dia and above.								
i	MS pipes of 300 mm dia					RM	R/o		
ii	MS pipes of 250 mm dia					RM	365		
iii	MS pipes of 200 mm dia					RM	90		
2	Supplying and fixing <b>MS class 'C'</b> pipes cut to required lengths and complete with welded joints. Quoted price shall include providing and fixing in position fittings, elbows, tees, reducers, expanders, mating flanges & sockets for Building Automation System as required.. The pipes shall be of following sizes:								
i	MS pipes of 150 mm dia					RM	90		
ii	MS pipes of 125 mm dia					RM	95		
iii	MS pipes of 100 mm dia					RM	70		
iv	MS pipes of 80 mm dia					RM	35		
v	MS pipes of 65 mm dia					RM	28		
vi	MS pipes of 50 mm dia					RM	412		
vii	MS pipes of 40 mm dia					RM	244		

viii	MS pipes of 32 mm dia	RM	252		
ix	MS pipes of 25 mm dia	RM	1192		
x	MS pipes of 20 mm dia	RM	740		
<b>3</b>	Supplying, laying/ fixing, testing and commissioning of following nominal size of <b>Condensor water pipe</b> of following size inside the plant room (with necessary clamps, vibration isolators and fittings but excluding valves, strainers, gauges etc.)				
	<b>Note:-</b> The pipes of sizes 150 mm and below shall be M.S 'C' class as per IS:1239 and pipes size above 150 mm shall be welded black steel pipe heavy class as per IS: 3589, from minimum 6335 mm 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.				
i	300 mm Dia	RM	88		
ii	250 mm Dia	RM	R/o		
iii	200 mm Dia	RM	109		
iv	150 mm Dia	RM	R/o		
v	100 mm Dia	RM	38		
vi	65 mm Dia	RM	62		
<b>4</b>	<b>Condensor Drain GI Pipe</b>				
	Supply, installation, testing and commissioning of Class "B" GI ,complete with fittings, supports,U trap arrangement,Clean Plug and accessories for AHU/AIR WASHER/ SCRUBBER as per specifications, drawings.				
i	50 mm Dia	RM	60		
ii	40 mm Dia	RM	R/o		
iii	32 mm Dia	RM	30		
iv	25 mm Dia	RM	55		
v	20 mm Dia	RM	68		
<b>5</b>	Supplying, fixing, testing & commissioning of <b>Butterfly Valve</b> for chilled water/condensor circulation, with C.I body SS disc nitrile sheet & O- ring & PN-16 pressure rating as specified. Chilled water valve shall be insulated with the same material as of pipe insulation material.				
i	250 mm dia	No.	3		
ii	200 mm dia	No.	24		
iii	150 mm dia	No.	12		
iv	125 mm dia	No.	4		
vii	65 mm dia	No.	5		
viii	50 mm dia	No.	10		
viii	40 mm dia	No.	10		
viii	32 mm dia	No.	16		

6	Supplying, installing and fixing in position Lug type <b>Motorised butterfly</b> valves of PN 16 rating and suitable for following pipe sizes. Price shall include the cost of Insulation, material and external treatment will be same as of pipe :				
i	Valves of 150 mm dia	No.	6		
ii	Valves of 200 mm dia	No.	9		
7	Supplying, installing and fixing in position <b>balancing valves</b> of PN 16 rating and suitable for following pipe sizes:				
i	Valves of 150 mm dia	No.	6		
ii	Valves of 200 mm dia	No.	9		
8	Supplying, installing and fixing in position <b>Ball valves</b> of PN 16 rating and suitable for following pipe sizes:				
i	Valves of 40 mm dia	No.	5		
ii	Valves of 32 mm dia	No.	6		
iii	Valves of 25 mm dia	No.	10		
9	Supplying, installing and fixing in position <b>Y Strainers</b> of PN 16 rating and suitable for following pipe sizes:				
i	Valves of 200 mm dia	No.	3		
iii	Valves of 150 mm dia	No.	3		
iii	Valves of 65 mm dia	No.	2		
iv	Valves of 50 mm dia	No.	5		
v	Valves of 40 mm dia	No.	5		
vi	Valves of 32 mm dia	No.	8		
10	Supply, installation, testing and commissioning of <b>Digital cooling thermostats</b> to be installed for controllig air handling units & fan coil units as described elsewhere in BOQ.				
i	Proportional cooling thermostat for controlling AHU.	No.	22		
11	Supplying, installing and fixing in position <b>Auto air vent</b> sof PN 16 rating.	No.	33		
12	Supplying, installing and fixing in position industrial type SS 304 construction <b>Pressure gauges</b> with gun metal including GI nipple valves.	No.	68		
14	Supplying, installing and fixing in position mercury-in- glass industrial type SS 304 construction <b>thermometers</b> within brass encasing	No.	56		

15	Supply, installing and fixing in position <b>Flexible connections</b> of required pressure rating ( PN 16) installed at pump & chiller suction & discharge and at pipes crossing building expansion joints.					
i	200 mm Dia		No.	12		
ii	150 mm Dia		No.	12		
16	Providing and fixing in position of approved make <b>Flow Switch</b> complete with copper control wiring at condenser outlet of each machine.		No.	6		
17	Supply, Installation, Testing ,& Commissioning of Ball Valve of 25 mm diameter ( <b>Drain Valve</b> ) in dirt legs complete with nipples etc. as required as per specifications.		No.	6		
18	<b>POT STRAINER:</b> having MS body, bolted cover, flanged ends, basket of stainless steel screen with 1.5 mm perforations and a permanent magnet for condenser water application complete with flanges, nuts-bolts, gaskets etc. as per specifications.					
i	200 mm Dia		No.	1		
ii	300 mm Dia		No.	1		
<b>TOTAL CARRIED TO SUMMARY</b>						
<b>C</b>	<b>AIR DISTRIBUTION</b>					
1	Supply, installation and testing of GI sheet metal ducts fabricated in factory as per SMACNA Standard and approved shop drawings. Duct shall be supported via Gripples supports as per the specifications :					
	<b>Duct Size</b>		<b>Recommended Gauge of GI sheet</b>			
i	1 - 900 mm		26	Sqm	3,634	
ii	901 -1200 mm		24	Sqm	1,955	
iii	1201 -1800 mm		22	Sqm	854	
iv	1801 - 2100 mm		20	Sqm	357	
v	2101 - above		18	Sqm	18	
2	Supply, installation and testing of GI sheet metal ducts Site fabricated as per IS Standard and approved shop drawings. Duct shall be supported via Gripples supports as per the specifications :					
	<b>Duct Size</b>		<b>Recommended Gauge of GI sheet</b>			
i	Upto 750mm		24	Sqm		
ii	750mm- 1500 mm		22	Sqm		

				.	196		
iii	1510 mm- 2250 mm		20	Sqm	85		
iv	above 2250 mm		18	Sqm	36		
3	Kitchen ducting 16 G thick mild steel with all accessories as per specifications. (with clean outs as per NFPA at base of vertical riser and change in direction and maximum at every 6.1 M in horizontal.			Sqm	436		
4	Supply, installation, testing and commissioning of fire paint on kitchen/Fire exhaust ducts with 2hr fire rating, complete in all respects.			Sqm	450		
5	Supply, fabrication, installation and testing the <b>flexible connections</b> constructed of fire resistant double resin sleeve as required and as per specifications.			Sqm	25		
6	Supply, installation, testing and commissioning of <b>motorised combined smoke &amp; fire damper (UL rated)</b> . The quoted price shall include control panel alongwith fire resistant inter connecting wiring and also termination of Fire alarm control wiring.						
i	Smoke & Fire Dampers.			Sqm	18		
ii	Control Panel & Wiring (including actuators)			No.	37		
7	Supply, installation, testing and commissioning of <b>motorised modulating damper</b> complete with control panel, inter connecting wiring at locations shown in approved shop drawings and as per specifications.						
i	Motorized Dampers.			Sqm	16		
ii	Control Panel & Wiring (including actuators)			No.	24		
8	Supply, installation and balancing of Extruded Aluminium construction <b>Supply air Grilles</b> with volume control dampers. The grilles will be powder coated in shade approved by Client and installed as per approved shop drawings and specifications. The grilles may be double or single louvered, adjustable or fixed as required by Client			Sqm	113		
9	Supply, installation and balancing of Extruded Aluminium construction <b>Return air Grilles</b> without volume control dampers. The grilles will be powder coated in shade approved by Client and installed as per approved shop drawings and specifications. The grilles is 0 deg/15 degdeflection 1 way with single louver.			Sqm	94		

10	Supply, installation and balancing of Extruded Aluminium construction <b>Fresh/Exhaust air Grilles</b> without volume control dampers. The grilles will be powder coated in shade approved by Client and installed as per approved shop drawings and specifications. The grilles may be double or single louvered, adjustable or fixed as required by Client	Sqm .	58		
11	Supply, installation and balancing of Extruded Aluminium construction <b>Supply/Return air Linear Grilles</b> . The grilles will be powder coated in shade approved by Client and installed as per approved shop drawings and specifications. The grilles may be double or single louvered, adjustable or fixed as required by Client with removable core. Quoted price shall be inclusive of volume control damper behind supply air collar.	Rm	540		
12	Supplying & fixing of opposed blade GI construction <b>volume control dampers</b> in Rectangular supply air duct as per approved drawings and specifications.	Sqm .	36		
13	Supply, installation, testing and balancing of Powder coated/Anodised extruded aluminium construction <b>Fresh air louvers with bird screen</b> for fresh air alongwith GI construction volume control damper.The louvers will be powder coated in shade approved by Client and installed as per approved shop drawings and specifications.	Sqm .	25		
14	Supply, installation, testing and balancing of Powder coated/Anodised extruded aluminium construction <b>Exhaust air louvers with bird screen</b> .The louvers will be powder coated in shade approved by Client and installed as per approved shop drawings and specifications.	Sqm .	23		
15	Supply, installation, testing and balancing of Powder coated/Anodised extruded aluminium construction <b>Door Transfer Grille</b> for make up/exhaust air. The grilles will be powder coated in shade approved by Client and installed as per approved shop drawings and specifications.	Sqm .	5		
16	Supply, installation, testing and commissioning of <b>Collar damper</b>	Sqm .	48		
17	Supply, installation and balancing of Extruded Aluminium construction <b>Non return Damper</b> . The NRD will be powder coated in shade approved by Client and installed as per approved shop drawings and specifications.				
i	NRD Dampers.	Sqm .	30		
	<b><i>Note:All exposed surfaces &amp; duct shall be painted in black mat finish by the HVAC contractor.</i></b>				
	<b>TOTAL CARRIED TO SUMMARY</b>				

