Tender Fee: Rs. 5,000/-
(Non-Refundable)

TENDER FORM

Tender # ME/05/26-27

Provide, Supply, Install, Commissioning & Testing of Building Management System for HVAC

Date of Issue	**:**	**November 26, 2026,**
Last Date of Submission	**:**	**December 16, 2026 (2:30 PM)**
Date of Opening of Tender	**:**	**December 16, 2026 (3:00 PM)**

Company Name: _____

NTN: _____

SRB / GST Registration Number: _____

Pay Order / Demand Draft # _____, Drawn on Bank_____

Amount of Rs. _____, Dated: _____

Notice Invitation Tender (NIT)

Tender Notice

The Institute of Business Administration, Karachi (IBA) invites sealed bids from active taxpayers of manufacturers/firms/companies/distributors/suppliers registered with relevant tax authorities for the following tender.

Tender Title (Ref. No.)	Procedure	Bid Security
Provide, Supply, Install, Commissioning & Testing of Building Management System for HVAC (ME/05/26-27)	Singe Stage One Envelope	Rs. 300,000/-
Tender Fee & Dates		
Fee: Rs. 5,000/-		
Issuance start date:	*November 26, 2026, from 9:00 AM*	
Issuance end date & time:	*December 16, 2026, till 2:30 PM*	
Submission date & time:	*November 26, 2026, to December 16, 2026, from 9:00 AM to 2:30 PM*	
Mandatory Site Visit	***December 10, 2026, 11:00 AM at IBA Main Campus***	
Opening date and time:	*December 16, 2026, at 3:00 PM*	

Tender Document containing detailed terms and conditions are available at Office of **Head of Procurement, Fauji Foundation Building, IBA Main Campus, University Enclave, Karachi** on any working day (Monday to Friday). The tender document can also be downloaded from IBA and SPPRA EPADS system. The Tender fee challan is to be generated from the IBA website https://www.iba.edu.pk/tenders/ which may be deposited in any branch of Meezan Bank Ltd. Bidders are required to submit their bids (duly signed and stamped) on the uploaded Tender Document (along with a copy of Earnest Money and all supporting documents) through SPPRA EPADS system (www.eprocure.gov.pk). The original bid security along with the Original Bid (duly signed and stamped) must be delivered to IBA, Karachi on below mentioned address before bid opening and will be opened on same date & venue in the presence of the bidders' representatives who may wish to attend. Bid Security in the form of Pay Order or Demand Draft has to be submitted in favour of "**IBA Karachi**".

N.B. (1) IBA Karachi reserves the right to reject any bid or cancel the bidding process subject to the relevant provision of SPP Rules 2010.

(2) Only uploaded bid along with supporting documents will be accepted. In case there is a contradiction between bidder's EPADS submitted bid and manually submitted bid, bid submitted on EPADS will be considered valid for evaluation purpose.

REGISTRAR
IBA, Main Campus, Karachi University Enclave, Karachi-75270
UAN: 111-422-422, Fax: (92-21) 99261508
Contact Person: Assistant Manager Procurement on 38104700, Ext: 2150
Email: tenders@iba.edu.pk , IBA Website: https://tenders.iba.edu.pk
SPPRA EPADS Website: https://portalsindh.eprocure.gov.pk/

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1. Introduction

Dear Tenderer:
Thank you, the interest you have shown in response to the IBA's advertisement which has floated in IBA & SPPRA EPADS websites and leading newspapers on November 26, 2026, to "Provide, Supply, Install, Commissioning & Testing of Building Management System for HVAC".

The Institute of Business Administration, Karachi (IBA) is the oldest business school outside North America. It was established in 1955 with initial technical support provided by the Wharton School of Finance, University of Pennsylvania. Later, the University of Southern California (USC) set up various facilities at the IBA & several prominent American professors were assigned to the IBA. The course contents, the curriculum, the pedagogical tools & the assessment & testing methods were developed under the guidance of reputed scholars from these two institutions. IBA has zealously guarded the high standards & academic traditions it had inherited from Wharton & USC while adapting and adjusting them with the passage of time.

We expect to avail services/works/items of high standards meet our prime & basic specifications through this transaction.

Please contact Assistant Manager Procurement on 38104700 ext: 2150 for any information and query.

Thank you.

-sd-
Registrar

2. Instructions

(a) Sign & Stamp

It is necessary to fill in the Tender Form meticulously and sign & stamp every page. Moreover, attach the required supporting documentation according to the requirement. The tender document will be accepted ONLY on the IBA's prescribed Tender Document available on IBA's Website.

(b) Filling of Tender Form

It is mandatory to fill the Tender Form in writing in ink or type. Do not leave any column/item blank. If you want to leave the item/column un-answered please, write 'Doesn't Apply/Doesn't Arise'. If you need more space, please attach a paper & clearly mention the item/column name or number etc that referred to the column/item of the Tender Form.

(c) Collection of Tender

You can collect the Tender Document from the office of Head of Procurement, Ground Floor, Fauji Foundation Building, IBA Main Campus, University Enclave, Karachi from November 26, 2026, to December 16, 2026, during working 9:00 AM to 2:30 PM or download directly from IBA website or SPPRA EPADS portal.

(d) Tender Number

Please mention "Tender Number" at the top left corner of the envelopes. IBA, Karachi may reject any bid subject to the relevant provision of SPP Rules 2010 and may cancel the bidding process at any time before acceptance of bid or proposal as per Rule-25(i) of said rules.

(e) Communication

Any request for clarification regarding technical specification should be submitted in writing to:

Contact Person (IBA):	Mr. Rehan Hussain Senior Manager Operations & Maintenance Institute of Business Administration, Main Campus, University Enclave, University Road, Karachi.
Tel #:	021 38104700; Ext 2506
Email:	tenders@iba.edu.pk

(f) Submission of Documents and Address

Tender Document/Bid (with a copy of Bid Security/Earnest Money and supporting documents) should be submitted / uploaded on SPPRA EPADS https://portalsindh.eprocure.gov.pk/. The original Bid Security along with the Original Bid (duly signed and stamped) must be dropped in Tender Box placed at the Security Office, Gate # 4, IBA Main Campus, University Enclave, University Road, Karachi till 2:30 PM on December 16, 2026. **Tender Documents received by fax or email will not be accepted.**

(g) Date of Opening of Tender

The bid will be opened on December 16, 2026, at 3:00 PM in the presence of representative bidders who may care to attend.

Stamp & Signature

(h) Rights

Competent authorities reserve the right to accept or reject any quotation/ tender without any reason thereof.

(i) Location of Deliveries

Supply will be delivered at IBA Main Campus, University Enclave Karachi. IBA is not liable to pay any Custom duty, Levies, Taxes, Demurrage or any other charges, Warehousing, Logistics etc.

(j) Clarification / Proof

Please submit copies of certificates of registration with the Sales Tax and Income Tax departments. The manufacturer/firms/companies/distributors/ suppliers should also provide copy(ies) of the OEM certificate(s) etc. as proof of their claim.

k) Site Survey

The Bidder must survey the site on;

- Date: December 16, 2026
- Time: 11:00 AM
- Location: IBA Main Campus, University Road, University Enlcave, Karachi.
- Contact Person: Mr. Rehan Hussain

Stamp & Signature

3. Bidding Data

(a) Name of Procuring Agency: Institute of Business Administration, Karachi.

(b) Brief Description of the Procurement: Provide, Supply, Install, Commissioning & Testing of Building Management System for HVAC.

(c) Procuring Agency's address: Main Campus, University Enclave, Karachi.

(d) Amount of Bid Security: Bid Security of Rs. 300,000/- must be submitted along with Tender Documents in the shape of PAY ORDER / DEMAND DRAFT only in the name of the Institute of Business Administration, Karachi.

(e) Period of Bid Validity (days): Ninety Days.

(f) Deadline for Submission of Bids along with time: The last date of submitting the Tender Document is December 16, 2026, by 2:30 PM on SPPRA EPADS portal. The original Bid Security along with the Original Bid (duly signed and stamped) must be dropped in Tender Box placed at the Security Office, Gate # 4, IBA Main Campus, University Enclave, University Road, Karachi till 2:30 PM on December 16, 2026. The Tender will be opened on the same day at 3:00 PM in the presence of representatives who may care to attend.

(g) The venue, Time, and Date of Bid Opening: The Tender will be opened on December 16, 2026, at 3:00 PM at IBA Main Campus, University Enclave, University Road, Karachi in the presence of representatives who may care to attend.

(h) Time for Completion from written order of commencing: 6 months

(i) Liquidity damages: In the event of delay in delivery at supplier fault, the supplier shall inform the purchaser before the expiry of such period giving reasons or justification for delay. However, the purchaser reserves the right to take the following actions:

1) Evaluate the request for extension in the delivery period as per its merit and may consider extension in delivery period or otherwise.
2) May cancel the contract.
3) Liquidated damages (if imposed) will be recovered at the rate of up to 2% per month and shall not exceed 10% of the total value of the contract.

(j) Contract Agreement: Contract Agreement shall be assigned to the successful bidder on Stamp Paper comprising stamp duty of 0.35% (converted amount in PKR) of the total value of Bid offered in response to the tender. Stamp duty will be paid by the bidder.

(k) Deposit Receipt No: _____ Dated: _____
Amount (in words and figures): _____
Pay Order / Demand Draft #: _____, Amount: Rs. _____
Drawn on Bank: _____, Dated: _____
 # ……., Amount :Rs……Drawn on Bank…… Dated…….

_____
Stamp & Signature

4. Terms & Conditions

(a) Bid Security

Bid Security of Rs. 300,000/- in the shape of a bank draft/pay order in the name of "**Institute of Business Administration**" Karachi, should be submitted along with the tender documents.

(b) Performance Security

Successful bidder should provide 5% Performance Security of the total value of the Letter of Intent/Acceptance in the form of Pay Order or bank guarantee before submission of invoice. The Performance Security shall extend at least three months beyond the Date of Delivery or Completion of the contract.

(c) Validity of the Tender

All proposals and prices shall remain valid for 90 days from the closing date of the submission of the proposal. However, the Manufacturer/Firm/Company/Distributor/Supplier is encouraged to state a longer period of validity for the proposal.

(d) Currency

All currency in the proposal shall be quoted in Pakistan Rupees (PKR).

(e) Ownership

The ownership of all products and services rendered under any contract arising as a result of this tender will be the sole property of IBA.

(f) Arbitration and Governing Law

This tender and any contract executed under this tender shall be governed by and construed following the laws of Pakistan. The IBA and all Manufacturer/Firm/ Company/Distributor/Suppliers responding to this tender and parties to any contract executed according to this tender shall submit to the exclusive jurisdiction of the Pakistani courts. The arbitration proceeding will be governed by the Arbitration Act, 1940, and the substantive and procedural law of Pakistan. The venue shall be Karachi.

(g) Acceptance of Tender

The IBA reserves the right not to accept the lowest and to annul the bidding process without assigning any reason whatsoever. IBA Karachi may ask to provide a demo unit that the supplier quoted in the tender. After the final inspection of the unit, the decision will be made.

(h) Support Capabilities

The Manufacturer/Firm/Company/Distributor/Supplier should indicate the support capabilities for all the hardware and software provided during the warranty.

(i) Compliance to Specifications

The Manufacturer/Firm/Company/Distributor/Supplier shall provide information as per requirements given in BoQ. However, Manufacturer/Firm/Company/Distributor/ Suppliers can submit multiple solutions. Manufacturer/Firm/Company/Distributor/ Supplier may not propose/supply any kind of refurbished hardware equipment/ components in their proposals.

Stamp & Signature

(j) Cancellation

IBA reserves the right to cancel any or all the above items if the material is not in accordance with its specifications or if the delivery is delayed.

(k) Invoice

Invoice/bill should be submitted to Purchase Department.

(l) Stamp Duty

Stamp duty 0.35% against the total value of the Letter of Intent/Acceptance will be levied accordingly.

(m) Delivery / Completion Time

Within 06 months after receiving the Letter of Intent/Acceptance.

(n) Payment Terms

All payments will be made after the complete delivery and installation as per the Bill of Quantity, within 30 working days after submission of the commercial invoice.

(o) Packing & Transportation

All Equipment shall be individually packed in standard packing provided by the manufacturer for onwards transportation and delivery. Any item damaged during transportation will be replaced by the bidders at their own cost.

(p) Default

If the Bidder fails to timely deliver items or services as per Bill of Quantity, IBA, Karachi reserves the right to penalize and may also terminate the contract.