<b>D.</b>	<b>THERMAL INSULATION</b>				
1	Supply and fixing of duct acoustic lining (Open cell nitrile rubber) with in supply and return air ducts as per specifications.				
i	15 mm thick acoustic lining	Sqm	R/o		
ii	20 mm thick acoustic lining.	Sqm	102		
2	Supply and fixing of external insulation on supply & return air ducts as per specification. Material of insulation shall be closed cell Plain crosslinkedpolyethelene/ Al foil faced Nitrile rubber as per thickness given below:				
i	Insulation of 13 mm thickness	Sqm	3448		
ii	Insulation of 19 mm thickness	Sqm	2898		
iii	Insulation of 25 mm thickness on supply & return air ducts exposed to air. Quote price shall include cost of UV protection coating on the insulation.	Sqm	550		
3	Supplying and fixing of <b>32 mm thick XLPE insulation with GC cloth</b> on chilled water piping/fittings includng valves, flanges, union etc.as per the approved shop drawings and specifications. Pipe shall be provided with 7 mil fibre cloth cladding and finished with 2- coats of Starbond coating, as per specifications.				
i	Pipes of 25 mm dia	RM	1192		
ii	Pipes of 20 mm dia	RM	740		
4	Supplying and fixing of <b>38 mm thick XLPE insulation with GC cloth</b> on chilled water piping/fittings includng valves, flanges, union etc.as per the approved shop drawings and specifications. Pipe shall be provided with 7 mil fibre cloth cladding and finished with 2- coats of Starbond coating, as per specifications.				
i	Pipes of 50 mm dia	Rm	412	1,320	5,43,840
ii	Pipes of 40 mm dia	RM	244	1,200	2,92,800
iii	Pipes of 32 mm dia	RM	252	1,120	2,82,240
5	Supplying and fixing of <b>44 mm thick XLPE insulation with GC cloth</b> on chilled water piping/fittings includng valves, flanges, union etc.as per the approved shop drawings and specifications. Pipe shall be provided with 7 mil fibre cloth cladding and finished with 2- coats of Starbond coating, as per specifications.				
i	Pipes of 125 mm dia	Rm	95		
ii	Pipes of 100 mm dia	Rm	70		
iii	Pipes of 80 mm dia	Rm	35		
iv	Pipes of 65 mm dia	Rm	28		

6	Supplying and fixing of <b>50 mm thick XLPE insulation with GC cloth</b> on chilled water piping/fittings including valves, flanges, union etc.as per the approved shop drawings and specifications. Pipe shall be provided with 7 mil fibre cloth cladding and finished with 2- coats of Starbond coating, as per specifications.				
v	Pipes of 300 mm dia	Rm	R/o		
vi	Pipes of 250 mm dia	Rm	365		
vii	Pipes of 200 mm dia	Rm	90		
viii	Pipes of 150 mm dia	Rm	90		
<b>TOTAL CARRIED TO SUMMARY</b>					
<b>E</b>	<b>ELECTRICAL INSTALLATION</b>				
<b>1</b>	<b>CONTROL PANELS FOR AHU's (IP 55 Rated)</b>				
	Design, manufacture, supply, installation, testing and commissioning of the following cubicle type, dead front, sheet steel, wall mounted control panels including anchoring into the wall, wiring, incoming, earthing& terminating into MCCB in each panel shall be provided by the electrical contractor. Control & panel cable with earthing in GI Cable tray from panel to motor shall be included in the cost and space in Panel for mounting the VFD.				
	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.				
	The panel shall include the following components & accessories.				
	a. MCCB as per the ratings given below, suitable for motor duty and able to withstand fault level of 20 KA.				
	b. DOL/SD starter as HP rating				
	c. Terminal block for power distribution as required.				
	d. Contactor, over load relay with built in single phasing protection.				
	e. Phase indicating lights and indicating light for ON status.				
	f. Digital voltmeter and digital ammeter.				
	g. 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.				
	h. 3 No. of Single Pole MCB's Shall be provided at the incoming section of the starter panel for DDC Panel , fire damper actuator & as a spare.				
	i. All starters shall be provided with suitable potential free contract for connections to the Building Automation System.				
	l. 220 / 24 V Transformer				
	The number of control panels shall be as follows.				
i	Suitable rating MPCB with DOL starter for upto 2.0 HP motor	No.	8		
i	Suitable rating MPCB with DOL starter for upto 3 HP motor	No.	2		
i	Suitable rating MPCB with DOL starter for upto 5 HP motor	No.	7		

iii	Suitable rating MPCB with S/D starter for upto 7.5 HP motor	No.	3		
vi	Suitable rating MPCB S/D starter for upto 10 HP motor	No.	1		
<b>2</b>	<b>CONTROL PANELS FOR FANS (IP 55 Rated)</b>				
	Design, manufacture, supply, installation, testing and commissioning of the following cubicle type, dead front, sheet steel, wall mounted control panels, including anchoring into the wall, wiring terminating into MCCB and copper earthing, in each panel shall be provided by the electrical contractor. Control & panel cable with earthing in GI Cable tray from panel to motor shall be included in the cost. And space in Panel for mounting the VFD				
	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.				
	The panel shall include the following components & accessories.				
	a. MCCB as per the ratings given below, suitable for motor duty and able to withstand fault level of 20 KA.				
	b. DOL/SD starter as HP rating				
	c. Terminal block for power distribution as required.				
	d. Contactor, over load relay with built in single phasing protection.				
	e. Phase indicating lights and indicating light for ON status.				
	f. Digital voltmeter and digital ammeter.				
	g. 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.				
	h. 3 No. of Single Pole MCB's Shall be provided at the incoming section of the starter panel for DDC Panel , fire damper actuator & as a spare.				
	i. All starters shall be provided with suitable potential free contract for connections to the Building Automation System.				
	j. 220 / 24 V Transformer				
	The number of control panels shall be as follows.				
i	Suitable rating MPCB with DOL starter for upto 5 HP motor	No.	7		
ii	Suitable rating MPCB with S/D starter for 7.5 HP motor	No.	4		
iii	Suitable rating MPCB with S/D starter for 10 HP motor	No.	1		
iv	Suitable rating MPCB with S/D starter for 12.5 HP motor	No.	1		
iv	Suitable rating MPCB with S/D starter for 15 HP motor	No.	R/o		
v	Suitable rating MPCB with S/D starter for 20 HP motor	No.	R/o		
vi	Suitable rating MPCB with S/D starter for 25 HP motor	No.	R/o		
vii	Suitable rating MPCB with S/D starter for 30 HP motor	No.	R/o		
viii	Suitable rating MCCB for upto 3 HP VFD motor 2.2	No.	R/o		
viii	Suitable rating MCCB for upto 5 HP VFD motor 3.3	No.	6		

ix	Suitable rating MCCB for 7.5 HP VFD motor 5.5	No.	3		
x	Suitable rating MCCB for 10 HP VFD motor 7.5	No.	5		
xi	Suitable rating MCCB for 12.5 HP VFD operated motor	No.	10		
xii	Suitable rating MCCB for 15 HP VFD operated motor	No.	1		
xiii	Suitable rating MCCB for 20 HP VFD operated motor	No.	5		
xiv	Suitable rating MCCB for 25 HP VFD operated motor	No.	R/o		
xv	Suitable rating MCCB for 30 HP VFD operated motor	No.	2		
<b>3.1.1 DOAS -1</b>					
a.	Incoming				
b.	63 amps TPN MCCB with Thermal magnetic release for SC and OL protections - 1 Set				
	96 mm x 96 mm 0-500 volt digital voltmeter with selector switches-1 set				
b.	0-100 amps digital electronic ammeter with selector switch and 125/5 amps 5VA, CL.1CTs – 1 set				
	Phase indicating light through 2 amps SP MCB -3 sets				
c.	Bus Bars				
	300 amps TPN aluminium bus bars with heat shrinkable insulation sleeve.				
<b>3.1.2 Outgoing (DOAS-1)</b>					
	1 No. Suitable rating MPCB with 30 HP Star Delta starter and outgoing feeder to Supply fan. Compartment shall contain direct operated digital electronic ammeters of 0-63 amps rang, Auto / Manual selector switch and ON / OFF trip indicating lamp with MCB 's and push button for ON / OFF status of motor - 1 set				
	Suitable rating MPCB with 1.0 HP DOL starter and outgoing feeder to Heat Recovery wheel Motor Compartment shall contain direct operated digital electronic ammeters of 0-12 amps rang, Auto / Manual selector switch and ON / OFF trip indicating lamp with MCB 's and push button for ON / OFF status of motor - 1 set.				
i	Control Panel as described above	Set	2		
<b>6 Control Panels For Scrubber For Kitchen</b>					
	Design, manufacture, supply, installation, testing and commissioning of the following cubicle type, dead front, sheet steel, wall mounted control panels including anchoring into the wall, wiring, incoming, earthing& terminating into MCCB in each panel shall be provided by the electrical contractor. Space in Panel for mounting the VFD shall be included in the price. All Outgoing feeders shall be provided with Energy Meter for VAF, PF, Power & energy with RS - 485 port equivalent to Schneider make EM6438H and all meters wired at one point for BMS compatibility.				

	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.				
	The panel shall include the following components & accessories.				
	a. MCCB as per the ratings given below, suitable for motor duty and able to withstand fault level of 20 KA.				
	b. DOL/SD starter as HP rating				
	c. Terminal block for power distribution as required.				
	d. Contactor, over load relay with built in single phasing protection.				
i					
	e. Phase indicating lights and indicating light for ON status.				
	f. Digital voltmeter and digital ammeter.				
	g. 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.				
	h. 3 No. of Single Pole MCB's Shall be provided at the incoming section of the starter panel for DDC Panel , fire damper actuator & as a spare.				
	i. All starters shall be provided with suitable potential free contract for connections to the Building Automation System.				
	j. The item includes providing emergency stop button along with NO/NC contacts / control wiring or any other accessories required to complete installation in all respects. The button shall be placed near the AHU only.				
	k. 220 / 24 V Transformer				
	The number of control panels shall be as follows:				
	1 No. Suitable rating MCCB for 3 HP VFD starter for Dry Scrubber fan				
	2 No. 6 Amp single Phase switch socket & control Cable for interlocking between scrubber& fan shall be included.				
	Control panel as described above.	Set	2		
	1 No. Suitable rating MCCB for 5 HP VFD starter for Dry Scrubber				

fan				
2 No. 6 Amp single Phase switch socket & control Cable for interlockingbetween scrubber& fan shall be included.				
Control panel as described above.	Set	2		
1 No. Suitable rating MCCB for 10 HP VFD starter for Dry Scrubber fan				
2 No. 6 Amp single Phase switch socket & control Cable for interlockingbetween scrubber& fan shall be included.				
Control panel as described above.	Set	1		
1 No. Suitable rating MCCB for 15 HP VFD starter for Dry Scrubber fan				
2 No. 6 Amp single Phase switch socket & control Cable for interlockingbetween scrubber& fan shall be included.				
Control panel as described above.	Set	1		
<b>TOTAL CARRIED TO SUMMARY</b>				

<b>SUMMARY OF FINANCIAL OFFER</b>		
<b>Financial</b>	<b>Description of Item</b>	<b>Amount (INR)</b>
A.	EQUIPMENT	
B.	PIPING- CHILLED WATER	
C.	AIR DISTRIBUTION	
D.	THERMAL INSULATION	
E.	ELECTRICAL INSTALLATION	
	<b>Grand Total</b>	
<b><u>OPERATION &amp; MAINTENANCE</u></b>		
<b>YEAR</b>	<b>OPERATION</b>	<b>ALL INCLUSIVE COMPREHENSIVE MAINTENANCE</b>
DLP		<b>Part of DLP</b>
First Year after DLP		
Second Year after DLP		
Third Year after DLP		
Fourth Year after DLP		
Fifth Year after DLP		