(q) Force Majeure

The Supplier shall not be held liable in the event of their failure to comply with the delivery schedule of the ordered items(s) for reasons of Force Majeure including to war and other instabilities invasion, the act of foreign enemies, embargo, civil war etc.

(r) Increase in Price

No increase in the value of the above-mentioned items will be accepted on account of either unit price, total price, any or all other charges, duties, taxes, the scope of supply or services and or any other head of account shall be allowed.

Stamp & Signature

5. Integrity Pact

Declaration of Charges, Fees, Commission, Taxes, Levies etc. payable by the Bidder;

M/s. _____, the Bidder hereby declares that:

(a) Its intention is not to obtain the Provide & Supply work of any Contract, right, interest, privilege, or other obligation or benefit from the IBA or any administrative or financial offices thereof or any other department under the control of the IBA through any corrupt practice(s).

(b) Without limiting the generality of the forgoing the Bidder represents and warrants that it has fully declared the charges, fees, commission, taxes, levies etc, paid or payable to anyone and not given or agreed to give and shall not give or agree to give to anyone within the IBA directly or indirectly through any means any commission, gratification, bribe, gifts, kickback whether described as consultation fee or otherwise, with the object of obtaining or including the Provide & Supply or service contract or order or other obligations whatsoever from the IBA, except that which has been expressly declared pursuant hereto.

(c) The Bidder accepts full responsibility and strict liability for making any false declaration/statement, not making full disclosure, misrepresenting facts or taking any action likely to degrade the purpose of declaration, representation and warranty. It agrees that any contract/order obtained aforesaid shall without prejudice to any other right & remedies available to the IBA under any law, contact, or other instruments, be stand void at the discretion of the IBA.

(d) Notwithstanding any right and remedies exercised by the IBA in this regard, Bidder agrees to indemnify the IBA for any loss or damage incurred by it on account of its corrupt business practice & further pay compensation to the IBA in any amount equivalent to the loss of any commission, gratification, bribe, gifts, kickback given by the company/firm/supplier/agency/bidder as aforesaid for the purpose of obtaining or inducing Provide & Supply/work/service or other obligation or benefit in whatsoever from the IBA.

Note:

This integrity pact is a mandatory requirement other than auxiliary services/works.

Stamp & Signature

6. Bidder Qualification Criteria

S.No.	Mandatory Eligibility Criteria	Remarks Yes / No	Required Supporting Documents
1.	Successful completion of at least three (03) similar projects completed / in hands in last ten years. Testimonial from the customer or can be confirmed by IBA, Karachi.		Verifiable Purchase Orders / Satisfactory work completion certificates/letters.
2.	Last 3 years' turnover with a minimum of 30 million (per year) on average		Annual audited statement and Annual Income Tax Returns of last three years.
3.	Active Income Taxpayer at the time of submission of the bid		NTN and STRN registration certificates.
4.	Active Sales Taxpayer		Copy of Last month's Sales Tax & Services Tax return.
6.	OEM Authorized System Integrator and Partner for last 10yrs		Certificate / Authorization Letter verifiable through e-mail
7.	Not blacklisted by any organization during last 5 years		Affidavit on stamp paper

Note: Bidder must submit all the Supporting Documents for evaluation.

Stamp & Signature

7. Scope of Work

BUILDING MANAGEMENT SYSTEM

1.1 SCOPE OF WORK

1.1.1 The Building Management System (BMS) shall have Central Command Centre (CCC) control room at office building housing the operator interface workstation. This shall provide a centralized monitoring and control facility. The BMS must have a capacity to provide remote access of BMS over the network. The BMS shall be able to undertake all monitoring and control functions for the entire Building. The BMS Contractor shall be responsible for the detailed design and engineering of the system, based on drawings and specifications.

1.1.2 Provide complete BMS turnkey installations and undertake the integration of the low voltage building systems as detailed in this and other sections of these specifications. The BMS shall comprise, at minimum, the following components:

1.1.2.1 Operator Interface Workstations (OIW).

1.1.2.2 Communication Control Panels (CCP)

1.1.2.3 Distributed Control Panels (DCP).

1.1.2.4 Unitary Controllers (UC).

1.1.2.5 Network Controller (NC)

1.1.2.6 Remote Operator Workstations (ROW).

1.1.2.7 Local Area Networks (LAN).

1.1.2.8 Field instrumentation.

1.1.2.9 Automatic Valve.

1.1.2.10 Actuators for automatic valves and motorized dampers.

1.1.2.11 Hardware & Software, etc. as necessary to implement the required interfaces with other third party systems.

1.1.2.12 Operating Software.

1.1.2.13 Low voltage (less than 240Vac) cable.

1.1.2.14 All power supplies and conditioners, interlocking and control relays, equipment enclosures and other components, materials and services required for a completed and fully operational turnkey BMS installation meeting these specifications.

1.1.3 The BMS contractor shall provide the consoles at the Central Command Centre (CCC), The BMS contractor shall furnish all information to the other contractors in order that the MEP contractors can provide the necessary facilities for the BMS components at these locations.

1.1.4 Provide the following support for all components furnished under this contract:

1.1.4.1 Warranty and service during the defects liability period.

1.1.4.2 Submittals, samples and record documentation.

1.1.4.3 Comprehensive commissioning and testing.

1.1.4.4 Training services for the Supervisors and Operators.

1.1.4.5 Coordination with other site contractors.

1.1.4.6 Reporting to the Employer and Engineer for the coordinated and timely execution of the Work.

1.1.5 The components furnished under this contract shall be the most recent products that meet the specifications. If there are improved models of any components furnished under this contract that become available before the on-site commencement of installation then these shall be offered to the Employer at no additional cost to the Employer. The Employer shall have the option to accept or decline the offer.

1.1.6 It is the intent of these specifications that the BMS contractor will be responsible for:

1.1.6.1 Developing detailed point summary sheets based on the drawing and information provided in these specification for approval by the engineer so as to achieve a fully

functional system wherever equipment is to comply with the requirements of authorities having jurisdiction the BMS contractor shall incorporate all the requirements of the authorities at no extra cost to employer.
1.1.6.2 Developing detailed write up's of each sequence of operation based on these documents for the review / approval of the engineer. Any changes / amendments required by the engineer shall not automatically result in a price variation as / long as no additional hardware is added.
1.1.7 BMS Contractor shall provide all software licenses necessary for the legal operation of the components furnished under this contract.
1.2 BMS TOPOLOGY
1.2.1 The BMS shall meet the following general criteria:
1.2.1.1 Computer based. (Web Based)
1.2.1.2 Fully networked
1.2.1.3 Real time.
1.2.1.4 Distributed processing.
1.2.1.5 No single point of failure
1.2.2 The BMS shall be configured to ensure reliability of systems operation and control of critical functions/systems. In general, all monitoring and control of separate systems shall be achieved via single control panels. Critical inputs of a system shall be wired directly to the controlling panel. Where required, dedicated control panels shall be provided and shall not share any point monitoring or control with other systems.
1.2.3 The following describes, in very general terms, a relationship between the various components of the BMS that would be acceptable. Other BMS topologies shall be acceptable if they meet the intent and performance requirements defined in these specifications. Refer to the schematic at the end of this Section.
1.2.4 The OIW shall incorporate, at minimum, Personal Computers (PC) and Operator terminals. Provide the BMS with a "peer-to-peer" primary communication network. The OIW shall reside on the primary Local Area Network (LAN), or shall interface to a node on the primary LAN, and shall provide the Operator with a "window" into the BMS for the accessing of data, the changing of database parameters at the CCP, DCP, and UC and the execution of manually entered commands.
1.2.5 The primary communication LAN shall be a high speed Fiber Optic Ethernet TCP/IP network.
1.2.6 The CCP shall be capable of a peer-to-peer communication and shall reside as nodes on the primary LAN. CCP shall be fully programmable control panels or servers. CCP shall provide communication coordination with the DCP, interface to the secondary LAN, and/or shall provide a gateway to third party systems.
1.2.7 The DCP shall be capable of "peer-to-peer" communication and shall reside as nodes on the primary LAN and/or the secondary LAN. DCP shall be fully programmable control panels. DCP shall provide an interface to the field instrumentation and final control elements and/or shall provide a gateway to secondary LAN.
1.2.8 UC shall reside as nodes on the secondary LAN. The secondary LAN shall be an RS485 or similar network. UC shall be "freely programmable" type controllers. Control and monitoring using UC shall be limited to unitary equipment. UC shall provide an interface to the field instrumentation and final control elements for specified items of equipment.
1.2.9 The ROW shall provide the Operator with an interface to the BMS at each CCP and DCP location. The ROW shall also provide the Operator with remote access to the BMS via auto-dial/auto answer modems. The ROW shall be a portable PC. The ROW shall also enable the Operator to access each UC. The BMS Contractor shall also provide hand held terminals that shall enable the Operator to access data, change database parameters and execute manually entered commands at the UC to which it is connected.
1.2.11 an illustration of topology is shown in the Drawings. It is appreciated that different vendors have different topologies and this schematic is provided solely for the purposes of illustrating the relationship between components.
1.3 COORDINATION WITH OTHER TRADES

1.3.1. The BMS Contractor shall coordinate the work of this contract with the work of all other trades on the project.
1.3.2 Any task related to the BMS turnkey installation that is not clearly identified in these documents as being the responsibility of another trade shall be the responsibility of the BMS Contractor.

2.0 GENERAL REQUIREMENTS

2.1 ABBREVIATIONS

ACI - Automatic Controls Interface
BMS - Building Management System
BSI - British Standards Institution
CCP - Communications Control Panel
CCC - Central Command Centre
CPU - Central Processing Unit
DCP - Distributed Control Panel
DIU - Damper Interface Unit
FAS - Fire Alarm System
FCU - Fan Coil Unit
FMS - Facility Management System
FTS - Field Termination Schedule
HHT - Hand Held Terminal
HVAC - Heating, Ventilating and Air Conditioning
ICT - Information Communication Technology
IEE - Institute of Electrical Engineers
I/O - Input/Output
LAN - Local Area Network
LCD - Liquid Crystal Display
LED - Light Emitting Diode
OIW - Operator Interface Workstation
PC - Personal Computer
PIM - Process Interface Module
RAM - Random Access Memory
RFI - Radio Frequency Interference
RH - Relative Humidity
RMSP - Refrigeration Machine Sequence Panel
ROW - Remote Operator Workstation
SD - System Diagram
SVGA - Super Video Graphics Adapter
UC - Unitary Controller
VAV - Variable Air Volume
GUI - graphical user interface
VFC - Volt Free Contacts
VFD - Variable Frequency Drive
RTD - Resistive Temperature Detector

2.2 UNIT PRICES

2.2.1. The BMS contractor is to provide a tender price for the complete BMS. In addition, the Contractor shall provide unit prices for all items of equipment installed under the contract in sufficient detail to enable additions and deletions to the contract to be priced by the Employer.

2.3 EQUIPMENT AND MATERIALS - GENERAL

2.3.1. When a specific reference to a manufacturer of a product is made, and the term "equal and approved" is used, substitutions of a product by another manufacturer will be allowed, but the substituted product must conform to all specified requirements. The Engineer’s determination on the acceptability of substitutes shall be final. Approved substituted equipment shall conform to available space requirements. Substituted equipment that does not conform to the available space requirements shall be replaced or required modifications shall be made at no additional cost to the Employer.

2.3.2. All equipment and materials shall be new and without any defect. All components of one type shall be products of one manufacturer (like temperature sensors, dampers, etc.).

3.0 DOCUMENTATION

3.1 WORK OF THIS SECTION

3.1.1 This section of the specifications details the components to be provided by the BMS contractor relating to the following:

3.1.1.1 Shop drawings.

3.1.1.2 Coordinated drawings.

3.1.1.3 Cable and containment drawings.

3.1.1.4 Record Documentation.

3.1.1.5 Tenants' documentation

3.2 SHOP DRAWINGS - GENERAL

3.2.1 The primary purpose of the shop drawing and equipment documentation submittals is to give instruction and information to those responsible for providing a turnkey BMS which is compliant with the BMS specifications in all respects. The Engineer shall review the shop drawings and equipment documentation submittals with the intent of identifying as many potential areas of noncompliance as possible, but the review of shop drawings and equipment documentation submittals by the Engineer shall not relieve the contractor of the responsibility for complete compliance with the specifications. Identification of some errors by the Engineer but overlooking others does not relieve the contractor of his responsibilities nor does it allow him to proceed based on erroneous shop drawings and equipment documentation submittals.