**SECTION 5: CONTRACT DATA, CONTRACT FORM**

**&**

**CONDITIONS OF CONTRACT**

## CONTRACT DATA

Clause	Description
<b>1. Name of Work</b>	SUPPLY, INSTALLATION, TESTING & COMMISSIONING OF HVAC-LOW SIDE AND ALLIED WORKS at Gopalpur Palm Resort – (Item Rate Contract)
<b>2. Name of the Client</b>	Swosti Group
<b>3. Client's Representative</b>	Project Management Consultant (PMC) – [Insert PMC Firm Name]
<b>4. PMC Contact Details</b>	Name: Designation: Project Manager – PMC Email: [Insert] Phone: [Insert]
<b>5. Site Location</b>	Gopalpur-on-Sea, Ganjam District, Odisha – 761002
<b>6. Scope of Work</b>	All HVAC-HIGH Side SUPPLY, INSTALLATION, TESTING & COMMISSIONING OF HVAC LOW SIDE AND ALLIED as per drawings and specifications.
<b>7. Estimated Contract Value</b>	₹ [Insert Amount] (Inclusive of all costs except GST)
<b>8. Tender Type</b>	Item Rate-Fixed Price Contract
<b>9. Contract Type</b>	Item Rate
<b>10. Time for Completion</b>	[Insert duration – e.g., 9 months] from the date of Letter of Acceptance (LoA)
<b>11. Date of Commencement</b>	Within 7 (seven) days from issuance of LoA or handing over of site, whichever is later
<b>12. Defects Liability Period (DLP)</b>	12 months from the date of issuance of Completion Certificate
<b>13. Performance Security</b>	2% of Contract Value in the form of Bank Guarantee to be submitted within 7 days of LoA
<b>14. Retention Money</b>	3% of Running Account Bills; to be released after successful completion of the Defects Liability Period
<b>15. Mobilisation Advance</b>	No
<b>16. Schedule of Payments</b>	Item-based payments linked to actual progress of works (Refer to Section – Payment Terms)
<b>17. Liquidated Damages (LD)</b>	0.2 % <b>per day</b> of the value of balance work delayed <b>beyond the stipulated date of completion</b> , subject to a <b>maximum of 10% of Contract Value</b>
<b>18. Arbitration</b>	In accordance with the Arbitration and Conciliation Act, 1996; sole arbitrator to be mutually appointed
<b>19. Governing Law and Jurisdiction</b>	Laws of India; jurisdiction: Bhubaneswar, Odisha
<b>20. Insurance</b>	Contractor to provide insurance for Works, Workmen Compensation, Equipment, and Third-Party Liability to indemnify the Client from damage/Claims arising out all such items including loss arising out of natural calamity.
<b>21. Taxes and Duties</b>	Quoted price is inclusive of all taxes and duties except GST; GST shall be paid extra as applicable
<b>22. Sub-contracting</b>	Permitted only with prior written approval of the Client / PMC

<b>Clause</b>	<b>Description</b>
<b>23. Safety &amp; Compliance</b>	Contractor to comply with safety regulations, labor laws, and site protocols
<b>24. Force Majeure</b>	As per General Conditions of Contract
<b>25. Advance Payment</b>	10% of Contract Value, against submission of Bank Guarantee of 100% of amount; recoverable in equal instalments from running bills
<b>26. Secured Advance</b>	To be considered on request

## **PAYMENT TERMS:**

### **Mobilization Advance:**

- Contractor will be paid any mobilization advance as indicated in contract data.

### **PAYMENT SCHEDULE**

The stage-wise payment to the Contractor shall be released based on the items of work executed as contained in the Bills of Quantities and rates agreed to thereto. Upon completion that item of work. Detail procedure are as below :

Preparation of R/A Bills :

- After satisfactory completion of each item of work, the bill shall be submitted with detailed measurements and invoice.
- Final bill along with no claim certificate should be submitted within 2 months from date of completion of work.
- Upon clearing the site of all debris, materials, temporary structures and machinery.
- Payments for supply/work done will be made in R/A bill based on monthly progress or work, verified with measurement by PMC/Authorised Engineer.
- R/A bills will be certified against final amounts as in contract.

### **Withholding of Payments:**

- Payment may be withheld if contractor fails to meet contractual obligations.
- Failure to pay workers' wages or bills of contractor.

### **SECURED ADVANCE :**

Any request for a secured advance may be requested for by Contractor along with invoice/ original shipping document copy of invoice and duly signed payment invoice. This may be considered by the Employer(Client) upon assessment by PMC/Engineer-in-Charge for items of non-perishable, non-fragile & non-consumable in nature and required for the work and in accordance with contract (Conditions & Technical Specifications), which have been brought to the site in connection with execution (having reference to an item of work in BOQ) and are adequately stored and/or protected against damage by weather or other causes and have not been incorporated in the work earlier. The amount of such advance shall be deducted from next/final payment. However, any secured advance for any material/equipment lying unutilized after 3 months/completion of work shall be recovered fully from the next/final bill.

### **Note:**

Each payment shall be certified by the Engineer based on physical progress at site against the approved GFC drawings.

No advance payment shall be made unless specifically agreed in the contract data or special conditions.

All payments are subject to retention, tax deduction at source, and recoveries as per the contract.

## AGREEMENT

AN AGREEMENT is made this ----- BETWEEN the SWOSTI PREMIUM LTD ,Bhubaneswar, which expression shall include its successor, unless repugnant to or Excluded by the contract here of and assignees of and represented by its .....(the first party (hereinafter called the Authority) and by..... its sole proprietor/partners/Director and having registered office at (which expression shall be including his / its successor's heirs executors, representative and or assignees of the second party (hereinafter called the contractor}).

WHEREAS the Authority has, under tender Notification No. -----

WHEREAS the contractor has submitted tender for carrying out the work as above as per the tender document page ---- to ---- and has represented that in conformity with his / its obligation contained in the tender as modified by the correction slips and corrigendum contained he / it shall carryout the same truly, faithfully and honestly.

THE SAME has been accepted by both the parties on the terms and conditions, corrections, corrigendum contained in the tender as modified as well as the letter of acceptance , at a total Contract Price of Rs. Crores (Rupees Crores) excluding GST (To be paid extra as applicable ) as Issued party No.1 annexed here to as.

The same shall be binding on both the parties.

IN WITNESS WHEREOF, the parties have signed the deed of agreement on the date, month and year referred to above.

Date: At

New Delhi.

Signed by

Party No.1 Party No.2

WITNESS

1. Party No.1

2. Party No.2

## **Conditions of Contract**



## **GENERAL**

Terms, which are defined in the Contract Data and not defined in the Conditions of Contract shall keep their defined meanings. Capital initials are used to identify defined terms.

**Bill of Quantities** means the priced and completed Bill of Quantities;

**Compensation Events** are those defined in Document;

The **Completion Date** is the date of completion of the Works as certified by the Engineer.

The **Contract** is the contract between the Client and the Contractor to execute, complete and maintain the Works.

The **Contract Data** defines the documents and other information, which comprise the Contract;

The **Contractor** is a person or corporate body whose Bid to carry out the Works has been accepted by the Client [obligations of the Contractor mentioned in the Contract Data].;

The **Contractor's Bid** is the completed Bidding document submitted by the Contractor to the Client and includes Technical and Financial bids;

The **Contract Price** is the price stated in the Letter of Acceptance and thereafter as adjusted in accordance with the provisions of the Contract;

**Days** are calendar days; months are calendar months;

A **Defect** is any part of the Works not completed in accordance with the Contract;

The **Defects Liability Period** is the period named in the Contract Data and calculated from the Completion Date;

The **Client** is the party who will employ the Contractor to carry out the Works; [As mentioned in the Contract Data].

**The Engineer** is the person named in the Contract Data (or any other competent person appointed and notified to the contractor to act in replacement of the Engineer) who is responsible for supervising the Contractor's work, administering the Contract, certifying payments due to the Contractor, issuing and valuing Variations to the Contract, recommending extensions of time, and valuing the Compensation Events;

**Equipment** is the Contractor's machinery and vehicles brought temporarily to the Site to construct the Works;

**Initial Contract Price** is the Contract Price listed in the Client's Letter of Acceptance;

**Intended Completion Date** is the date on which it is intended that the Contractor shall complete the Works. The Intended Completion Date is specified in the Contract Data. The Intended Completion Date may be revised only by the Client by issuing an extension of time;

**Materials** are all supplies, including consumables, used by the contractor for incorporation in the Works;

**Plant** is any integral part of the Works, which is to have a mechanical, electrical, electronic or chemical or biological function;The **Site** is the area defined as such in the Contract Data;

**Site Investigation Reports** are those, which were included in the Bidding documents and are factual interpretative reports about the surface and sub-surface conditions at the site;

**Specification** means the Specification of the works included in the Contract and any modification or addition made or approved by the Client;

The **Start Date / Date of Commencement** is given in. the Contract Data. It is the date when the Contractor shall commence execution of the works. It does not necessarily coincide with any of the Site Possession Dates;

A **Subcontractor** is a person or corporate body who has a Contract with the Contractor to carry out a part of the work in the Contract, which includes work on the Site;

**Temporary Works** are works designed, constructed, installed, and removed by the Contractor, which are needed for construction or installation of the Works;

A **Variation or Change in Scope** is an instruction given by the Client, which varies and change the scope of Works;

**Works** are what the Contract requires the Contractor to construct, install, and turn over to the Client, as defined in the Contract Data;

Year may be understood as financial year;

**“Approved Make”** means makes of items as specified in the “List of Approved Makes/Approved Manufacturers” in this RFP. However, a higher or equivalent make can be utilized after obtaining prior approval of “Engineer-In-Charge” in writing.

## **Interpretation**

In interpreting the Conditions of Contract, singular also means plural, male also means female or neuter, and the other way around. Headings have no significance. Words have their general meaning under the language of the Contract unless specifically defined. The Client will provide instructions clarifying queries about the Conditions of Contract.

If sectional completion is specified in the Contract Data, references in the Conditions of Contract to the Works, the Completion Date, and the Intended Completion Date apply to any Section of the Works (other than references to the Completion Date and Intended Completion date for the whole of the Works).

The documents forming the Contract shall be interpreted in the following order of priority:

- (a) Agreement
- (b) Letter of Acceptance, notice to proceed with the works
- (c) Contractor's Bid

- (d) Contract Data
- (e) Conditions of Contract including Additional & Special Conditions of Contract
- (f) Specifications
- (g) Drawings
- (h) Bill of quantities (optional) and
- (i) Any other document listed in the Contract Data as forming part of the Contract.

### **Languages and Law**

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

### **Engineer's Decisions:**

Except where otherwise specifically stated, the Engineer will decide contractual matters between the Client and the Contractor in the role representing the Client as per the provision of the contract.

### **Delegation:**

The Engineer may delegate any of his duties and responsibilities to other people after notifying the Contractor and may cancel any delegation after notifying the Contractor.

### **Communications:**

Communications between parties which are referred to in the conditions are effective only when in writing. A notice shall be effective only when it is delivered (in terms of Indian Contract Act).

### **Sub-contracting:**

The Contractor may sub-contract any portion of work, up to a limit of 10% of contract value, with the approval of the Engineer but may not assign the Contract without the approval of the Client in writing. Sub-contracting does not alter the Contractor's obligations.

### **Other Contractors:**

The Contractor shall cooperate and share the Site with other contractors, public authorities, utilities, and the Client between the dates given in the Schedule of other Contractors. The Contractor shall as refer to in the Contract Data, also provide facilities and services for them as described in the Schedule. The Client may modify the schedule of other contractors and shall notify the contractor of any such modification.

### **Personnel:**

The Contractor shall employ the key personnel named in the Schedule of Key Personnel as referred to in the Contract Data besides those as listed to carry out the functions stated in the Schedule or other personnel approved by the Engineer. The Engineer will approve any proposed replacement of key personnel only if their qualifications, abilities, and relevant experience are substantially equal to or better than those of the personnel listed in the Schedule.

If the Engineer asks the Contractor to remove a person who is a member of the Contractor's staff or his work force stating the reasons the Contractor shall ensure that the person leaves the Site within seven days and has no further connection with the work in the Contract.

### **Client's and Contractor's Risks:**

The Client carries the risks which this Contract states are Client's risks, and the Contractor carries the risks which this Contract states are Contractor's risks.

### **Client's Risks:**

The Client is responsible for the excepted risks which are in so far as they directly affect the execution of the Works in India, the risks of war, hostilities, invasion, act of foreign enemies, rebellion, revolution, insurrection or military or usurped power, civil war, riot commotion or disorder (unless restricted to the Contractor's employees), and contamination from any nuclear fuel or nuclear waste or radioactive toxic explosive.

### **Contractor's Risks:**

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

### **Insurance:**

The Contractor shall provide, in the joint names of the Client and the Contractor, insurance cover **for the period as stated below against the events and** in the amounts and deductibles stated in the Contract Data for the following events, which are due to the Contractor's risks:

**A) From the starting date to the end of defect liability period:**

(a) Loss of or damage to the works

**B) From the start date till completion of the work as per agreement:**

(a) Loss of or damage to plant, materials and equipment,

(b) Loss of or damage of property (except the works, plant, materials and equipment) in connection with the contract, and

(c) Personal injury or death.

If all the items as listed above can be combined / grouped under one insurance cover like Contractor's, All Risks (CAR) Policy **covering all-natural calamities as per local conditions.**

Prior to seven days before the start date, the Contractor shall furnish to the Engineer notarized true copies of the certificates of insurance, copies of insurance policies and premia payment receipts in respect of such insurance for the Client's approval. All such insurance shall provide for compensation to be payable in the types and proportions of currencies required to rectify the loss or damage incurred.

If the contractor does not provide any of the policies and certificates required, the Client may affect the insurance which the contractor should have provided and recover the premiums the Client has paid from payments otherwise due to the contractor or, if no payment is due, the payment of the premiums shall be a debt due.

Alterations to the terms of insurance shall not be made without the approval of the Client.

Both parties shall comply with any conditions of the insurance policies.

## **Site Investigation Reports:**

The Contractor, in preparing the Bid, may rely on any site Investigation Reports referred to in the Contract Data, which are indicative and not exhaustive. The Client shall provide all available details to the Contractor (Bidder) for his information, if requested by him at least one week prior to the bid submission date. The bidder shall be responsible for interpreting all such data. After award of work, the Contractor shall carry out detail survey and investigation for preparation of detail designs as per the scope of work and time period stipulated.

To the extent which was practicable (taking account of cost and time), the Contractor (Bidder) shall be deemed to have obtained all necessary information as to risks, contingencies and other circumstances which may influence or affect the Tender or Works. To the same extent, the Contractor (Bidder) shall be deemed to have inspected and examined the Site, its surroundings, the above data and other available information, and to have been satisfied before submitting the Tender as to all relevant matters, including (without limitation):

- (a) the form and nature of the Site, including sub-surface conditions,
- (b) the climatic conditions,
- (c) the extent and nature of the work and Goods necessary for the execution and completion of the Works and the remedying of any defects,
- (d) the Laws, procedures and labour practices of the Country, and
- (e) the Contractor's requirements for access, accommodation, facilities, personnel, power, transport, water and other services.
- (f) availability of required materials

## **Queries about the Contract Data:**

The Client will clarify queries on the Contract Data if any during the Pre-bid references.

## **Contractor to Construct the Works:**

The Contractor shall construct and install the Works in accordance with the approved specification and drawings. All designs, drawings and specifications to be furnished by the contractor shall be approved by the Client before execution.

## **The Works to be completed by the Intended Completion Date:**

The Contractor may commence execution of the Works on the Start Date and shall carry out the Works in accordance with the programme submitted by the Contractor, as updated with the approval of the Engineer, and complete them by the Intended Completion Date.

## **Approval by the Engineer:**

The Contractor shall be provided Specifications and Drawings showing the proposed Temporary Works by the Engineer.

The Contractor shall be responsible for design of Temporary Works.

The Engineer's approval shall not alter the Contractor's responsibility for design of the Temporary Works.

The Contractor shall be provided approved design, drawings and specifications of all components of the building and all allied infrastructure works, except those for the temporary works.

**Safety:**

The Contractor shall be responsible for the safety of all activities on the Site.

**Possession of the Site:**

The Client shall give possession of all parts of the Site to the Contractor. If possession of a part is not given by the date stated in the Contract Data the Client is deemed to have delayed the start of the relevant activities and this will be Compensation Event.

**Access to the Site:**

The Contractor shall allow the Client and any person authorized by the Client access to the Site, to any place where work in connection with the Contract is being carried out or is intended to be carried out and to any place where materials or plant are being manufactured / fabricated / assembled for the works.

**Instructions:**

The Contractor shall carry out all instructions of the Engineer pertaining to works, which comply with the applicable laws where the Site is located.

The Contractor shall permit the Client to inspect the Contractor's accounts and records relating to the performance of the Contractor and to have them audited by auditors appointed by the Client, if so, required by the Client.

**Disputes:**

That for the purpose of jurisdiction in the event of disputes if any of the Contract would be deemed to have been entered in to within the State of Odisha and it is agreed that neither party to the Contract will be competent to bring a suit in regard to the matter by this Contract at any place outside the State of Odisha.

**Procedure for Settlement of Disputes:**

In case of Dispute or difference arising between the Client and the contractor relating to any matter arising out of or connected with this agreement, such disputes or difference shall be settled mutually.

## **TIME CONTROL**

### **Programme:**

Within **7 days of issue of letter of award**, the successful bidder shall submit to the Client detail work programme for approval showing the general methods, arrangements, order and timing for all the activities in the Works along with monthly cash flow forecast. The agreed work programme / milestones during such contract negotiation shall form part of the agreement.

An update of the Programme shall be a programme showing the actual progress achieved on each activity and the effect of the progress achieved on the timing of the remaining work including any changes to the sequence of the activities.

The contractor shall submit to the Client, for approval, an updated Programme at intervals no longer than 15days. If the Contractor does not submit an updated Programme within this period, the Engineer may withhold the amount stated in the Contract Data from the next payment certificate and continue to withhold this amount until the next payment after the date on which the overdue programme has been submitted.

The Client's approval of the Programme shall not alter the Contractor's obligations. The Contractor may revise the Programme and submit it to the Client again at any time. A revised Programme is to show the effect of Variations and Compensation Events.

### **Extension of the Intended Completion Date:**

The Client shall extend the Intended Completion Date if a Compensation Event occurs or a Variation is issued which makes it impossible for Completion to be achieved by the intended Completion Date without the Contractor taking steps to accelerate the remaining work and which would cause the Contractor to incur additional cost.

The Client shall decide whether and by how much to extend the Intended Completion Date within 15 days of the Contractor asking the Engineer for a decision upon the effect of a Compensation Event or Variation and submitting full supporting information. If the Contractor has failed to give early warning of a delay or has failed to cooperate in dealing with a delay, the delay by this failure shall not be considered in assessing the new Intended Completion Date.

The Engineer shall within 7 days of receiving full justification from the contractor for extension of Intended Completion Date refer to the Client his recommendation. The Client shall in not more than 15 days communicate to the Engineer the Client's decision.

**Delays Ordered by the Engineer:**

The Client may instruct the Contractor to delay the start or progress of any activity within the Works.

**Management Meetings:**

Either the Engineer or the Contractor may require the other to attend a management meeting. The business of a management meeting shall be to review the plans for remaining work and to deal with matters raised in accordance with the early warning procedure.

The Engineer shall record the business of management meetings and is to provide copies of his record to those attending the meeting and to the Client. The responsibility of the parties for actions to be taken is to be decided by the Engineer either at the management meeting or after the management meeting and stated in writing to all who attended the meeting.

**Early Warning:**

The Contractor is to warn the Client/Engineer at the earliest opportunity of specific likely future events or circumstances that may adversely affect the work resulting delay in the execution. The Engineer may require the Contractor to provide an estimate of the expected effect of the future event or circumstance on the Completion Date.

The Contractor shall cooperate with the Engineer in making and considering proposals for how the effect of such an event or circumstance can be avoided or reduced by anyone involved in the work and in carrying out any resulting instruction of the Engineer.

**QUALITY CONTROL****Identifying Defects:**

The Engineer shall check the Contractor's work regularly and notify the Contractor of any Defects that are found. Such checking shall not affect the Contractor's responsibilities. The Engineer may instruct the Contractor to search for defects and to uncover and test any work that the Engineer considers may have a Defect

**Tests:**

If the Engineer instructs the Contractor to carry out a test not specified in the Specification to check whether any work has a Defect and the test shows that it does, the Contractor shall pay for the test and any samples. If there is no Defect the test shall be a Compensation Event.

**Correction of Defects:**

The Engineer shall give notice to the Contractor of any Defects before the end of the Defects Liability Period, which begins at Completion and is defined in the Contract Data. The Defects Liability Period shall be extended for as long as Defects remain to be corrected.

Every time notice of a Defect is given; the Contractor shall correct the notified Defect within the length of time specified by the Engineer's notice.

### **Uncorrected Defects:**

If the Contractor has not corrected a Defect within the time specified in the Engineer's notice, the Engineer will assess the cost of having the Defect corrected, and the Contractor will pay this amount.

## **COST CONTROL**

### **Changes in the Quantities:(OPTIONAL)**

#### **Change of Scope (Variations) and Procedure for change of Scope:**

The Client may, require the Contractor to make modifications/alterations to the works before the issue of the completion certificate either by giving an instruction or by requesting the contractor to submit a proposal for change of scope involving additional cost or reduction in cost. Any such change of scope shall be made and valued in accordance with the provisions of this contract and the contractor, in that event, will have no further claim on the ground that had it been known / disclosed earlier he would have made such charges in other connected work in their design, construction which would have saved him some cost and given him other consequential benefits.