3.2.2 Approval of shop drawings or submittal data by the Engineer shall not constitute an order to fabricate, purchase, ship to the site or undertake any other action. The sole responsibility for the timely purchase and/or fabrication of components, obtaining approval on shop drawings and equipment documentation submittals, and delivery of components to the project to comply with the requirements of the project schedule is that of the contractor.

3.2.3 The intent of the record documentation is to provide the Employer with complete information on the BMS provided. The record documentation shall be in such detail that a person familiar with installations of this nature shall be able to perform any operating, maintenance or engineering functions with respect to this BMS without having to contact the BMS contractor or obtain any additional documentation.

3.2.4 The shop drawings, including containment and cable drawings, related to the any area of the project shall be completed within 8 calendar days of the coordinated MEP drawings for the area. The equipment submittals shall be provided to the MEP contractors in a single issue within 1 month of the award of contract.

4 Nos. hard copies shall be provided of each shop drawing submittal and 2 Nos. electronic copies shall also be submitted.

3.3 COORDINATION DRAWINGS

3.3.1 The BMS contractor shall participate in the development of coordinated drawings with all other contractors, in particular those contractors furnishing systems with which the BMS has a digital communications interface. The MEP contractors shall indicate all mechanical, plumbing and fire protection work on the drawings. The MEP contractors shall then add the electrical and fire alarm system (FAS) work to the drawings. The BMS contractor shall indicate the required BMS work on the drawings. Assist and cooperate with the other trades to ensure a complete and coordinated set of drawings has been generated.

3.3.2 The coordination drawings shall be submitted within 2 months of award of contract.

3.4 CABLE AND CONTAINMENT DRAWINGS

3.4.1 The BMS contractor shall provide shop drawings indicating the following:

3.4.1.1 Requirements for all cabling and containment serving BMS components for voltages of 240Vac or greater.

3.4.1.2 Requirements for all BMS low voltage (less than 240Vac) containment.

3.4.1.3 Requirements for BMS LAN containment. These LAN containment shop drawings shall detail LAN containment required.

3.4.2 These cable and containment shop drawings shall indicate all BMS component locations and the type and size of all required BMS power, BMS monitoring and control and BMS primary and secondary LAN cable and containment. These cable and containment shop drawings shall include wiring details for the unitary controllers associated with the VAV terminal units and the Fan Coil Units (FCU). The drawings shall be in such detail that the MEP contractors' personnel shall be able to undertake the installation without further instruction from the BMS contractor.
3.4.4 The contractor shall terminate the power wiring at the MCC/ distribution panel as applicable and at a power outlet adjacent to the BMS component. The BMS contractor shall connect between the power outlet and the BMS component.
3.4.5 The contractor shall provide low voltage cable (less than 240Vac) and shall terminate the cable at both ends. Whereas excess wire shall not be looped or coiled in the controller cabinet.
3.4.6 The contractor shall provide and terminate LAN cabling at all BMS controllers etc.
3.4.7 Any errors or omissions that occur in the installation and are a result of errors and omissions in the cable and containment shop drawings shall be corrected at the expense of the BMS contractor.
3.5 SHOP DRAWINGS
3.5.1 Prepare an itemized listing of all shop drawings and equipment documentation submittal data for the Project including all required submissions identified throughout the Contract Documents. The itemized listing shall include a shop drawing sheet number or equipment documentation submittal number, reference to the specific Specification section and description of the shop drawing or equipment documentation submittal item. Submit the itemized listing within two (2) weeks after commencing work.
3.5.2 Prepare all shop drawings, diagrams, equipment and device schedules, equipment technical data sheets and software information necessary to ensure compliance with the Specifications. Submit all shop drawings and equipment documentation submittal data for the work within 1 months of receiving the notice to proceed except the cable and containment shop drawings detailed below which shall be submitted within 2 weeks after commencing work.
3.5.3 Prepare all shop drawings, diagrams, equipment and device schedules, equipment technical data sheets and software information necessary to ensure compliance with the specifications. Submit all shop drawings and equipment documentation submittal data for the work within 1 months of receiving the notice to proceed except the cable and containment shop drawings detailed below which shall be submitted within 15 days of the notice to proceed.
3.5.3 Shop drawings shall be AutoCAD drawing format, minimum A1 plot size. Drawings shall include diagrams, mounting instructions, installation procedures, equipment details and software descriptions for all aspects of the system to be installed. At minimum, the shop drawings shall include:
3.5.3.1 BMS topology schematic.
3.5.3.2 Installation drawings and schedules.
3.5.3.3 DCP, UC and other panel layouts, including floor plan location and interconnection drawings.
3.5.3.3 Field instrumentation locations on floor plan drawings.
3.5.3.5 Schematic of systems indicating instrumentation locations.
3.5.3.6 Installation details.
3.5.3.7 Schedule of cabling including details of proposed cable types.
3.5.3.8 Composite drawings of all motor starter terminal strips and damper terminal strips indicating all existing and new wiring by all contractors on the motor terminal strip.
3.5.4 Equipment submittals shall include design, performance and installation details or all aspects of the system to be installed. At minimum, the equipment documentation submittals shall include:
3.5.4.1 Equipment technical data sheets with mounting and installation details.
3.5.4.2 Central monitoring and control equipment details.
3.5.4.3 Operator terminal specifications and data sheets.
3.5.4.3 Software specifications and descriptions including operating sequences.
3.5.4.5 Field sensor and instrumentation specification sheets.
3.5.4.6 Damper Interface Unit (DIU) drawings.
3.5.4.7 Valves and valve actuator specification sheets and valve schedules.
3.5.4.8 Details of PID and other appropriate control algorithms.
3.5.4.9 Proposed GUI schematics.

3.5.5 Operating sequences shall not be implemented by the BMS contractor until the Engineer has given approval. The BMS contractor shall make any changes to the operating sequences as requested at the shop drawing stage and as requested by the Engineer following their implementation up to the issue of the Certificate of Substantial Completion at no additional cost to the Employer.
3.5.6 All literature pertaining to a particular item, piece of equipment or installation shall be submitted at one time and shall be specifically prepared for this project. General sales information brochures shall not be acceptable. Each equipment documentation submittal shall be properly marked with service or function, any options available that are not to be provided shall be crossed out or options that will be provided shall be highlighted.
3.5.7 Comply with the requirements of the specifications. Any deviations from the specifications will not be allowed. Submittals not in accordance with the specification requirements shall be rejected. Before equipment, devices and materials are installed, they shall have submittals that are stamped by the Engineer “Approved” or “Approved as Noted”. Submittals stamped “Approved” or “Approved as Noted” shall not relieve the contractor from the requirements to comply with the complete requirements of the Specifications. Corrections or modifications to the work because of errors and/or omissions shall be at the contractor’s expense.
3.5.8 Each submittal shall be reviewed, stamped and certified by the contractor prior to submission to the Engineer.
3.5.9 Submittals shall be in accordance with the General Contract. Submittals marked “Revise and Resubmit” shall be resubmitted within two (2) weeks of their receipt by the BMS contractor.
3.6 RECORD DOCUMENTATION
3.6.1 Prepare an itemized listing of all record documentation that will be provided. Submit the listing within 2 months after commencing work. At minimum, the record documentation shall include all submittals made at the shop drawing stage up-dated to reflect the actual installation and the manuals outlined below.
3.6.2 The record documentation shall be submitted one (1) month prior to the time for acceptance testing. Following the acceptance testing and, if necessary, the subsequent rechecking of deficiencies, the BMS contractor shall re-submit the record documentation incorporating all changes resulting from the acceptance testing and any other changes requested by the Engineer as a result of the Engineer’s review of the draft version of the record documentation. The Certificate of Substantial Completion shall not be granted until the final approved record documentation has been received. Coordinate and meet the requirements of the Employer’s designated representative responsible for the operations and maintenance manuals and record drawings.
3.6.3 Provide record documentation in manuals as indicated below:
3.6.3.1 Operators’ Manuals (3No. copies at each workstation location).
3.6.3.2 Hardware Manuals (3No. copies and each workstation location).
3.6.3.3 1No. Reproducible Mylar sepia, 2Nos. drawings prints and AutoCAD files of all record shop drawings at each workstation location. Manuals shall be placed in hardcover binders with index page and indexing tabs.
3.6.4 Provide Operators’ Manuals that shall be customized to reflect the individual requirements for each area. These manuals shall contain, at minimum, the following information:
3.6.4.1 Details of all features and functions available to the Operators.
3.6.4.2 Details of all alarm, diagnostic, error and other messages. Detail the Operator action to be taken for each instance.
3.6.4.3 Detail special programs provided and provide a complete programming instruction manual. Detail operation of all software applications.
3.6.4.4 Detailed listing of the database for all installed devices.
3.6.4.5 Details of all data base management functions and features.
3.6.4.6 All details and descriptions shall be in a step-by-step format such that an Operator/ Manager would be able to undertake the respective actions solely on the basis of information provided in the manuals and drawings.
3.6.5 Provide hardware manuals that shall be customized to reflect the specific requirements of each workstation location and shall include, at minimum, the following:
3.6.5.1 Specifications, maintenance requirements and installation requirements for all hardware

components.
3.6.5.2 Record drawings and schedules of the completed installation including location of devices, mounting details, and cabling details.
3.6.5.3 Operating sequences and interlocks.
3.6.5.4 Names and addresses of spare parts suppliers.
3.6.6 Record drawings shall be customized to reflect the individual areas and systems. They shall be CAD generated and shall include, at minimum, the following:
3.6.6.1 Details required by the shop drawings.
3.6.6.2 Final locations and point ID for each monitored and controlled device.
3.6.7 Operations manuals shall be prepared for the tenants explaining in an easily understood manner the facilities available to them and the functions that can be performed.
3.6.8 Provide cabling diagrams laminated in clear plastic at each field panel enclosure showing all cable terminations, relays, interlocks, power supplies, etc. Provide a spare copy at the associated workstation location and the CCC.

4.0 INSTALLATIONS REQUIREMENTS

4.1 WORK OF THIS SECTION
4.1.1 This section of the specifications details the components to be provided by the BMS contractor relating to the following:
4.1.1.1 Panels and enclosures.
4.1.1.2 Labeling of equipment and components.
4.1.1.3 Warning notices.
4.1.1.4 Boring and patching.
4.1.1.5 Fire stopping.
4.1.1.6 Hanging and supporting.
4.1.1.7 Conduit and fittings.
4.1.1.8 Cable - copper.
4.1.1.9 Uninterruptible power sources.
4.2 INSTALLATIONS – GENERAL
4.2.1 Each component shall meet, at minimum, the following requirements:
4.2.1.1 Manufactured by experienced manufacturers of the specific component and facilities.
4.2.1.2 Designed to minimize the requirement for field repair or maintenance.
4.2.1.3 Modular design.
4.2.1.4 Electronic components shall have internal failure diagnostics.
4.2.1.5 Each component shall be maintainable without significantly affecting the ongoing operation of the other components.
4.2.1.6 Components, test ports and cable terminations shall be readily accessible.
4.2.1.7 Damage caused by the failure of one component will be limited to the component that has failed without affecting the ongoing operation of the other components.
4.2.2 All electrical equipment, devices and components and their installation shall be in compliance the latest edition of the IEE Wiring Regulations (BS 7671:1992 Requirements for electrical installations) and all associated addenda and all other applicable codes, regulations and statutes.
4.2.3 All components shall be IP 2X finger protected to BS 60529 such that live components cannot be accidentally touched.
4.2.4 All electrical installation work shall conform to the requirements specified in the electrical trade contract documents. Where there is any conflict between the requirements of the different project trade contract documents, statutes, codes, regulations, local ordinances and any requirement of an agency having jurisdiction over the project, the most stringent requirement shall apply. Advise the Engineer of any discrepancy between the various requirements for the project.
4.2.5 All containment shall be provided by the MEP contractors. Cable for voltages of 240V and greater shall be provided by the MEP contractors. Cable for voltages less than 240V shall be furnished by the BMS contractor, shall be laid by the MEP contractors and shall be terminated by

the BMS contractor. The BMS contractor shall prepare shop drawings from which the MEP contractors shall install cable for all voltages and containment for cable of all voltages. These cable and containment shop drawings shall identify all cable and containment requirements for the BMS. The cable and containment shop drawings shall clearly identify the earthing of the screened cable and shall ensure that earthing is at one end only. Requirements are detailed to a greater extent in subsequent paragraphs.

4.3 INTERFERENCES

4.3.1 Equipment, devices and materials shall conform to all performance requirements of the specifications when exposed to the following interferences:

4.3.1.1 Project lighting, telephone and elevator equipment.

4.3.1.2 VHF and UHF signals as generated by external or internal portable or fixed transmitters.

4.3.1.3 AM signals as generated from transmitters.

4.3.1.4 Electrical noise on the building power system, both spurious and harmonics.

4.3.2 Provide adequate earthing on all equipment to prevent the build-up of electromagnetic voltage potentials. Provide screening of panels, enclosures, devices, or components that emit interferences. All monitoring and control cables shall be screened with one end earthed.

4.3.3 The installations shall not radiate signals that cause interference to the correct operation of any tenant or Employer on-site equipment.

4.3.4 The BMS and all individual electrical equipment, devices and components shall comply with the requirements of BS EN 50081-1 (General Emission Standard) and BS EN 50082-1 and 2 (General Immunity Standard) and all other applicable codes and statutes with respect to the radiation and conduction of radio frequency interference.

4.4 BMS CONTAINMENT

4.4.1 The MEP contractors shall provide all containment required by BMS contractor.

4.4.2 The BMS contractor shall prepare shop drawings detailing all containment requirements (size, type, etc.) The shop drawings shall be submitted for approval within 1 month of receiving the notice to proceed and shall be in such detail that the electrical trade can install all of the required containment without further instruction. Once the shop drawings have been approved they shall be issued to the MEP contractors for implementation.

4.5 BMS ELECTRICAL CABLE– 240VAC AND GREATER

4.5.1 Cable for the provision of power (240Vac and greater voltages) to components furnished under this contract shall be supplied and installed by the MEP contractors. The cable shall be terminated by BMS Contractor at a breaker inside DDC Panel for the equipment. The BMS contractor shall provide transformers as necessary to meet the power requirements of the BMS components.

4.5.2 The contractor shall prepare shop drawings detailing all cable requirements (size, type, etc.) and indicating the location of all components furnished under this contract that require 240Vac and greater voltage power. The shop drawings shall be submitted for approval within 1 month of receiving the notice to proceed and shall be in such detail that the electrical trade can install all of the required power cable and containment without further instruction. Once the shop drawings have been approved they shall be issued to the MEP contractors for implementation.

4.5.3 The MEP contractors shall terminate all cable at the power source and the BMS contractor shall terminate all power cable at the BMS components.

4.6 BMS ELECTRICAL CABLE– VOLTAGES LESS THAN 240VAC

4.6.1 The cable for the BMS monitoring and control functions (less than 240Vac) shall be furnished by the BMS contractors, installed in the containment by the BMS contractors and terminated by the BMS contractor.

4.6.2 The cable for the BMS shall be provided by the BMS contractor

4.6.3 The BMS contractor shall furnish all cable for voltages less than 240VAC. The BMS contractor shall terminate both ends of all cables carrying voltages less than 240Vac.

4.6.4 The BMS Contractor shall provide the Control Panel (DCP) having interface terminal strip and a mounting plate. The BMS contractor shall mount all associated BMS components, including the Fuse Breaker for isolation/protection of controller, DDC, relays, wiring guides, etc., on the plate at the BMS contractor's offices. The re-installation of the mounting plate in the DCP shall be by the

BMS contractor and all cable between the interface terminal strip and the DCP shall be by the BMS contractor. All containment from the DCP to the field devices shall be by the MEP contractors and all cable connecting field devices to the DCP shall be furnished and terminated by the BMS contractor and installed in the containment by the BMS contractors.

4.7 BMS ELECTRICAL CABLE - LOCAL AREA NETWORKS

4.7.1 The contractor shall provide network cable as shown in the drawing. The contractor shall install the same in the contract at it shall also be terminated by the BMS contractor.

4.7.2 The BMS contractor have to coordinate with MEP contractor for primary LAN control panels at any of the locations as indicated on the drawings and approved by the engineer and may also locate BMS primary LAN control panels in any mechanical room. Unitary Controllers (UC) and Distributed Control Panels (DCP) shall generally be located at the equipment they monitor and control or at the associated MCC panel.

4.7.3 The BMS contractor shall provide mounting supports etc. for all DCPs and shall supply communications cable for the interconnection of the DDCs. The containment shall be provided by the MEP contractors who shall also install the power cable in the containment. The BMS contractor shall install the communications cable and terminate both.

4.8 LOW SMOKE AND FIRE (LSF) RATED CABLE

4.8.1 All cable shall be LSF rated and shall be screened with one end only earthed. The MEP contractors shall provide a telecommunications functional earthing via 3 wire circuiting. The MEP contractors shall extend this earth to an earth bus bar in each of the rooms where the BMS contractor equipment is installed. The BMS contractor shall be responsible for the termination of all earths.

4.9 SYSTEM OPERATION UNDER EMERGENCY POWER CONDITIONS

4.9.1 The equipment that is fed from emergency power and which is controlled by the BMS shall operate normally under emergency power conditions and shall be monitored and controlled by the BMS under emergency power conditions. Ensure that all equipment furnished under this contract that is associated with the control of equipment on emergency power is fed from the emergency power service and can maintain normal equipment operations when the equipment is on emergency power. Following a loss of normal power, the BMS shall resume normal equipment control and monitoring functions for that equipment on emergency power within 20 seconds of the availability of emergency power and similarly when there is a return to normal power. Provide an uninterruptible power source in order to meet this 20 seconds resumption of operation requirement.

4.9.2 The BMS contractor shall identify on the cable and containment shop drawings which components are to be fed from emergency power and which components are to be fed from a UPS source.

4.10 PANELS

4.10.1 Provide panels and enclosures for all components of the BMS except where it is specifically identified within these contract documents that the enclosure shall be furnished by another trade. Panels and enclosures shall meet, at minimum, the following requirements:

4.10.1.1 Painted steel panels with locking door. All panels shall be lockable with the same key.

4.10.1.2 Ventilated to prevent excessive heat build-up, where required.

4.10.1.3 Location where environment is dirty, air filter must be placed at air vent.

4.10.1.4 Field cabling shall be terminated on a terminal strip. Provide strain relief.

4.10.1.5 Internal components shall be installed to allow easy access for diagnostics, maintenance, removal or replacement.

4.10.1.6 Panel or enclosure shall be suitable rated for the environment for which it is to be installed. Interior enclosures shall be, at minimum, IP 45 to BS 60529 and exterior enclosures shall be weather proof IP 65 to BS 60529 unless specifically noted otherwise within these contract documents.

4.10.2 Panels and enclosures shall only be located as indicated on the drawings and at Engineer approved locations.

4.10.3 The contractor shall not furnish motor starters and local disconnect switches. The trade furnishing

the motor starters and variable speed drives shall provide the interface terminal strip in a dedicated enclosure which may be a separate external enclosure or may be a compartment within the motor starter enclosure. Refer to the contract documents for the trade furnishing the motor starter and the variable speed controllers for the details of the enclosures.

4.11 LABELLING

4.11.1 Provide labeling for all CCP, DCP, UC, gateways, routers, hubs, etc, panels and enclosures. Labeling shall meet, at minimum, the following requirements:

4.11.1.1 Plastic laminated label that shall be affixed to the panel or enclosure with rivets or permanent adhesive.

4.11.1.2 Lettering 6mm (0.25 inch) high that sharply contrasts the background color.

4.11.1.3 Consistent throughout the project.

4.11.1.4 Indicated on the record documentation.

4.11.2 Provide labeling of all cabling. Labeling shall meet, at minimum, the following requirements:

4.11.2.1 Identified with permanent tag or self-adhesive label within the panel.

4.11.2.2 Cross referenced on the associated record documentation and laminated record drawing within the panel enclosure.

4.11.2.3 The BMS contractor shall provide labeling for all cable furnished and installed by the MEP contractors for the use of the BMS contractor.

4.11.2.3 The BMS contractor shall provide labeling for all cables that are terminated in side he ddc panel.

4.12 WARNING NOTICES

4.12.1 Provide warning notices at all equipment controlled by the BMS and at all associated motor starters and MCC panels where notices of a similar manner have not been provided by other trades. Warning labels shall be installed, at minimum, at the following locations:

4.12.1.1 AHU plenum doors.

4.12.1.2 AHU motor starter and VSD controllers.

4.12.1.3 Pump motors.

4.12.1.4 Pump motor starter and VSD controllers.

4.12.1.5 Fan enclosure or access panel.

4.12.1.6 Fan motor starter and VSD controllers.

4.12.1.7 Chilling unit control panel.

4.12.1.8 Chilling unit disconnect/power panel.

4.12.1.9 All other equipment and installations that are monitored and/or controlled by the BMS.

4.12.2 The warning notices shall be 75 mm by 125 mm (3in. by 5in.) minimum, with yellow background and with black lettering. The notices shall state the following:

THIS EQUIPMENT IS UNDER THE CONTROL OF THE BMS AND MAY START OR STOP AT ANY TIME WITHOUT WARNING.

4.12.3 The warning notices shall be securely attached to the equipment at a location approved by the Engineer and shall be highly visible. Submit a sample with shop drawings.

5.0 NETWORKS AND WORKSTATIONS

5.1 WORK OF THIS SECTION

5.1.1 This section of the specifications details the components to be provided by the BMS contractor relating to the following:

5.1.1.1 Primary LAN.

5.1.1.2 Secondary LAN.

5.1.1.3 Operator Interface Workstations (OIW).

5.1.1.4 Remote Operator Workstations (ROW) and Hand Held Terminals (HHT)

5.1.1.5 Operator interface software facilities for the OIW, ROW and web access.

5.2 OPERATOR INTERFACE WORKSTATION (OIW)

5.2.1 The Operator Interface Workstation will comprise a Personal Computer (PC) together with operator terminals. The PC will be a fully integrated node on the primary BMS network and shall provide the operator with a "window" into the entire network. The monitoring and control functions of the BMS shall be totally independent of the PC at the OIW such that if the PC is not operational there shall be no impact on the BMS except for the reduced operator interface

capability at the OIW location.
5.2.2 Provide the following OIW:
5.2.2.1 BMS OIW at the Central Command Centre (CCC) control room**.**
5.2.3 Provide 2No. Fault tolerant Network Data Servers at the Central Command Centre (CCC) control room located. These servers shall be used for the storage of data and copies of all system software. The BMS operation shall not depend on the availability of the servers and the BMS shall maintain normal operation in the event that both servers are disconnected from the network.
5.2.4 The OIW and servers shall have a Microsoft Windows operating system latest edition. The OIW shall
be free of all date related problems and shall comply with all of the requirements of British Standards Institution standard BSI DISC PD2000-1.
5.3 OPERATOR INTERFACE SOFTWARE
5.3.1 This section details the operator interface that shall be substantially the same for both the OIW and the ROW. The web access feature shall mimic the OIW interface but shall have limited functionality as defined herein. The operator interface portion of this section details those software requirements specifically related to the following:
5.3.1.1 BMS access control
5.3.1.2 The input by the operator of:
5.3.1.2.1 Requests for information.
5.3.1.2.2 Operator commands.
5.3.1.2.3 Databases and operating sequences
5.3.1.3 The output by the BMS of:
5.3.1.3.1 Alarms
5.3.1.3.2 Reports
5.3.1.3.3 GUI displays
5.3.1.3.4 Event messages
5.3.2 Provide the capability for any OIW, accessed with the appropriate password access, to perform all operator functions and that all operator actions shall be immediately echoed to all other OIW.
5.4 COMPUTER ANTI VIRUS
5.4.1 Provide anti virus software for every computer. Anti virus software shall be provided with free virus
definition updates for the duration of the warranty. Anti virus software should automatically scan the computer bios and all files opened, created, copied, and/or received for viruses. Include directions for updating virus definition files upon expiration of warranty within the record documentation.
5.5 SERVERS AND PERSONAL COMPUTERS (PC)
5.5.1 The PCs at the OIW shall, at minimum, provide the following services to the networks:
5.5.1.1 The storage, analysis and retrieval of data and information in addition to that provided at the CCP and DCP.
5.5.1.2 The storage of copies of CCP and DCP software, including schedules and databases. The PC shall maintain copies of all CCP and DCP software. The PC shall downline load copies to the CCP and DCP upon failure or loss of data.
5.5.1.3 The supervision of connected operator terminals and other interface devices such as the auto-dial/auto-answer modem.
5.5.2 The PCs at the OIW shall, at minimum, provide the following services to the Operator:
5.5.2.1 The PC shall be a node on the network that shall enable it to provide the operator with a "window" into the network via the operator terminals.
5.5.2.2 The storage and retrieval of stored data and information for reporting.
5.5.3 The CCC control room print server shall have, at minimum, the following facilities:
5.5.4.1 Capable of networking and sharing up to 4 printers.
5.5.4.2 USB, serial and high speed parallel ports as necessary to meet the requirements of the printers provided under this contract at the CCC control room. Minimum of 2No. serial ports and 2No. Parallel ports.
5.5.4.3 Shall support latest Windows Operating System and TCP/IP protocol.