Change in scope may include;

- (a) Change in specifications of any item of works
- (b) omission/ deletion of any item of work from the scope of work
- (c) any additional work (such as addition of extra plinth area) which are not included in the scope of work including any additional test on completion

In the event of the Client determining that a change of scope is necessary, it shall issue notice to the contractor a notice specifying in reasonable detail the works contemplated there under ("Change in scope notice")

Upon receipt of change in scope notice, the contractor shall with due diligence, provide to the Client through the Engineer within seven days time such information as is necessary together with documentation in support of;

- (a) the impact, of any, which the change in scope is likely to have on the completion of the work
- (b) the options for implementing the proposed change of scope and the effect, if any, each on the cost and time thereof including the following details;
  - i. break down of quantities, unit rates and cost for different items of work
  - ii. proposed design for the change of scope
  - iii. proposed modifications, if any, to the construction period with updated work programmes (all

Variations shall be included in updated programmes produced by the Contractor).

Any change in scope shall be calculated on the basis of the following priority:

The total value of all change of scope of work shall not exceed 10% of total contract price for the construction work.

**Payments for Change of Scope (Variations):**

The Client shall assess the change in scope proposal and Contractor's quotation at the time of bidding in financial form and upon reaching an agreement; the Client shall issue the Change of Scope Order requiring the contractor to proceed with the performance thereof.

If the Contractor's quotation is unreasonable, the Client may order the Variation and make a change to the Contract Price which shall be based on Client's own forecast of the effects of the Variation on the Contractor's costs.

If the Client decides that the urgency of varying the work would prevent a quotation being given and considered without delaying the work, no quotation shall be given and the Variation shall be treated as a Compensation Event, subject to condition that such variation shall not exceed 10% of the total contract price for the contract work.

The Contractor shall not be entitled to additional payment for costs, which could have been avoided by giving early warning.

**Payment Certificates:**

The Contractor shall submit to the Engineer statements of the value of the work completed.

The Engineer shall check the Contractor's statement within 15 days and certify the amount to be paid to the Contractor as per contract payment schedule after taking into account any credit or - debit for the month in question in respect of materials for the works in the relevant amounts and under conditions set forth, including adjustment of advance.

The value of work executed shall be determined by the Engineer.

The value of work executed shall comprise the value of the quantities of the items as per the BoQ and work programme attached to the contract.

The value of work executed shall include the valuation of Change in Scope (Variation) and Compensation Events, if any.

The Engineer may exclude any item certified in a previous certificate or reduce the proportion of any item previously certified in any certificate in the light of later information.

**Payments:**

Payments shall be adjusted for deductions for retention, other recoveries in terms of the contract and taxes at source, as applicable under the law. The Engineer shall pay the Contractor the amounts as per the items of work executed and agreed rates thereto as well as payment schedule attached to the contract.

**Tax:**

The rates quoted by the Contractor shall be deemed to be exclusive of the GST and inclusive of Royalty, Income Tax, Labour CESS and all other statutory taxes that the Contractor will have to pay for the performance of this Contract. The Client will perform such duties in regard to the deduction of such taxes at source as per applicable law.

**Currencies:**

All payments shall be made-in Indian Rupees.

**Retention:**

The Client shall retain from each payment due to the Contractor the proportion stated in the Contract Data until Completion of the whole of the works or settlement of final payment.

On completion of the whole of the works and issue of the completion certificate the performance security shall be repaid to the contractor. The retention amount shall be paid after the Defects Liability Period has passed and the Engineer has certified that all defects notified by the Engineer to the contractor before the end of the period have been corrected.

**Liquidated Damages:**

The Contractor shall pay liquidated damages to the Client at the rate as stated in the Contract Data that the Completion Date is later than the Intended Completion Date (for the whole of the works or the milestone as stated in the contract data). The total amount of liquidated damages shall not exceed the amount defined in the Contract Data. The Client may deduct liquidated damages from payments due to the Contractor. Payment of liquidated damages shall not relieve the contractor from his / her / their obligation to complete the works or from any other duties, obligations or responsibilities which he / she / they may have under the contract.

If the Intended Completion Date is extended after liquidated damages have been paid, the Engineer shall correct any overpayment of liquidated damages by the Contractor by adjusting the next payment certificate.

**Bonus Payment:**

Deleted

**Advance Payment:**

The Client may make advance payment to the Contractor for mobilization and cash flow support of the amounts stated in the Contract Data by the date stated in the Contract Data, only against provision by the Contractor of an Unconditional Bank Guarantee in a form and by a Bank acceptable to the Engineer in amounts and currencies equal to 110% of the advance payment.

The Advance Payment shall not be released until the camp setup, mobilisation of key personnel, equipment and labour at site.

The guarantee shall remain effective until the advance payment has been repaid, but the amount of the guarantee shall be progressively reduced by the amounts repaid by the Contractor. The contractor shall ensure that the Bank Guarantee remain enforceable until the advance payment has been fully repaid and accordingly renew it, from time to time, until the advance payment has been fully repaid.

If the terms of guarantee specify its expiry date, and the advance payment has not been re-paid by the date then 28 days prior to the expiry date, the contractor shall extend the validity of the guarantee until the advance payment has been fully repaid.

The advance payment shall be repaid through percentage deductions from the interim payments as follows:

**Securities:**

The Performance Security shall be provided to the Client no later than the date specified in the Letter of Acceptance and shall be issued in an amount and form and by a bank or surety acceptable to the Employee

The performance security shall be denominated in Indian Rupees. The Performance Security shall remain valid up to the period as defined in the Contract Data.

**Cost of Repairs:**

Loss or damage to the Works or Materials to be incorporated in the Works between the Start Date and the end of the Defects Correction periods shall be remedied by the Contractor at the Contractor's cost if the loss or damage arises from the Contractor's acts or omissions including the situation as stipulated in the RFP.

## **FINISHING THE CONTRACT**

**Completion:**

The Contractor shall request the Engineer to issue a Certificate of Completion of the Works and the Engineer will do so upon deciding that the Work is completed.

**Taking Over:**

The Client shall take over the Site and the Works within seven days of the Engineer issuing a certificate of Completion.

**Final Account:**

The Contractor shall supply to the Engineer a detailed account of the total amount that the Contractor considers payable under the Contract before the end of the Defects Liability Period. The Engineer shall issue a Defect Liability Certificate and certify any final payment that is due to the Contractor within 30 days of receiving the Contractor's account if it is correct and complete. If it is not, the Engineer shall issue within 30 days a schedule that states the scope of the corrections or additions that are necessary. If the Final Account is still unsatisfactory after it has been resubmitted, the Client shall decide on the amount payable to the Contractor and issue a payment certificate, within 30 days of receiving the Contractor's revised account.

## Termination:

The Client may terminate the Contract if the other party causes a fundamental breach of the Contract.

Fundamental breaches of Contract include, but shall not be limited to the following:

- (a) the Contractor stops work for 15 days when no stoppage of work is shown on the current Programme and the stoppage has not been authorized by the Engineer;
- (b) the Contractor is made bankrupt or goes into liquidation other than for a reconstruction or amalgamation;
- (c) the Engineer gives Notice that failure to correct a particular Defect is a fundamental breach of Contract and the Contractor fails to correct it within a reasonable period of time determined by the Engineer;
- (d) the Contractor does not maintain a security which is required;
- (e) the Contractor has delayed the completion of works by the number of days for which the maximum number of liquidated damages can be paid as defined in the Contract data; and
- (f) if the Contractor, in the judgment of the Client has engaged in corrupt or fraudulent practices in competing for or in executing the Contract.

For the purpose of this paragraph: "corrupt practice" means the offering, giving, receiving or soliciting of anything of value to influence the action of a public official in the procurement process or in contract execution. "Fraudulent practice" means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment of the Borrower and includes collusive practice among Bidders (prior to or after bid submission) designed to establish bid prices at artificial non-competitive levels and to deprive the Borrower of the benefits of free and open competition."

When either party to the Contract gives notice of a breach of contract to the Engineer for a cause other than those listed under Sub Clause 54.2 above, the Engineer shall decide whether the breach is fundamental or not.

Notwithstanding the above, the Client may terminate the Contract for convenience.

If the Contract is terminated the Contractor shall stop work immediately, make the Site safe and secure and leave the Site, as soon as reasonably possible.

### **Payment upon Termination:**

If the-Contract is terminated because of a fundamental breach of Contract by the Contractor, the Engineer shall issue a certificate for the value of the work done fewer advance payments received up to the date of the issue of the certificate, less other recoveries due in terms of the contract, less taxes due to be deducted at source as per applicable law and less the percentage to apply to the work not completed as indicated in the Contract Data. Additional Liquidated Damages shall not apply. If the total amount due to the Client exceeds any payment due to the Contractor, the difference shall be a debt payable to the Client.

If the Contract is terminated at the Client's convenience, the Engineer shall issue a certificate for the value of the work done, less advance payments received up to the date of the certificate, less other recoveries due in terms of the contract and less taxes due to be deducted at source as per applicable law. No extra cost will be paid by the Client for expenditure towards removal of Equipment, repatriation of the Contractor's personnel employed solely on the Works and the Contractor's costs of protecting and securing the Works.

### **Property:**

All materials on the Site, Plant, Equipment, Temporary Works and Works are deemed to be the property of the Client, if the Contract is terminated because of a contractor's default.

### **Release from Performance:**

If the Contract is frustrated by the outbreak of war or by any other event entirely outside the control of either the Client or the Contractor, the Engineer shall certify that the Contract has been frustrated. The Contractor shall make the Site safe and stop work as quickly as possible after receiving this certificate and shall be paid for all work carried out before receiving it and for any work carried out afterwards to which commitment was made.

## **ADDITIONAL CONDITIONS OF CONTRACT**

### **1.WORK DESCRIPTION**

The work shall be strictly carried out as per the scope listed in this document and in accordance with the specifications. The equipment & material supplied at site will also be selected out of the list of approved makes. Bill of quantity provided with the document is for contractor guidance. It is expected that after award of work, contractor shall prepare shop drawings for approval by the Consultant & Client representative and also submit Technical documentation duly identifying shortlisted make of material/equipment along with its data sheets. Actual ordering shall be based on approved shop drawings & documents.

The work at site shall comply with the approved shop drawings and will meet the satisfaction of Client representative. The contractor shall be required to demonstrate satisfactory operation of entire system (including client supplied equipment installed by contractor) and furnish the required labour, material & tools to install & commission the system.

The broad scope of work for proposed HVAC system covered under this contract shall include supply, installation, testing & commissioning of the following:

Water cooled chiller (free supply)  
Constant primary & Variable secondary Pumping system.  
Smart Air handling units (AHU's).  
FRP Cooling towers.  
VFD's.  
Dedicated outdoor air system including heat recovery wheel.  
Mechanical ventilation systems.  
Chilled, Condenser and Drain piping with associated fittings, valves etc.  
Air distribution system.  
Associated electrical works.  
Kitchen ventilation.  
Basement car parking ventilation.  
Testing Adjusting & Balancing of the entire HVAC and mechanical ventilation installation.