5.5.4 Provide an alarm to uniquely identify a PC communication failure. One way that this might be accomplished is by using a watchdog timer at a CCP or DCP.
5.5.7 All PC shall be the latest model at the time of purchase and shall be from a recognized manufacture of PCs.
5.6 OPERATOR TERMINALS
5.6.1 Printers:
5.6.1.1 Provide alarm printers at the following locations:
5.6.1.1.1 Central Command Centre (CCC) control room located adjacent to Central Plant Room.
5.6.1.1.2 Security control room at ground floor.
5.6.1.2 The operator shall be able to direct the hardcopy output to any printer. The BMS contractor shall set up the system such that all BMS generated messages such as alarms, returns to normal, etc. are directed to the appropriate alarm printers and all BMS automatically generated and operator requested reports are output to the appropriate report printer. The printer at each Control Room OIW shall act as both an alarm and report printer.
5.6.1.3 The printers at the Central Command Centre (CCC) control room shall be local printers to the print server. All printers shall be accessible from any OIW such that an operator at one location can generate a hardcopy message at any other location.
5.6.2 Keyboard:
5.6.2.1 Provide a keyboard for operator access at each OIW. This shall be in addition to any other operator input device such as a mouse.
5.6.2.2 The keyboard shall be in a standard typewriter (QWERTY) configuration with a full alphanumeric standard ASCII character set and with additional dedicated keys for other functions associated with the BMS such as print screen. Keyboard shall be wireless. Provide batteries sufficient for 12 months operation.
5.6.3 Mouse:
5.6.3.1 Provide a mouse at each OIW and configure the system such that cursor control can be undertaken from both the keyboard and mouse as selected by the operator.
5.6.3.2 Mouse shall be wireless. Provide batteries sufficient for 12 months operation.
5.6.4 Display):
5.6.4.1 Provide a high resolution LED display GUI at the OIW location.
5.6.4.2 The GUI shall be used for the display of operator entered and requested data and the output of BMS generated alarm and other information.
5.6.4.3 The GUI shall have a minimum screen diagonal measurement of 430mm.
5.6.4.4 The GUI shall have a minimum resolution of 1280 by 1024 pixels.
5.6.4.5 The unit shall be capable of displaying both schematic and alphanumeric data at the same time.
5.6.4.6 A minimum of 256 discrete colors shall be available for display selection.
5.7 GUI DISPLAYS
5.7.1 GUI displays of system diagrams are discussed in the Section titled “BMS Software” of these specifications.
5.7.2 GUI displays shall form the basis of the menu penetration means of operator access.
5.7.3 The time and date and the building kW shall appear on the GUI at all times and when there are system diagrams displayed on the GUI the outside air temperature and relative humidity shall be displayed.
5.7.4 Icons shall be used in conjunction with cursor control where possible to simplify access to data and the execution of operator commands.
5.7.6 System diagrams shall appear on the GUI complete with all associated data within five (5) seconds of the completion of the operator entry/ menu selection.
5.7.7 GUI shall cover the following sequence page view with high resolution, but not limited to below mentioned points
5.7.8 GUI shall cover different users with different access level.
5.7.9 Second page shall include list of navigation buttons for all the control systems.

Every system page shall contain the following features:
 Same theme must be used in all pages of GUI.
 Alarm for the moving system shall be informed of GIF or discrete images, which shall indicate the user about the alarming condition.
 Every system must be showcased in 3d on two dimensional axes.
 Every data point must be labeled with respect to their location.
 Every point (Digital/Analog) mapped on GUI shall contain navigation for the point's history.
 Every page must contain the action buttons to navigate on to any system and also to navigate to the home page.
 Layout shall be made of every floor to display the overall cooling in terms of temperature.
 Every point on the layout page shall be able to navigate to its desired controlled system.
 For the navigation of sub system there shall be a list of action button of sub system on the system page.
 Final GUI must be approved by consultant and client representatives.

5.8 OPERATOR COMMANDS

5.8.1 The operator shall be able to place any output in the BMS manual control mode and when in that mode the operator shall be able to place any output to any required value subject to any hardwired interlocks and any software interlocks that are specified to apply in the BMS manual control mode.

5.8.2 The operator shall be able to place any set point that is determined by software into the manual mode and to manually assign a value to the set point.

5.8.3 The operator shall be able to initiate the restart of equipment following a fire alarm and following a power failure. Refer to the paragraphs titled "Equipment restart following a fire alarm" and "Equipment restart following a power failure" in the Section titled “BMS Software”.

5.9 DATABASES AND OPERATING SEQUENCES

5.9.1 The operator shall be able to make on-line modifications, additions and deletions to all databases at the PC, CCP, DCP, and UC using interactive procedures. Prior to the acceptance of the changes by the BMS there shall be a restatement of the contemplated database modification, addition or deletion together with a question of the type "Do you wish to proceed?" which will require an affirmative answer before the change takes place.

5.9.2 The operator shall be able to modify a sequence, add a sequence and delete a sequence online as detailed in the Section titled “BMS Software”.

5.10 ALARMS

5.10.1 Alarms shall be generated by the BMS upon the occurrence of one of the following events:

5.10.1.1 Failure of a PC, CCP, DCP, UC, or any other BMS hardware components.

5.10.1.2 Failure of communications between nodes on the primary LAN.

5.10.1.3 Failure of communications of devices on the secondary LAN.

5.10.1.4 A monitored status indicates a discrepancy between the actual and the required value.

5.10.1.5 A monitored value does not meet criteria established by the operator.

5.10.1.6 The deviation of a variable from set point exceeds operator established criteria.

5.10.1.7 The output to a final control element is outside operator established criteria.

5.10.1.8 A digital input is in the state defined by the operator as indicating an alarm condition.

5.10.1.9 Software failures and errors shall be diagnosed and annunciated by the BMS.

5.10.2 The failure of a BMS hardware component, including communications failures, shall generate an alarm that shall be differentiated from process alarms. If the failure of a PC cannot be annunciated at a printer or GUI at the OIW because of the BMS topology then provide an alternative means such as a "watchdog timer” at a DCP. The alarm message generated by the BMS shall clearly identify the component that has failed and the location of a communications failure shall also be clearly indicated.

5.10.3 In the event that the BMS detects a disparity between the actual and the required status of a digital input, the BMS shall generate an alarm and shall set the control relay to the off state. This shall occur when the digital output is in both the BMS manual control mode and the BMS software control mode and shall automatically place the output in the BMS manual control mode.

5.10.4 The operator shall be able to define alarm conditions for each analog input, at minimum, as follows:
5.10.4.1 The high limit above which the variable is in alarm.
5.10.4.2 The low limit below which the variable is in alarm.
5.10.4.3 An end or range alarm. This shall occur when the analogue signal goes to zero or to its maximum value.
5.10.5 The operator shall be able to assign deviation limits to set point values. An alarm shall be generated when a controlled variable deviates from set point by more than an operator-defined amount.
5.10.6 The operator shall be able to assign alarm limits to analogue outputs. The BMS shall generate an alarm when an analogue output reaches or exceeds an operator assigned high limit and reaches or goes below an operator assigned low limit.
5.10.7 The operator shall be able to designate one state of a digital input as an alarm state.
5.10.8 The operator shall be able to assign a time delay following detection by the BMS of an alarm condition such that if there is a return to normal during the assigned time delay the alarm shall not be annunciated. If at the end of the time delay period the alarm condition still exists then the BMS shall annunciate an alarm within two (2) seconds (end-to-end time). The time delay shall be individually assignable to each alarm condition. All monitored points shall meet these alarm annunciation criteria regardless of type of panel used to monitor the point.
5.10.9 The operator shall be able to assign a deadband to all analogue high and low alarm limits so as to minimize the too frequent and unnecessary annunciation of alarms. An analogue alarm limit shall not have returned to normal until it is has returned beyond the alarm limit by a sufficient amount to have also cleared the deadband. The same shall also apply to analogue output high and low alarms.
5.10.10 A report shall be available to the operator detailing points in alarm and a further report shall be available to the operator detailing the alarm limits established for the monitored, controlled and calculated points.
5.10.11 Designated alarms shall be output on the alarm printer.
5.10.12 The occurrence of designated alarms shall initiate a visual alarm at the OIW. A switch, button or keyboard key shall be dedicated to the acknowledgment of alarms at the OIW. The visual alarm shall cease after acknowledgment of an alarm unless another alarm is awaiting acknowledgment. All alarms shall be acknowledged individually and the acknowledgment shall be recorded on the alarm printer. The alarm message shall uniquely identify the cause of the alarm together with the time of detection by the BMS. The operator shall be able to associate an "event message" with any alarm occurrence. The operator shall be able to designate which alarms annunciate at which workstation(s) the alarm shall be annunciated.
5.10.13 Alarms shall be allocated priorities by the operator on-line using an interactive procedure. If there
are concurrent alarms then they shall be annunciated in order of their priority. An icon shall appear on the GUI when there are alarms other than those displayed. The cursor and icon shall enable the operator to bring up an alarm report on the GUI at any time. There shall be at minimum, three levels of alarm priority. Alarms shall be prioritized in the following categories, with the following actions taking place:
Category Action Taken
Critical. Printout on alarm printer, display on GUI,
activate email alarm. Clearly distinguish critical
alarms and generate reports.
Non-critical Display on GUI and log report for the alarm
BMS component Printout on alarm printer, display on GUI,
Activate email alarm. Clearly distinguish BMS
Components alarms on hard copy print outs and
GUI displays and reports
5.10.14 Alarms shall remain on the OIW GUI alarm queue until the alarm has been acknowledged by the operator and returned to the normal state. If the alarm returns to normal before operator

acknowledgment, then it shall be identified as such via different color designation on the alarm queue. If the alarm is acknowledged before is has returned to normal, then is shall also be identified via a different color designation.
5.10.15
Operator actions of any alarms acknowledged shall be transmitted to all OIW locations. Any OIW, with appropriate password access utilized, may acknowledge alarms. Alarm shall only be required to acknowledge at one OIW.
5.10.16 Alarms sheet should display below information but not limited to mentioned points only
Categories such as HVAC, Maintenance, Fire, or Generator etc.
Date/time of occurrence, current status and report.
Area/Location.
Summary
Event Counter
Auto-Deletion from alarm sheet after acknowledged but record maintained in history
5.11 REPORTS
5.11.1 Reports shall be output when requested by the operator and when scheduled by the operator.
5.11.2 Reports shall be provided as detailed throughout these specifications and shall be output at the GUI at the OIW, the printer designated by the operator as the report printer or the screen at the ROW whichever is selected by the operator. The default output device for reports shall be the report printer at the OIW.
5.11.3 The operator shall be able to select reports to be output in the following manner:
5.11.3.1 for a specific point.
5.11.3.2 for a specific item(s) of equipment.
5.11.3.3 for all points located on a specific floor or area of the building.
5.11.3.4 For all equipment serving a particular floor.
5.11.3.5 For all points monitored, controlled and calculated.
5.11.3.6 For afterhours operation of the AHU.
5.11.3.7 For a specific schedule.
5.11.3.8 For a specific or group of trended points.
5.11.3.9 For a specific or group of totalized points.
5.11.4 Reports shall all have the time and date at which they were output recorded on them. Reports shall be formatted in such a manner as to make them easily understandable to the operator.
5.11.5 A menu of reports shall enable the operator to access any report on the BMS. Each report shall contain the date and time.
5.11.6 The operator shall be able to configure customized reports. Standard and customized reports shall
be configured through the BMS. Use of third party reporting packages is not allowed.
5.12 EVENT MESSAGES
5.12.1 The operator shall create messages up to 36 characters in length, at minimum, which shall be displayed upon the occurrence of a particular event. There shall be capacity for 100 event messages at any one time and the operator shall be able to associate a single message with more than one occurrence and shall be able to associate more than one event message with a particular event.
5.12.2 The event message shall be output at all devices selected on-line by the operator using an interactive procedure.
5.12.3 The operator shall be able to associate one or more event messages with the following events:
5.12.3.1 An alarm
5.12.3.2 A change of status.
5.12.3.3 The return to normal of an alarm condition.
5.12.3.4 An operator entered schedule.
5.12.3.5 Any other event initiated by the BMS or monitored by the BMS.
5.12.4 Provide reports on request and on a scheduled basis of schedule and set point changes. Reports shall include, time, date, duration, systems involved and zone and shall be available on an

individual office zone basis, individual apartment basis and individual company basis.