Besides above, contractor shall also be required to undertake following:

Obtain fire approval from Local Authorities prior & post installation for operation of system by the land owner. Coordination for submission of required documents & demonstration of systems to obtain the Approval by the Contractor.  
Minor civil works which include making openings in walls & slabs and making good of the same.  
Commissioning of the plant including test reports to demonstrate satisfactory working prior to handing over.  
Provide as-built drawings and handing over document comprising of list of recommended spares, catalogues and service schedule for each equipment/material.  
Training of Client's staff.  
Documents related LEED requirement

## 2.SITE MANAGEMENT

The Contractor shall be required to provide following staffing for the project:

Design Engineer who will work with Consultant for getting shop drawings, technical submittal and variation in quantity statement approved.

Procurement team.

Full time dedicated 1 manager (minimum 15 year experience) and Engineer (minimum 10 year experience) & one supervisor posted at site.

The contractor shall submit organization chart and CV prior to starting work at site.

The Contractor shall have required stores, tools & plant, security and facility to transport materials to place of installation for speedy execution of work.

## 3.REGULATIONS & PERMITS

Prior to starting work at site, the contractor shall obtain required permits/ licenses required for satisfactory execution and operation of the installation. All receipted amounts shall be reimbursed by Client on production of proof of payment by the contractor.

The executed work shall strictly confirm to applicable laws, regulations and Indian Standards which become applicable. In case the specifications and drawings contained in this document call for higher standard than those required by prevailing regulations, then these specifications & drawings shall become applicable. However, in case of any conflict or violation between the document/drawings and prevailing laws, then the applicable laws & regulations shall be governing & binding.

#### 4.SHOP DRAWINGS

A set of design drawings listed in this document are available at Consultant office and may be issued with the tender document. These design drawings are for reference of the contractor and indicate proposed arrangement and the extent of work covered in the contract. The data given in the drawings and specifications is as exact as could be procured, but its accuracy is not guaranteed. The contractor cannot execute work or scale these drawings for reference.

Following shall be the procedure followed by contractor while preparation of shop drawings:

The contractor shall refer the design drawings for understanding the scope and proposed routes to be followed during execution.

Collate latest architectural backgrounds from the Client representative / Architect / Consultant.

Examine all related services drawings but not limited to structural, plumbing, electrical, HVAC, Interior, landscape and others including as-built works before starting the work. Any discrepancy must be report to the Client's site representative in writing and obtain approval for go-ahead.

Within one week of award of work, the Contractor shall prepare a list of shop drawing along with submission schedule for approval of Client representative/Consultant. The list of drawings must include layouts for Plant room, Pump room, Typical drawings showing exact location of supports, flanges, bends, tee connections, reducers, detailed piping drawings showing exact location and type of supports, valves, fittings etc; electrical panels inside/outside views, power and control wiring schematics, cable trays, supports and terminations.

Maximum headroom shall be maintained at all points and in case the same is inadequate, then written approval from Client representative must be obtained prior to execution at site.

These shop drawings shall depict information required to complete the Project as per specifications and as required by the Consultant/Client representative. These Drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all items of equipment, also the details of all related items of work by other contractors. Each shop drawing shall contain tabulation of all measurable items of equipment/materials/works and progressive cumulative totals from other related drawings to arrive at a variation-in-quantity statement at the completion of all shop drawings.

Where the work under this contract is proposed to be installed in close proximity or is interfering with other trades, then based on client representative/consultant directions, the contractor shall prepare all services coordinated working drawings and sections at a suitable scale (not less than 1:50), clearly showing proposed installed in relation to the work of other trades.

The contractor shall thereafter furnish 6 sets of detailed shop drawings to Client representative/Consultant for obtaining comments/approval. The Contractor will make unlimited number of re-submissions of shop drawings unless Client representative/Consultant/Architect approval is obtained.

The Contractor will thereafter submit 6 sets of final shop drawings to the Client representative for their exclusive use and all other agencies.

No material or equipment may be delivered or installed at the job site until the contractor has in his possession, the approved shop drawing for the particular material/equipment/installation.

In case installation is carried out without following above process or obtaining a waiver to follow the procedure from Client representative, the work shall be rejected and contractor shall rectify the same at their own cost.

Shop drawings shall be submitted for approval minimum four weeks in advance of planned

delivery and installation of any material to allow Client representative/Consultant ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce shop drawings at the right time, in accordance with the approved program.

Approval of shop drawings shall not be considered as a guarantee of measurements or of building dimensions. Where drawings are approved, said approval does not mean that the drawings supersede the contract requirements, nor does it in any way relieve the contractor of the responsibility or requirement to furnish material and perform work as required by the contract.

## 5. TECHNICAL DOCUMENTATION

The contractor prior to supplying material at site, will submit the following documentation to Consultant/Client representative for approval:

Manufacturers drawings, catalogues, pamphlets and other documents in triplicate. Each item shall be properly labeled, indicating the specific services for which material or equipment is to be used, giving reference to the governing section and clause number and clearly identifying in ink the items and the operating characteristics. Data of general nature shall not be accepted.

Samples of all materials shall be submitted to the Client's site representative prior to procurement. These will be submitted in two sets for approval and retention by Client's representative and shall be kept in their site office for reference and verification till the completion of the Project. Wherever directed, a mockup or sample installation shall be carried out for approval before proceeding for further installation.

Where the contractor proposes to use an alternate make or model of equipment other than that specified, all new drawings and detailing required thereafter shall be prepared by the contractor at his own expense including any re-design required for other discipline/trade. Any delay on such account shall also be at the cost of and consequence of the Contractor.

Contractor to refer Annexure –II for list of approved makes & materials for this project.

## 6. VARIATION IN QUANTITY STATEMENT

After approval of major & relevant shop drawings, the contractor shall submit four copies of a comprehensive variation in quantity statement. This statement must be submitted prior to completing ordering of equipment and should identify imported/local materials in this contract as well as proposed spares/tools. The Consultant shall provide recommendation to Client representative for acceptance of anticipated variation in contract amounts and also advise Client to initiate action for procurement of spare parts and tools at the completion of project.

## 7. QUALITY ASSURANCE

The contractor to ensure that all materials and equipment supplied shall be new and of best available quality conforming to the relevant Indian Standard Specifications and to these specifications. Makes shall be strictly in conformity with list of approved manufacturers as per Annexure -II. Owners reserve the right to reject any item which in their assessment is second hand

Any deviations from above shall be clearly highlighted prior to supply and shall be brought to the notice of the Client representative/Consultant for further instructions in the matter.

Prior to starting execution work at site, the Contractor shall verify the sufficiency of the size of the shaft openings, clearances and ceiling spaces for proper installation. Failure to communicate insufficiency of any of the above, shall constitute Contractor acceptance of the same. The Contractor shall locate all equipment in fully accessible locations which can be easily serviced, operated or maintained. The exact location and size of access panels, required for each concealed, valve or other devices requiring attendance shall be finalized and communicated in sufficient time.

Failing this, the Contractor shall make all the necessary repairs and changes at own expense. Access panel shall be marked.

#### 8. WORKS NOT COVERED UNDER THIS CONTRACT

Following works are excluded from the scope under this contract. These shall be executed by respective contractor in accordance with approved shop drawings where these details must be highlighted. However, contractor shall be responsible for providing details and thereafter supervision to ensure satisfactory & timely execution of these associated items as they have a bearing on this contract.

#### 9. EXCLUDED FROM SCOPE OF WORK ASSOCIATED CIVIL WORKS

Following civil works associated with HVAC installation are excluded from the scope of this contract. These shall be executed by other agencies in accordance with approved shop drawings of and under direct supervision of the air conditioning contractor.

- i. RCC foundation for water chilling machine's pumps & centrifugal fans with angle iron frame work at the edges to protect these from damage.
- ii. RCC basin & supports & MS Joists for cooling towers.
- iii. PCC foundation blocks with angle iron frame work edging for all motor control center.
- iv. PCC foundation for pot strainers.
- v. PCC foundation blocks for all air handling units.
- vi. Air-tight fire doors with minimum one hour fire rating for plant room, AHU rooms, fan rooms and other equipment rooms.
- vii. Water proofing of floors of AHU rooms, air washer rooms and fan rooms.
- viii. Masonry drain channels and sumps with CI gratings in AC plant room including provision for sump pump and disposal.
- ix. Supply and fixing of G.I./wooden frame for mounting of grilles in masonry walls.
- x. Supply and fixing of GSS frame for mounting of grilles / diffusers in false ceiling / boxing.
- xi. Thermal insulation of terraces above air-conditioned areas exposed to sun.
- xii. Making of trenches and back filling the same after laying / pressure testing etc. of pipes.

#### ELECTRICAL SERVICES WORKS

All associated ELECTRICAL WORKS listed below are excluded from the scope of this contract. These shall be installed by other agencies in accordance with approved shop drawings of, and under direct supervision of the air conditioning contractor.

Providing power supply with earthing at the incoming of control panel in A/C plant room.

- ii. Providing power supply and earthing at the incoming MCCB in each air handling unit room.
- iii. Providing power and earthing at the incoming MCCB in each centrifugal fan panel and pump panel at locations called for on air conditioning Contractor's shop drawings.

iv. Providing 15 amps power outlet within 2 meter reach of each fan coil unit and VAV boxes at locations called for on air conditioning Contractor's shop drawings.

v. Providing 15 amps power outlet within 2 meter reach of each single phase propeller fan/inline fan at locations called for on air conditioning contractor's shop drawings.

vi. Providing wiring and earthing for sump pumps in air conditioning plant room.

#### PLUMBING SERVICES WORKS

All associated PLUMBING WORKS listed below are excluded from the scope of this contract. These shall be installed by other agencies, in accordance with approved shop drawings of, and under direct supervision, of the air conditioning contractor.

Providing soft water (Commercial hardness 0 ppm and PH 7+1) at air washers, humidifiers and at chilled water expansion tank.

Providing make up water for cooling tower as per RO water quality

iii. Disposal of condensate drain from fan coil units / ceiling suspended units beyond the condensate drain riser.

Providing sump pumps and necessary piping for drainage of air conditioning plant room and other machine rooms located below ground level.

Providing floor drains in cooling tower area and in air handling unit rooms.

Note : Preparation of shop drawings defining the Foundation details to civil contractor will be under HVAC Contractor scope of work.

#### 10. INTEGRATION WITH BUILDING AUTOMATION SYSTEM

The scope shall include providing following for the interface to Building Automation System.

Sockets /Nipples including shut-off valve for mounting sensors/transmitters on pipe lines.

Space in electrical panel for running of LV cables.

CT of 15 VA burden with potential free taps.

Auto/manual changeover switch with potential free contact at manual position.

Installation of motorized control valves with provision of counter flanges

Installation of current transformer & Transducer along with wiring between Current Transformer & Transducer up to the terminal block

Provision for mounting BAS sensors.

15 Amps. Power supply with MCB in all AHU panels and 32 Amps MCB on HVAC plant room panel for power supply to DDC Panel.

It is to be clearly understood that the final responsibility for the sufficiency, adequacy and conformity to the contract requirements lies solely with the contractor.

#### 11. TESTING, ADJUSTING AND BALANCING

Air and water balancing shall be carried out by the contractor through a specialist team (different than erection team) as per Specifications and ASHRAE Guidelines. Performance test shall consist of three days of 10 hour each operation of system for each season. The results for each season shall be submitted to Client representative/Consultant. The submittal shall include operational parameters marked on performance curves for each equipment along with test certificates and safety/control settings.

The installation shall be tested again after removal of defects and shall be commissioned only after approval by the Client's site representative. All tests shall be carried out in the presence of the

representatives of the Construction Manager/Architect /Consultant and Client's site representative. After commissioning, the results shall be submitted for scrutiny in quadruplicate.

All equipment installation shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Client's site representative. In case of rotating machinery sound or vibration noticeable outside the room in which it is installed, or annoyingly noticeable inside its own room, shall be considered objectionable. Such conditions shall be corrected by the Contractor at his own expense. The contractor shall guarantee that the equipment installed shall maintain the specified Noise Control levels.

## 12. COMPLETION CERTIFICATE

On completion of the installation, a certificate shall be furnished by the contractor, counter signed by the licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local authority engineer in-charge.

The contractor shall be responsible for getting the entire installation duly approved by the local authorities Engineer in Charge concerned, and shall bear expenses if any, in connection with the same.

## 13. AS-BUILT DRAWINGS

Contractor shall submit following as-built drawings as and when work is completed:

6 set of hard copies of all as-built drawings duly corrected and incorporating any modifications during execution.

Two set of pen drive containing the drawings.

The drawings shall provide plant room layouts, piping layouts, location of all concealed accessories/piping, wiring diagram, control diagram, Single line diagram, control schematic with detailed bill of materials, showing makes, types & description of all components & accessories and sequencing of automatic controls and other services.

## 14. MAINTENANCE MANUAL

Upon completion and commissioning of works, the contractor shall submit a draft copy of comprehensive operating instructions, maintenance schedule and log sheets for all systems and equipment included in this contract. This shall be supplementary to manufacturer's operating and maintenance manuals. Upon approval of the draft, the contractor shall submit four (4) complete bound sets of typewritten operating instructions and maintenance manuals; one each for retention by Consultant and Client's site representative and two for Clients Operating Personnel. These manuals shall also include basis of design, detailed technical data for each piece of equipment as installed, spare parts manual and recommended spares for 4 year period of maintenance of each equipment. The manuals shall include:

- i. Description of the work carried out / installed.
- ii. Operating instructions.
- iii. Maintenance instructions including procedures for preventive maintenance.
- iv. Manufacturers catalogues.
- v. Spare parts list.
- vi. Trouble shooting charts.
- vii. Drawings
- viii. Type and routine test certificates of major items.

Details of all the bought out item should be part of this maintenance manual.

## 15. ON SITE TRAINING

Upon completion of all work and all tests, the Contractor shall furnish necessary operators, labor

and helpers for operating the entire installation for such periods so as to enable the Client's staff to get acquainted with the operation of the system. During this period, the contractor shall train the Client's personnel in the operation, adjustment and maintenance of all equipment installed.

#### 16. DEFECTS LIABILITY PERIOD

##### Complaints

The Contractor shall receive calls for any and all problems experienced in the operation of the system under this contract, attend to these within 10 hours of receiving the complaints and shall take steps to immediately correct any deficiencies that may exist.

##### Repairs

All equipment that requires repairing shall be immediately serviced and repaired. Since the period of Mechanical Maintenance runs concurrently with the defects liability period, all replacement parts and labour shall be supplied promptly free-of-charge to the Client.

#### 17. UPTIME GUARANTEE

The contractor shall guarantee for the installed system an uptime of 98%. In case of shortfall in any month during the defects liability period, the Defects Liability period shall get extended by a month for every month having shortfall and no reimbursement shall be made for the extended period.

#### 18. OPERATION & MAINTENANCE CONTRACT

Contractor may be required to carry out the operation of the installation during and after the defects liability period. Further, it may also be required to carry out all-inclusive maintenance of the entire system for a period of four years beyond the defects liability period.

##### Operation Contract:

It will involve round the clock operation for 24 hours a day wherein work will include but not limited to operation of installation, maintaining log books, complain register and summary of operation.

The terms of payment shall be monthly at the end of each month on pro-rata basis.

##### All Inclusive Maintenance Contract:

The work will involve routine preventive maintenance with monthly status report. Entire installation shall be painted every two years. 98% uptime of all systems is expected under this contract wherein up time shall be assessed every month and in case of shortfall during any month the contract shall be extended by a month. No reimbursement shall be payable for the extended period.

Adequate number of persons to the satisfaction of the Client representative shall be provided including relievers wherein statutory compliances such as of EPF, ESIC and other applicable labour legislations shall be to contractor account. No overtime shall be payable. Routine shut downs shall be permitted with prior permission of the Owner.

Payment shall be Quarterly at the beginning of each quarter on pro-rata basis.

#### 19 BIM Implementation

It is expected that Contractor, if required shall prepare all shop drawings in latest version of Revit

only and coordinate with other contractors to provide a clash free model. Thereafter, all shop drawings shall be provided in PDF, 2D CAD plans and critical sections in 3D. The drawings shall be submitted in hard copy in A0/A1 size at 1:100 scale including all annotations, heights, bottom of duct/pipe/tray etc complete in all respect as required.

## 20. GREEN BUILDING COMPLIANCE

Actions required by Contractor:

Contractor will provide full support in complying to Green Building requirements for the desired level of Green Building Rating in the project.

Contractor shall implement the recommendations provided by Green Building Consultant and provide support during the site inspections.

Contractor shall provide respective documentation including but not limited to specification sheets, manufacturer cutsheets, Test Certificates, Brochures, purchase records, manufacturer declarations, calculations, site photographs, commissioning reports.

Contractor is encouraged to designate an individual in their existing team who will be responsible for regular coordination with respective site people to ensure implementation of required green building measures and ultimately provide the required documentation for aspired Green Building Rating.

In case of any deviations in implementing recommended green building measures and/ or using specified material/ equipment/ system, contractor will have to inform Owners/ Services Consultant/ Green Building Consultant/ Architect as applicable for their formal approval.

In case of any additional requirement to comply with Green Building rating as identified during construction/ installation/ commissioning based on the actual site conditions/ construction activities, Contractor shall implement

## 21 PERFORMANCE GUARANTEE

The contractor shall carry out the work in accordance with the Approved shop drawings, Specifications, Schedule of Quantities and other documents forming part of the Contract. Contractor shall carry out heat load calculation, Ventilation calculation & Smoke calculation & submit the same for client / consultants approvals. The contractor shall be fully responsible for the performance of the selected equipment (installed by him) at the specified parameters and for the efficiency of the installation to deliver the required end result.

The contractor shall guarantee that the HVAC system as installed shall maintain the inside conditions in the air-conditioned spaces as described under “Basis of Design” in the specifications.

Complete set of architectural drawings is available in the Architect/Consultant’s office and reference may be made to same for any details or information. The contractor shall also guarantee that the performance of various equipment individually, shall not be less than the quoted capacity; also actual power consumption shall not exceed the quoted rating, during testing and commissioning, handing over and guarantee period.

## **LABOUR:**

The Contractor shall, unless otherwise provided in the Contract, make his own arrangements for the engagement of all staff and labour, local or other, and for their payment, housing, feeding and transport.

The Contractor shall, if required by the Engineer, deliver to the Engineer a return in detail, in such form and at such intervals as the Engineer may prescribe, showing the staff and the numbers of the several classes of labour from time to time employed by the Contractor on the Site and such other information as the Engineer may require.

## **COMPLIANCE WITH LABOUR REGULATIONS:**

During continuance of the contract, the Contractor and his sub-contractors shall abide at all times by all existing labour enactments and rules made there under, regulations, notifications and bye laws of the State or Central Government or local authority and any other labour law (including rules), regulations, bye laws that may be passed or notification that may be issued under any labour law in future either by the State or the Central Government or the local authority. Salient features of some of the major labour laws that are applicable to the construction industry are given below. The Contractor shall keep the Client indemnified in case any action is taken against the Client by the competent authority on account of contravention of any of the provisions of any Act or rules made there under, regulations or notifications including amendments. If the Client is caused to pay or reimburse, such amounts as may be necessary to cause or observe, or for non-observance of the provisions stipulated in the notifications/bye laws/Acts/Rules/regulations including amendments, if any, on the part of the Contractor, the Engineer/Client shall have the right to deduct any money due to the Contractor including his amount of performance security. The Client/Engineer shall also have right to recover from the Contractor any sum required or estimated to be required for making good the loss or damage suffered by the Client.

The employees of the Contractor and the Sub-Contractor in no case shall be treated as the employees of the Client at any point of time.

## **SPECIAL CONDITIONS OF CONTRACT**

### **SALIENT FEATURES OF SOME MAJOR LABOUR LAWS APPLICABLE TO ESTABLISHMENTS ENGAGED IN BUILDING AND OTHER CONSTRUCTION WORK.**

- a) **Workmen Compensation Act 1923:** - The Act provides for compensation in case of injury by accident arising out of and during the course of employment.
- b) **Payment of Gratuity Act 1972:** Gratuity is payable to an employee under the Act on satisfaction of certain conditions on separation if an employee has completed 5 years service or more or on death the rate of 15 days wages for every completed year of service. The Act is applicable to all establishments employing 10 or more employees.

- c) Employees P.F. and Miscellaneous Provision Act 1952: - The Act Provides for monthly contributions by the Client plus workers @ 10% or 8.33%. The benefits payable under the Act are:
- (i) Pension or family pension on retirement or death, as the case may be.
  - (ii) Deposit linked insurance on the death in harness of the worker.
  - (iii) Payment of P.F. accumulation on retirement/death etc.
- d) Maternity Benefit Act 1951: -The Act provides for leave and some other benefits to women employees in case of confinement or miscarriage etc.
- e) Contract Labour (Regulation & Abolition) Act 1970: - The Act provides for certain welfare measures to be provided by the Contractor to contract labour and in case the Contractor fails to provide, the same are required to be provided, by the Principal Client by Law. The Principal Client is required to take Certificate of Registration and the Contractor is required to take license from the designated Officer. The Act is applicable to the establishments or Contractor of Principal Client if they employ 20 or more contract labour.
- f) The Code on Wages, 2019: This code consolidates the Laws relating to Wages and Bonus and matters connected therewith or incidental thereto.
- g) Industrial Disputes Act 1947: - The Act lays down the machinery and procedure for resolution of Industrial disputes, in what situations a strike or lock-out becomes illegal and what are the requirements for laying off or retrenching the employees or closing down the establishment.
- h) Industrial Employment (Standing Orders) Act 1946: - It is applicable to all establishments employing 100 or more workmen (employment size reduced by some of the States and Central Government to 50). The Act provides for laying down rules governing the conditions of employment by the Client on matters provided in the Act and get the same certified by the designated Authority.
- i) Trade Unions Act 1926: - The Act lays down the procedure for registration of trade unions of workmen and Clients. The Trade Unions registered under the Act have been given certain immunities from civil and criminal liabilities.
- j) Child Labour (Prohibition & Regulation) Act 1986: - The Act prohibits employment of children below 14 years of age in certain occupations and processes and provides for regulation of employment of children in all other occupations and processes. Employment of Child Labour is prohibited in Building and Construction Industry.