6.0 CONTROLLERS

6.1 WORK OF THIS SECTION

6.1.1 This section of the specifications details the components to be provided by the BMS contractor relating to the following:

8.1.1.1 Communication Control Panels (CCP).

8.1.1.2 Distributed Control Panels (DCP).

8.1.1.3 Unitary Controllers (UC).

6.2 GENERAL

6.2.1 All controllers shall have at minimum a 16-bit microprocessor.

6.3 COMMUNICATION CONTROL PANELS (CCP)

6.3.1 CCP shall be software programmable controllers / servers on the BMS primary Local Area Network (LAN) and shall fulfill one or both of the following roles:

6.3.1.1 A gateway between the BMS primary LAN and the BMS secondary LAN.

6.3.1.2 A gateway interface to third party monitors/controllers, if required.

6.3.2 Provide integral network communication connections.

6.3.3 The CCP shall incorporate software as necessary to provide communications on the network. Additionally, if the CCP acts as a gateway to secondary LAN, then the CCP shall also incorporate all software as necessary to perform this function including change of protocol between the networks.

6.3.4 CCP shall be totally independent of any and secondary LAN nodes for their operating functions.

6.3.5 CCP failure shall not place the BMS or any component controlled in a situation that may cause damage to equipment or harm or discomfort to building occupants and operations staff. The failure of a CCP shall not affect the operation of any other network node.

6.3.6 The failure of any CCP shall be annunciated as a critical alarm at the OIW.

6.3.7 Cabling shall be terminated on rugged and easily accessible terminal strips. Each termination shall be clearly marked and shall be as detailed in the shop and record drawings.

6.3.8 Each CCP shall have its own power supplies that shall be rated such that they will adequately accommodate all foreseeable uses of the CCP.

6.3.9 Each CCP shall have, at minimum, a 16-bit microprocessor.

6.3.10 Provide each CCP with a non volatile memory.

6.3.11 Provide a real-time hardware clock at each CCP. The hardware real-time clock shall be used to synchronize all other hardware and software clocks in the BMS. Synchronization shall take place at least once every 24 hours and immediately following start up of a component such as a CCP, DCP, UC and PC which has an integral real-time clock. The hardware clock shall have a battery back up of at least 72 hours.

6.3.12 The CCP shall have a port for the connection of the ROW.

6.3.13 If the CCP supports a secondary network, then there shall be the necessary network interface card(s) at the CCP.

6.3.14 CCP shall be housed in enclosures that shall meet the requirements detailed in Section titled "BMS
Installation Requirements" of these specifications.

6.3.15 CCP shall reside on Primary LAN.

6.4 DISTRIBUTED CONTROL PANELS (DCP)

6.4.1 DCP shall be software programmable controllers on the secondary LAN and shall fulfill one or more of the following roles:

6.4.1.1 Gateway interface to third party monitors/controllers, if required.

6.4.1.2 An interface via Point Interface Modules (PIM) to the field instrumentation and final control elements.

6.4.2 DCP may be used for any equipment monitored and controlled by the BMS. A dedicated DCP shall be provided, at minimum, to monitor and control:

6.4.2.1 Each air handling unit. Each AHU shall have a dedicated DCP.

6.4.2.2 Other major items of equipment.

6.4.3 The DCP shall control its own communications so that the failure of any one node, including the PC, shall not inhibit communications on the network between the remaining nodes. Provide integral network communication connections.
6.4.4 DCP shall be totally independent of any other primary and secondary LAN nodes for their monitoring and control functions. DCP shall monitor and control entire systems, multiple DCP for a single system shall not be allowed. Where a DCP receives data from other nodes, such as an outdoor air temperature, which is used for a global system program strategy executed at that DCP, then alternative control strategies shall be automatically initiated, based on operator definable default values, if there is a loss of communication of the required data.
6.4.5 DCP failure shall not place the BMS or any BMS controlled component in a situation that may cause damage to equipment or harm or discomfort to building occupants and operations staff. The failure of a DCP shall not affect the operation of any other network node.
6.4.6 The failure of any DCP shall be annunciated as a critical alarm at the OIW.
6.4.7 Cabling shall be terminated on rugged and easily accessible terminal strips. Each termination shall be clearly marked and shall be as detailed in the shop and record drawings.
6.4.8 Each DCP shall have its own power supplies that shall be rated such that they will adequately accommodate all foreseeable uses of the DCP.
6.4.9 Each DCP shall have, at minimum, a 16-bit microprocessor, 10 MHz clock speed.
6.4.10 All applications programs and operating sequences shall reside at the UC.
6.4.11 Provide each DCP with Non-volatile memory.
6.4.12 Provide a real-time hardware clock at each DCP. The system hardware real-time clock at the CCP shall be used to synchronize all other hardware and software clocks in the BMS. Synchronization shall take place at least once every 24 hours and immediately following start up of a component such as a CCP, DCP, UC and PC which has an integral real-time clock.
6.4.13 The DCP shall have a port for the connection of the ROW.
6.4.14 DCP shall be housed in enclosures that shall meet the requirements detailed in Section titled “BMS
Installations Requirements” of these specifications. The DCP shall be placed at the same location as the equipment they control. If the equipment motor starters are located in a MCC panel and if the MCC is at the same location as the mechanical equipment the DCP shall be located in the cubicle provided at the MCC for controls. The controls cubicle at the MCC panel shall have an interface terminal strip as indicated in the electrical drawings. The cubicle shall have a mounting plate that shall be free issued to the BMS contractor by the MEP contractors. The BMS contractor shall mount all associated BMS components, including the DCP, relays, wiring guides, etc., on the plate at the BMS contractor's offices. The re-installation of the mounting plate in the control cubicle shall be by the BMS contractor and all cable between the interface terminal strip and the DCP shall be by the BMS contractor. All containment from the DCP to the field devices shall be by the MEP contractors and all cable connecting field devices to the DCP shall be furnished and terminated by the BMS contractor and installed in the containment by the MEP contractors.
6.4.15 Interfaces to field instrumentation and final control elements shall have Point Interface Modules (PIM) that will:
6.4.1.5.1 Enable the DCP to receive signals from the digital and analogue instrumentation.
6.4.1.5.2 Enable the DCP to output control signals to the final control elements.
6.4.16 PIM shall be incorporated into the DCP by one or the following methods:
6.4.16.1 Plug in type modules with specific or universal input/output capabilities.
6.4.16.2 Integral to the DCP controller board.
6.4.17 PIM shall accommodate the following point types:
6.4.17.1 Analogue and digital inputs.
6.4.17.2 Analogue and digital outputs.
6.4.17.3 Pulse inputs.
6.4.18 All PIM shall be easily exchanged and the failure of one PIM shall not affect any other PIM. Field terminations shall be such that the removal of a failed PIM shall not require the removal and reconnecting of field device cable terminations.
6.4.19 All field instrumentation shall terminate on a sub base, while the PIM shall need not be installed

until the system is free from construction debris and is ready to commission if for the case of spare maintainability. The DCB shall have single PIM serving all I/OS. Each DCP shall process minimum of 20 R/OS.
6.4.20 Provide LED on the PIM to indicate the status of each PIM.
6.4.21 Control shall be based on either three term algorithms, i.e. proportional plus integral plus derivative, or two term algorithms, i.e. proportional plus integral, unless specified otherwise.
6.4.22 DCP mounted on vibrating equipment, such as on heat pumps, shall have vibration isolation protection that ensures their satisfactory operation.
6.5 UNITARY CONTROLLERS - GENERAL
6.5.1 Unitary Controllers (UC) shall be "freely programmable" microprocessor based interoperable BACnet controllers with prepackaged operating sequences maintained in EEPROM or flash EPROM. Customization of "freely programmable" controllers shall be possible to the extent that variable operating parameters, such as sequences of operation, set points, control loop parameters, control constants, and schedules shall be changeable on-line by the operator and locally from the HHT. UC shall be on the secondary LAN and shall provide an interface via PIM to the field instrumentation and final control elements of the equipment.
6.5.2 The UC shall be a node on one of the secondary LANs and shall control its own communications so that the failure of any one node shall not inhibit communications on the network between the remaining nodes and the OIW.
6.5.3 UC shall be totally independent of other secondary LAN nodes for their monitoring and control functions.
6.5.4 UC failure shall not place the BMS or any component controlled in a situation that may cause damage to equipment or harm or discomfort to building occupants and operations staff. The failure of a UC shall not affect the operation of any other secondary network node.
6.5.5 The failure of any UC shall be annunciated as a critical alarm at the OIW.
6.5.6 Cabling shall be terminated on rugged and easily accessible terminal strips. Each termination shall be clearly marked and shall be as detailed in the shop and record drawings.
6.5.7 UC shall be powered from the electrical service that serves the equipment monitored and controlled by the UC. The BMS contractor shall furnish transformers suitably rated for the application. The UC shall be housed in an enclosure that provides adequate physical and electrical protection.
6.5.8 Each UC shall have, at minimum, an 8-bit microprocessor.
6.5.8.1 Provide each UC with non volatile memory.
6.5.9 Provide a hardware or software clock at each UC. The system hardware real-time clock at the CCP shall be used to synchronize all other hardware and software clocks in the BMS. Synchronization shall take place at least once every 24 hours and immediately following start up of a component such as a CCP or PC that has an integral real-time clock. The clock shall have a battery back up of at least 72 hours.
6.5.10 UC shall be housed in enclosures that shall meet the requirements detailed in Section titled “BMS
Installations Requirements” of these specifications. The UC shall be placed at the same location as the equipment they control. If the equipment motor starters are located in a MCC panel and if the MCC is at the same location as the mechanical equipment the UC shall be located in the cubicle provided at the MCC for controls.
6.5.11 Interfaces to field instrumentation and final control elements shall have integral Point Interface Module (PIM) that will:
6.5.11.1 Enable the UC to receive signals from the digital and analogue instrumentation.
6.5.11.2 Enable the UC to output control signals to the final control elements.
6.5.12 PIM shall accommodate the following point types:
6.5.12.1 Analogue and digital inputs.
6.5.12.2 Analogue and digital outputs.
6.5.12.3 Pulse inputs.
6.5.13 Analogue input PIM shall have a minimum 8-bit analogue-to-digital conversion and shall interface

to all of the signal types listed in the Field Termination Schedules.
6.5.14 Analogue output PIM shall have a minimum 8-bit digital-to-analogue conversion and shall meet all of the output signal requirements detailed in the Field Termination Schedules.
6.5.15 Digital input and output PIM shall have electrical isolation and all relay contacts shall be suitably rated for the application.
6.5.16 UC shall control and monitor all points associated with a system. Multiple UC shall not be used to control and monitor a single system.
6.5.17 All applications programs shall reside at the UC.
6.5.18 Operating sequences for UC shall be resident at the UC. Database changes shall be undertaken from the OIW and ROW.
6.5.19 Control shall be based on either three term algorithms, i.e. proportional plus integral plus derivative, or two term algorithms, i.e. proportional plus integral, unless specified otherwise.
6.5.20 UC mounted on vibrating equipment, such as on heat pumps, shall have vibration isolation protection that ensures their satisfactory operation.
6.6 UNITARY CONTROLLER - FAN COIL UNITS
6.6.1 Each fan coil unit shall have a UC. The number, type and location of FCU shall be as indicated on the Mechanical Drawings.
6.6.2 The FCU manufacturer shall provide the following components for each fan coil unit for interface and mounting of the UC:
6.6.2.1 24 Vac fan control relay interface.gui
6.6.2.2 Suitable mounting device for the temperature sensors for those FCU that have the temperature sensor located in the recirculation port.
6.6.3 The BMS contractor shall furnish the following components for each FCU to the MEP contractors for installation by the MEP contractors:
6.6.3.1 Unitary controller.
6.6.3.2 24 Vac control transformer.
6.6.3.3 Temperature sensors for those FCU that have the temperature sensor located in the recirculation port.
6.6.3.4 Chilled water valve and actuator. The MEP contractors shall install the valve.
6.6.3.5 Enclosure that shall house the controller and the transformer. The BMS contractor shall provide all necessary wiring within the enclosure and shall extend the wiring as necessary to an external terminal strip that shall be provided on the exterior of the enclosure to facilitate the interface wiring to the FCU. The terminal strip shall include the connections for the temperature sensor, the fan control relay, the valve control signal, the manual/automatic switch (where applicable), the button/switch that is definable by the operator (where applicable) and the temperature setpoint reset signal (where applicable) and other functions as appropriate. The 240Vac cable and containment shall be provided by the MEP contractors to the enclosure. The BMS contractor shall provide suitable terminals to accept the 240Vac service. The MEP contractors shall install the enclosure on site and shall provide wiring from the enclosure terminal strip to the FCU, including the temperature sensor if housed in the recirculation port of the FCU. Wiring from the enclosure to wall mounted temperature sensor housings shall be done on site by the BMS contractor.
6.6.4 Temperature sensors for FCU in the certain area shall be as follows:
6.6.4.1 FCU shall have a temperature sensor in a wall-mounted enclosure. The BMS Contractor shall furnish a tamper proof enclosure. The tamper proof enclosure shall be given to the Employer.
6.7 CONTROL PANELS - LOCATIONS
6.7.1 The control panel installation shall meet the requirements detailed in Section titled “BMS Installations Requirements” of these specifications.