- k) Inter-State Migrant workmen's (Regulation of Employment & Conditions of Service) Act 1979: - The Act is applicable to an establishment which employs 5 or more inter-state migrant workmen through an intermediary (who has recruited workmen in one state for employment in the establishment situated in another state). The Inter-State migrant workmen, in an establishment to which this Act becomes applicable, are required to be provided certain facilities such as housing, medical aid, travelling expenses from home up to the establishment and back, etc.
  
- l) The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996 and the Cess Act of 1996: - All the establishments who carry on any building or other construction work and employs 10 or more workers are covered under this Act. All such establishments are required to pay cess at the rate not exceeding 2% of the cost of construction as may be modified by the Government. The Client of the establishment is required to provide safety measures at the building or construction work and other welfare measures, such as Canteens, First-Aid facilities, Ambulance, Housing accommodations for workers near the work place etc. The Client to whom the Act applies has to obtain a registration certificate from the Registering Officer appointed by the Government.
  
- m) Factories Act 1948: -The Act lays down the procedure for approval at plans before setting up a factory, health and safety provisions, welfare provisions, working hours, annual earned leave and rendering information regarding accidents or dangerous occurrences to designated authorities. It is applicable to premises employing 10 persons or more with aid of power or 20 or more persons without the aid of power engaged in manufacturing process.

## SPECIAL CONDITIONS

1.It must be understood that the work has to be completed as per the time provided in the contract and as such time is the essence of the contract.

2.The quantities furnished in the bills of quantities are only probable quantities liable to alternation by omission, deduction or addition, and it would be clearly understood that the contract is not a lump sum contract and the SWOSTI PREMIUM LTD do not, in any way, assure the tenderer or guarantee that the said probable quantities are correct or that the work would correspond thereto. Payments will be regulated on the actual quantities of work authorizedly done and measured at the accepted rates. No claims due to change in quantities (+ or -) will be entertained. The drawings, forming parts of complementary installations work specifications and the bills of quantities, of the contract, are explanatory of and are to one another, representing together the works / to be carried out. If neither the drawings nor the specifications nor the accepted bills of quantities include any part/parts the intention to include which is nevertheless clearly inferred and which are obviously necessary for the proper completion of the works/ installations, all such parts shall be supplied and executed by the contractor at no extra charge. Anything contained in one or another of (a) the drawings, (b) the specifications and (c) the accepted bills of quantities and not found in the others will be equally binding as if it were contained in each of them.

3.No alterations, that might have been made by the tenderer in the drawings, specifications, conditions or probable quantities accompanying this notice will be recognized and if any such alterations are made the tender, will be invalid. Conditional tenders will however be liable for rejection.

4.The tenderer must obtain for himself on his own responsibility and at his own expense all the information necessary, including risks, contingencies and other circumstances to enable him to make a proper tender and to enter into a contract with the SWOSTI PREMIUM LTD . He must examine the drawings, specifications, conditions and so on and must inspect the site of work, examine the nature of the ground and the subsoil (so far as is practicable) and acquaint himself with local conditions, means of access to the work, storage facilities or areas for staff colony, the nature of the work, in fact all matters pertaining thereto before he submits his tender.

5.The tender accepted shall not be entitled to make any claim for increase in the rates quoted and accepted excepting in pursuance of any specific provision in the contract.

6.Only approved agencies/ skilled workers shall be deployed to carry out requisite specialized items of work. The Officer/ Engineer in charge's decision in consultation with Architect's/ in this regard shall be binding to all the parties concerned.

7. The rates shall be firm and not be subject to any variations in exchange rates, in taxes, duties etc. in railway freight and the like including labour conditions, etc. The rates are not subject to escalation.

8.It will be the sole responsibility of the contractor to procure all the equipments/ materials and other materials required for the work.

9.The SWOSTI PREMIUM LTD further reserves the right to delete or reduce at any time, any section of the bills of quantities with out assigning any reasons whatsoever there for and no claim will be entertained in this regard.

10. The tenderer whose tender is accepted is bound to execute formal agreement with the SWOSTI PREMIUM LTD within one week of the date of intimation of award of work in accordance with the draft agreement which will include conditions of tender, form of tender (general conditions of contract & Special Condition of Contract), Articles of Agreement, Bills of quantities, Conditions of contract, Special conditions if any, the drawings and specifications, but his liability under the contract shall commence from the date of written order to commence work whether the formal agreement is drawn or not.

The Contractor shall bear all expenses in connection with the execution of the said agreement including fees for stamping and registration of documents as required.

11. The Security Deposit will bear no interest whatsoever until the date of release.

12.

(a) The contractor, upon award of work, shall submit a memorandum of procedure giving the outline of his general scheme, programme and time table, in the form of a chart that shall be scrutinized and approved (with modifications as necessary), which shall become the approved programme for execution. The approved programme shall be the basis for assessment of comparative progress under the relevant conditions of contract.

(b). Over and above, the contractor has to supply programme chalked out showing important milestones to be achieved and the progress actually achieved compared with, the target of the same in the programme and shortfall, if any planned for being made up in the programme for next month.

13. The work in general shall conform to the Specifications provided.

(a) In case items not covered by the general specifications referred above, reference shall be made to the appropriate I.S. Code.

(b) Should there be any difference in the particular specifications of individual item of work and the description of item as given in the Schedule of quantity, the latter shall prevail, which will be as per the relevant drawing.

(c) In case of any work for which there is no specification in I.S. specifications or in the specifications forming part of tender documents or in case there is any variation, such work shall be carried out in all respects in accordance with the instructions to be issued by the Engineer in charge.

14. The work of any part of it shall not be transferred, assigned or sublet without the written consent of the SWOSTI PREMIUM LTD .

15. The Contractor shall be required to co-operate and work in co-ordination with and afford reasonable facilities for such other agencies / specialists / interior designers/ consultants as may be employed by the Architects / Project Management Consultant/ Officer in Charge on other works / sub-works in connection with the project/scheme of which this work forms a part.

16. The Contractor shall get the necessary insurance done for their personal employed/ Swosti Premium Ltd third party insurance in name of G.M(B D), Swosti Premium Ltd and for all other risk insurance or any other insurance as required.

17. The Contractor shall make arrangements of carrying water and electricity .

18. The Contractor is required to comply with all Acts of Government relating to labour, safety, environment and other Rules and Regulations made there under from time to time and to submit at the proper times all particulars and statements required to be furnished to the appropriate Authorities.

19. Contractor shall not in any way interrupt or do any act, matter or thing to prevent or hinder such other Contractor or other person or persons employed for completing and finishing or using the materials and plant for the Work. When the Work shall be completed or as soon thereafter as convenient the Architect shall give a notice in writing to the Contractor to remove his surplus materials and plant, and should the Contractor fail to do so within a period of 14 days after receipt thereof by him, Owner shall sell the same, and shall give credit to the Contractor for the amount realized. The Architect shall thereafter ascertain and certify in writing what (if anything) shall be due or payable to or by the Owner for the value of the said plant and materials so taken possession of by the Owner and the expense or loss which the Owner shall have been put to in procuring the works to be completed, and the amount, if any, owing to the Contractor and the amount which shall be so certified shall thereupon be paid by the Owner to the Contractor or by the Contractor to the Owner, as the case may be, and the certificate of the Architect shall be final and conclusive between the parties.

20. If at any time after the commencement of the work the Owner shall for any reason whatsoever not require the whole thereof, as specified in the tender, to be carried out, but need to abridge the Contract, the Owner shall give notice in writing of the fact to the Contractor who shall have no claim to any payment or compensation which he might have derived from the execution of the work in full, but which he did not derive in consequence of the whole amount of the work not having been carried out. The Contractor shall in this case, however, be entitled to payment for the work already executed by him in accordance with the agreed rates. The Owner shall also take over all building materials as might have been ordered for the work, but orders for which cannot be canceled, if delivered within a reasonable time, and shall pay for them at cost price. The Contractor shall also be allowed to remove his tools and plants from the site.

## Contractor Responsibility Matrix

Work Element / Activity	Contractor	Client (Swosti)	PMC (You)	Architect / Consultants
1. Mobilisation & Site Establishment	R	A	C	-
2. Setting Out and Site Survey	R	C	C	C
3. Site Safety & Housekeeping	R	C	C	-
4. Approvals from Local Authorities (as applicable)	C	A	R	C
5. Scaffolding, Centering, and Shuttering	R	I	C	-
6. Quality Control & Testing	R	I	C	C
7. Coordination with MEP teams	C	I	C	C
8. Materials Procurement (Cement, Steel, Bricks, etc.)	R	I	C	-
9. Submission of Progress Reports & MIS	R	I	A	-
10. Adherence to Timeline / Work Schedule	R	I	C	-
11. Rectification of Defects During DLP	R	A	C	-
11. Final Handover & Completion Report	R	A	C	-

### Legend:

- **R = Responsible** – Main executor.
- **A = Accountable** – Final decision-maker or owner.
- **C = Consultative** – Provides input and coordination.
- **I = Informed** – Kept in the loop, but not involved in execution.

### Management Meetings

- Either the Engineer or the Contractor may call for a management meeting.
- These meetings are held to review progress plans and handle issues flagged under the early warning system.
- The Engineer shall record meeting proceedings and circulate to attendees and the Client.
- Action items shall be assigned and communicated in writing.

### Quality Control

- The Engineer shall regularly inspect the Contractor's work and identify any defects. Instructions may be issued to uncover or test work suspected to be defective.

- **Tests** If the Engineer instructs tests not specified in the specifications, and the work is found defective, the Contractor shall bear the cost of tests. If no defect is found, it will be treated as a Compensation Event.

#### Payments & Liquidated Damages Payments

- Payments shall be adjusted for deductions for retention, other recoveries in terms of the contract and taxes at source, as applicable under the law.
- The Engineer shall pay the Contractor the amounts as per the payment schedule attached to the contract.

#### Retention

- The performance security obtained at the time of signing of contract shall be retained till successful conclusion of project completion and issue of completion certificate.
- The Client shall retain from each payment due to the Contractor the proportion stated in the Contract Data until Completion of the whole of the works or settlement of final payment.
- On completion of the whole of the works half the total amount retained is repaid to the contractor and half when the Defects Liability Period has passed, and the Engineer has certified that all defects notified by the Engineer to the contractor before the end of the period have been corrected.

#### Milestone

Milestone No.	To be Achieved	Timeline
Milestone 1-	<b>60 % of value of contract</b>	<b>Upto 120 Days</b>
Milestone 2-	<b>100 % of value of contract</b>	<b>Upto 180 Days</b>

#### Liquidated Damages

- The Contractor shall pay liquidated damages to the Client at the rate 0.2%/day on the value of balance work beyond stipulated date of completion as per following milestones of execution subject to a maximum of 10% of contract value.
  - a) Up to end of 120 days of signing of contract – 60 % of value of contract
  - b) Up to end of 180 days of signing of contract –100 % of value of contract