7.0 THIRD PARTY INTERFACES

7.1 WORK OF THIS SECTION
7.1.1 This section of the specifications details the components to be provided by the BMS Contractor relating to BACnet.

7.2 INTERFACES - GENERAL

7.2.1 The BMS contractor shall lease with the manufacturer and/or contractor responsible for the third party system and shall determine the points that are to be mapped from the BMS to the third party system and the points that are to be mapped from the third party system to the BMS. Where it is possible to map points from one system to the other that are not identified in these contract documents, the BMS contractor shall advise the Engineer within 2 months of the notice to proceed. The Engineer shall determine whether additional points are to be mapped from one system to the other and shall instruct the BMS contractor accordingly. Additional points requested by the Engineer shall be mapped and monitored by the BMS at no additional cost to the Employer. A sufficient reserve capacity must be provided for the future mapping from one system to the other of, at minimum, 100 percent more points. Following a power failure, the digital communications link between the BMS and the third party system must be reactivated without operator intervention at either system.

7.2.2 The BMS contractor shall liaise with the manufacturer and/or contractor responsible for the third party system and shall elicit all details regarding the protocol as necessary to implement the interface between the BMS and the third party system. If the necessary information is not forthcoming from the third party system manufacturer and/or contractor responsible for the third party system, then the BMS contractor shall advise the Engineer immediately in writing. The BMS contractor shall be ultimately responsible for the interfacing of the two systems and, in particular, it shall be the responsibility of the BMS contractor to procure the punctual supply of all necessary protocol descriptions.

7.2.3 The personnel responsible for the integration of the BMS and the third party system shall be those identified in the tender submittal as being responsible for the integration work, shall be full time employees of the BMS contractor, shall be experienced and skilled in this type of work and shall be residents of Pakistan.

7.2.4 The BMS contractor shall prepare a short report that provides details of the method of integration and the information to be transferred between the systems. The report shall be signed by an authorized representative of the BMS contractor and the third party system manufacturer and/or contractor. The report shall be submitted with the shop drawings.

7.2.5 The third party system manufacturer/contractor shall provide a communications port specifically for the interfacing of the third party system to the BMS. The MEP contractors shall provide cable and all appurtenances such as connectors, protocol converters (gateways) as necessary for the digital communications link from the third party system to the BMS shall be provided by the BMS contractor. Containment shall be provided by the MEP contractors as detailed in the Section titled “BMS Installation Requirements”.

7.2.6 The fact that the points are mapped from the third party system to the BMS shall be transparent to
the operator. It shall not be necessary for the BMS operator to know that the points are mapped from another system in order to implement such functions as adding and deleting a mapped point on a report/graphic, adjusting schedules and alarm limits associated with a mapped point, including a mapped point in a sequence of operations, etc.

7.2.7 The interface between the BMS and the third party system shall be tested at an offsite location. If the test is successful the BMS contractor shall advise the Engineer and a time shall be established that is acceptable to the Engineer when the interface can be demonstrated to the Engineer at the BMS contractors facility or some other location acceptable to the Engineer. The BMS contractor may use an emulation device for the third party system offsite tests. The BMS hardware shall not be installed at the project location until all third party interfaces to the BMS have been successfully demonstrated to the Engineer. The BMS contractor shall be responsible for providing all equipment, including applicable components of the third party system, necessary to perform the demonstration and for ensuring the presence at the testing of suitably skilled personnel from the third party system manufacturer/contractor. The testing of the interface between the two systems shall verify, at minimum, that:

7.2.7.1 All data points mapped from the third party system to the BMS are displayed correctly on the BMS monitor and have the same functionality as points directly monitored/controlled

by the BMS. There is not a requirement that the data be displayed on graphics during the initial tests but they must be displayed on the final graphics at the time of final acceptance testing.
7.2.7.2 All data points mapped from the BMS to the third party system are displayed correctly on the third party system monitor.
7.2.7.3 All mapped points are identical with regard to value, engineering units and significant digits on both systems.
7.2.7.4 All points mapped from the third party system to the BMS meet all of the specifications detailed in the contract documents for points directly monitored/controlled by the BMS.
7.2.7.5 The communications watchdog is functioning correctly.
7.2.7.6 Communications speed between the two systems is satisfactory.
7.2.7.7 Both systems restart and communications between the two systems resume following a power failure without operator intervention.
7.2.8 Each of the third party systems shall be tested on-site without the interface to the BMS. Once the systems have been accepted by the Engineer the systems shall be interfaced to the BMS and shall be retested as part of the final acceptance testing.
7.2.9 Documentation regarding the third party BMS interfaces shall be provided in sufficient detail as to enable a person reasonably skilled in the writing of real time software applications to add/delete points mapped from one system to the other. At minimum the documentation shall include a detailed description of each protocol used and the model, version and firmware details of any protocol converter (gateway) that is used.
7.2.10 A watchdog procedure must be implemented by the BMS contractor that enables the identification of the point of failure, i.e. where in the communications chain between the two systems did the failure occur. The watchdog function must operate at a frequency that detects a communications failure within a maximum of 5 seconds for the chillers and within a maximum of 30 seconds for all other interfaces except the fire alarm system that shall implement a check every hour.
7.2.11 The BMS contractor shall warrant the third party system interface and provide software support for
a minimum of 5 years. Software code associated with the third party interface shall be deposited at a secure third party establishment if so requested by the Employer.
7.3 INTERFACE BETWEEN BMS AND THE FIRE ALARM SYSTEM
7.3.1 There shall be a transfer of information from the Fire Detection, Alarm and Communication System
(FAS) to the BMS. The communication shall be unidirectional from the FAS to the BMS only.
7.3.2 The information shall be transferred in an ASCII format on an RS232C link or by some other equivalent method. The BMS contractor shall provide line drivers if required and the BMS contractor shall also provide all interconnect wiring between the BMS and the FAS RS232C port, which shall be located in the Fire Command Centre. The FAS contractor shall provide the FAS RS 232 port and shall provide the BMS contractor with all relevant information to enable the transfer of data as detailed herein.
7.3.3 Whenever there is a change of status of a detector, input device, zone or fire alarm control panel electronics, the FAS shall communicate the appropriate information to the BMS, whether the change of status is the result of an alarm, fault or return to normal. The point monitoring shall be as identified in the Field Termination Schedules.
7.3.4 The BMS contractor shall cooperate with the FAS subcontractor to ensure that the digital transfer of information from the FAS to the BMS is accomplished within 5 seconds of the detection of the fire alarm situation by a FAS, sprinkler, pull station, etc.
7.3.5 The BMS contractor shall coordinate with the FAS subcontractor to establish a communication protocol l and a message format. The start and end of the message shall be uniquely identified and the message shall indicate the following information at minimum:
7.3.5.1 Time
7.3.5.2 Date
7.3.5.3 Zone of incidence

7.3.5.4 Indication of whether it is a fire alarm, return to normal or FAS system fault.
7.3.6 The BMS contractor shall provide the necessary RS232C port / USB port to accept the information from the FAS and shall provide the necessary database (look up table) for the interpretation of the data.
7.3.7 The FAS shall send a message to the BMS on an operator determined scheduled basis, initially set at once every hour. The BMS shall generate an alarm if the message is not received or if the message is not decipherable.
7.3.8 The BMS shall automatically shut down all terminal units serving the zone of incidence in the event
of a fire alarm and shall automatically restart equipment following a return to normal message, as detailed in the Part titled “Equipment Restart Following a Fire Alarm” in the Section titled “Software”.
7.4 INTERFACES BETWEEN BMS AND CHILLED WATER SYSTEM
7.4.1 Each chilled shall have a microprocessor-based controller which shall be BACNET compliant. The BMS shall have an high level interface to the chiller system controller which shall map all operating data and system parameter to the BMS.
7.4.2 A flow switch shall be fitted in the chilled water line from each chiller and shall be hard wired interlocked to the chiller panel to prevent chiller startup in the absence of water flow. Similarly the chiller shall be prevented from operating if there is no flow in the corresponding condenser water circuit as detected by flow switches in the condenser water inlet to each chiller. The BMS contractor shall furnish the flow switches. The MEP contractors shall provide all interconnect wiring.
7.4.3 The condenser water and chilled water pumps shall operate when the corresponding chiller is required to operate. The operation of the constant speed primary chilled water pump shall be preceded by the operation of the condenser pump.
7.4.4 The chiller system controller shall undertake all control functions when an enable signal is received
from the BMS. There shall be a requirement for chilled water whenever one or more of the chilled water secondary pumps is operating.
7.4.5 Comprehensive fault and exception list shall be relayed to the BMS system from each chilled control panel.
7.4.6 In the event of a primary pump failure on the condenser water or chilled waterside of the chillers an alarm shall be generated together with a message advising the maintenance team to manually initiate the corresponding standby pump.
7.4.7 The selection of how many and which chillers shall operate shall be determined by the BMS or by the operator.
7.4.8 The BMS shall generate an alarm if a pump or chiller fails to start or fails in service. An alarm shall also be generated if a chiller alarm is communicated by the chiller controller to the BMS.
7.4.9 The operator shall be able to manually reset the chilled water supply temperature setpoint and the current limit setpoint. All operating chiller shall have the same chilled water supply temperature setpoint and the same current limit setpoint.
7.4.10 Chilled water to the complex shall be provided by the variable speed main secondary pumps that shall operate as required. If a coil in a block requires chilled water the tertiary pump with the least accumulated run time shall be started on minimum speed. The speed of the pump shall be modulated to ensure that there is a adequate flow to meet the differential pressure requirements. The startup of any tertiary pump will cause the secondary pumps with the least accumulated run time to be started on minimum speed. The speed of the pump shall be modulated to ensure that if the differential pressure has been below setpoint for at least 3 minutes (this period may be varied by the operator) the duty pump shall be set to minimum speed and a 2nd duty pump shall be started on minimum speed and the pumps shall then be ramped up and down together so as to attain the desired differential pressure. The above procedure shall be repeated in case two pumps are insufficient to meet the requirements and a third pump is required to be started. Should one of the duty pumps fail to start or fail in service the fourth (standby pump shall be started.
7.4.11 The BMS setpoints for the system shall be as follows:

7.4.11.1 Differential pressure between supply and return mains shall be set at a value to be provided by the MEP contractors as a result of his pressure drop calculations for full design flow through the loop.
7.4.12 An alarm shall be generated if:
7.4.12.1 The bypass flow is in the wrong direction.
7.4.12.2 An alarm condition is communicated from an inverter drive to the BMS.
7.4.12.3 Differential pressure drops to a preset value.
7.5 INTERFACES BETWEEN BMS AND CONDENSER WATER SYSTEM
7.5.1 The BMS shall initiate control of a cooling tower when a chiller controller starts the associated condenser water pump and opens the motorized condenser isolation valves.
7.5.2 If after an operator-determined period of time, initially set at 5 minutes, the condenser water supply temperature is above set point the BMS shall start the 2-speed cooling tower fan on slow speed. If the supply water temperature has been above sepoint and the fan has been operating on low speed for an operator determined period of time, initially set at 5 minutes, the fan shall be set to high speed. The set point of the condenser water leaving temperature shall be maintained by reducing the speed of the fans and/or switching the fans on and off. The set point shall be maintained below 35 0C at all times but shall vary to suit the ambient conditions. At very low loads heat rejection may be achieved by natural draught alone.
7.5.3 An alarm shall be generated if the condenser water leaving temperature rises above 37 °C of falls below 20 °C.
7.5.4 The condenser water setpoint shall be set an operator determined value, initially set at 3 ºC., above the wet bulb temperature.
7.6 INTERFACES BETWEEN BMS AND MAKE-UP WATER CONTROLLER AND EXPANSION TANK MONITORING
SYSTEM
7.6.1 Provide an BACnet serial interface between the BMS and the pressurization unit.
7.6.2 The digital communications interface shall be set up so as to provide, at minimum, the following monitoring and control points:
7.6.2.1 Make-up cold water pumps run status.
7.6.2.2 Make-up cold water pumps trip status.
7.6.2.3 Low water level alarm.
7.6.2.4 High water level alarm.
7.6.2.5 Low pressure alarm.
7.6.2.6 High pressure alarm.
7.6.2.7 System working pressure.
7.6.2.8 Hours run each pump.
7.6.2.9 System leakage alarm (Pump running too frequently)
7.6.3 Refer to MEP contract documents.
7.7 INTERFACES BETWEEN THE BMS AND GAS SUPRESSION SYSTEM FOR SERVER ROOM
7.7.1 Provide a BACnet interface between the Control unit of the Gas Suppression System and the BM
7.8 INTERFACE BETWEEN BMS AND THE LIGHTING CONTROL SYSTEMS
7.8.1 The Lighting System shall be as detailed in the electrical trade documents. The lighting system will be controlled via Building Management System inputs from push button. The control will be achieved by the use of relays mounted adjacent to the relevant lighting distribution board. The BMS contractor shall provide the relays.
7.8.2 Lighting control shall be achieved by contactors mounted adjacent to the lighting distribution boards is separate enclosure. The contactors shall be controlled by the BMS system via local controllers. The BMS contractor shall refer to the distribution board schedules in the electrical design documents for selecting the number and location of the contactors to be controlled by the BMS. The contractors shall be provided by the BMS contactor The following are the details of the lighting contactor control module:
7.8.2.1 Contactor coil rating: 220V AC
7.8.2.2 Contactor contact rating: 25A AC for inductive loads.
7.8.2.3 Contact configuration: 2 sets of changeover contacts per contactor.

7.8.2.4 Mounting: DIN rail
7.8.2.5 Switching is fail-safe mode, i.e. contactors are de-energized to switch lights on. The lighting shall fail ON in the event of a BMS component failure.
7.8.2.6 Contractor power supply; Derived from local distribution board.
7.8.2.7 Labeled terminal blocks shall be provided by the electrical trade to accommodate the field wiring interface between the lighting contactor control module and the BMS controller.
7.8.3 The BMS contractor shall include the cable between the lighting control system contactors and the BMS controllers on the cable and containment shop drawing. The BMS contractor shall supply all cable and the installation shall be by the MEP contractors. Containment shall be provided by the MEP contractors as detailed in the Section titled “BMS Installation Requirements”.
7.8.4 The lighting control shall also include local lighting control switches provided by the BMS contractor that shall be as follows:
7.8.5 The BMS operator shall be able to undertake the following function from the BMS contractor that shall be as follows:
7.8.5.1 Change the schedule for any lighting zone.
7.8.5.2 Display in schematic form on the OIW GUI and/or the CCC control room the lighting status of the lighting zones.
7.9 INTERFACE BETWEEN BMS AND PARKING SYSTEM
7.9.1 The employer shall provide a parking system and the BMS contactor shall provide an interface between the parking system and the BMS to map data from the parking system to the BMS.
7.10 INTERFACE BETWEEN BMS AND VARIABLE FREQUENCY DRIVES (VCD)
7.10.1 Provide a BACNET interface between the BMS and the variable frequency drive units. The VFD manufacturer shall provide the communication interface card at each VFD.
7.10.2 The digital communications interface shall be set up so as to provide, at minimum, the following monitoring and control points:
7.8.1.1 Start and stop control
7.8.1.2 Speed control
7.8.1.3 Speed reference feedback
7.8.1.4 Motor operating status
7.8.1.5 VFD alarm
7.8.1.6 Motor power in kW.
7.8.1.7 Motor kWh
7.8.1.8 Motor current
7.8.1.9 Motor voltage
7.8.1.10 Hours run
7.8.1.11 DC link voltage
7.8.1.12 Thermal load on motor
7.8.1.13 Thermal load on VFD
7.8.1.14 Heat sink temperature
7.10.3 The start/stop control and the speed control capabilities shall not be available at the BMS for those VFD associated with stairwell and fire lift pressurization.
7.11 INTERFACE BETWEEN BMS AND SWITCHBOARD ELECTRONIC METERSES
7.11.1 Each switchboard shall be provided with an electronic meter. Provide BACNET interface between the BMS and the switchgear units.
7.11.2 The digital communications interface shall be set up so as to provide the BMS with, at minimum, the following monitoring points:
7.11.2.1 Current per phase and total
7.11.2.2 Voltage phase-to-phase and phase-to-neutral and total
7.11.2.3 kWh
7.11.2.4 kW and/or kVA
7.11.2.5 kW maximum demand
7.11.2.6 kVAR
7.11.2.7 Power factor average

7.11.2.8 Frequency
7.11.2.9 Total harmonic distortion (current and voltage)
7.11.3 Coordinate with the electrical trade to ensure that the above information is monitored by the BMS for all incoming electrical power meters on the project.
7.11.4 Provide any interconnecting cabling required between switchboards and from the switchboard to the communication gateway. Containment shall be provided by the MEP contractors as detailed in the Section titled "BMS Installation Requirements:.
7.12 INTERFACE BETWEEN BMS AND THE LIFT MONITORING AND CONTROL SYSTEM (LMCS)
7.12.1 If a direct interface is require between the BMS and the LMCS:
7.12.1.1 It shall be LON TALK or equivalent
7.12.1.2 The LMCS contractor shall provide a communication port and all relevant details of the protocol.
7.12.1.2 The BMS contractor shall furnish and terminate the communications cable at the BMS end
7.12.1.3 The MEP contractors shall provide containment and shall install the communications cable in the containment.
7.12.1.4 The LMCS contractor shall terminate the communications cable at the LMCS equipment.
7.12.1.5 The following points shall be mapped to the BMS:
- Lift Status
- Enable / Disable lift operation
- Trouble alarms
- Interfaces with FACs for the hotel block E lifts shall have a feature to bypass a floor during certain timings.

7.13 INTERFACE BETWEEN BMS AND CENTRAL BATTERY SYSTEM
7.13.1 If a direct interface is required between the BMS and the CBS:
7.13.1.1 It shall be BACNET or equivalent
7.13.1.2 The CBS contractor shall provide a communications port and all relevant details of the protocol.
7.13.1.3 The BMS contractor shall furnish and terminate the communications cable at the BMS end.
7.13.1.4 The MEP contractors shall provide containment and shall install the communications cable in the containment.
7.13.1.5 The CBS contractor shall terminate the communications cable at the CBS equipment
7.13.1.6 The following points shall be mapped to the BMS:
- Usage / pattern / trends
- Capacity / available capacity
- Mode of operation i.e. charge / discharge
- Faults
- Alarms

7.14 INTERFACE BETWEEN BMS AND SCADA SYSTEM
7.13.1 If a direct interface is required between the BMS and the SCADA:
7.13.1.1 It shall be BACNET/IP or equivalent
7.14.1.2 The SCADA contractor shall provide a communications port and all relevant details of the protocol.
7.14.1.3 The BMS contractor shall furnish and terminate the communications cable at the BMS end.
7.14.1.4 The MEP contractors shall provide containment and shall install the communications cable in the containment.
7.14.1.5 The SCADA contractor shall terminate the communications cable at the equipment
7.14.1.6 All available points in the SCADA shall be mapped for every item.
7.14.1.7 Not less than the following items shall be mapped to the BMS:
- Diesel, Dual Fuel & Gas Generators
- Transformer
- Main Distribution Boards (MDB's)

- Auto Load Synchronization and Auto Load Sharing (ASALS) System
- Alarms
- Faults
- Usage / pattern / trends
- Total Load
- Total power available
- Differentiate b/w loads

8.0 SOFTWARE

8.1 WORK OF THIS SECTION

8.1.1 This section of the Specifications details the components to be provided by the BMS contractor relating to the following:

8.1.1.1 Software executive operating systems.

8.1.1.2 Monitoring and control software.

8.1.1.3 Applications software packages.

8.1.1.4 Sequences of operation

8.2 INTERACTIVE PROCEDURE

8.2.1 The term "interactive" is used to mean that the system shall operate in a conversational mode whereby the operator shall receive English language prompts in the form of:

8.2.1.1 Tables into which the operator enters data.

8.2.1.2 Questions that are responded to by the operator.

8.2.1.3 Selections that are made by the operator based on a list of suggested alternatives that is generated by the BMS.

8.2.2 Interactive procedures shall be such that the operator can readily execute a task without reference to instruction manuals and without knowledge of the BMS control language.

8.2.3 All set points, alarms limits, dead bands, software time delays, report configuration and requests, operating time limits, etc. shall be operator definable through an interactive procedure via the associated GUI system diagram or appropriate display.

8.3 APPLICATIONS PACKAGES

8.3.1 The applications software packages shall reside at the DCP or UC at which they are used except as noted in the Section titled “BMS Unitary Controllers” and except that it shall be acceptable for the applications packages associated with the presentation of data, data storage, data analysis and data retrieval to reside at the OIW.

8.3.2 Provide the following programs for the storage, analysis and retrieval of data:

8.3.2.1 GUI system diagram displays

8.3.2.2 Real-time plotting

8.3.2.3 Historical data trends

8.3.3 Provide the following programs for the presentation of data:

8.3.3.1 Energy usage and demand

8.3.3.2 Psychometric properties

8.3.3.3 Equipment operating time

8.3.4 Provide the following programs for the optimization of energy usage:

8.3.4.1 Equipment scheduling

8.3.4.2 Optimized scheduling

8.3.4.3 Peak electrical demand control

8.3.4.4 Equipment cycling

8.3.5 Provide the following programs for the restart of building mechanical systems:

8.3.5.1 Equipment restarts following a fire alarm

8.3.5.2 Equipment restarts following a power failure

8.3.6 Implement all applications programs such that the BMS is fully functional and does not require input from the operator in order to be a fully commissioned turnkey system meeting all the requirements of these Specifications.

8.3.7 Request any data required for the implementation of the application packages at least four weeks before the date the information is needed. Submit the request for information in the form of tables or forms for the Employee’s personnel to complete and return.

8.4 GENERAL SOFTWARE REQUIREMENTS
8.4.1 The Distributed Control Panels, Workstations and Unitary Controllers shall run under the control of
proven real-time executive operating software systems. These operating systems are collectively referred to as the BMS operating systems.
8.4.2 The BMS operating systems shall support their associated operator terminals and shall incorporate
diagnostic software and a priority interrupt structure.
8.4.3 The Workstation operating systems shall be Microsoft Windows 7 server edition or approved and equal.
8.4.4 Following a loss of power the PC, DCP and UC shall reboot in an orderly fashion and attain a normal operating status within 2 minutes of the return of power. This shall be accomplished without operator intervention.
8.4.5 The operating sequences and all databases related to monitoring and control functions shall reside at the associated DCP and/or UC. Copies of these databases, operating sequences, schedules and other programmable software shall reside at the PC at the OIW. It shall be ensured that at all times there is no mismatch between software resident at the DCP and/or UC and the software copy resident at the PC.
8.4.6 Provide software checking for data transmission error and failure detection.
8.5 MONITORING AND CONTROL SOFTWARE – GENERAL
8.5.1 Scan rates at the DCP and/or UC shall meet the following requirements:
8.5.1.1 Each analogue and digital input point shall be scanned at least once every 5 seconds.
8.5.1.2 If a point is in alarm, then the alarm shall be annunciated at the OIW within 2 seconds of the termination of the time delay period following detection of the alarm condition.
8.5.2 DDC outputs shall be updated at a frequency defined by the operator. The operator shall be able to select a frequency, at minimum, in the range of 2 seconds to 256 seconds.
8.5.3 The operator shall be able to define a minimum time delay between successive starts of equipment so that disturbances created on the building electrical system are minimized in frequency and amplitude.
8.5.4 BMS analogue and digital outputs shall change as the result of either an operator entered command or a BMS generated software command. These two modes of BMS output are referred to as the BMS MANUAL CONTROL mode and the BMS SOFTWARE CONTROL mode and differ as follows:
8.5.4.1 In the BMS manual control mode, the signal to a final control element such as a valve or a damper actuator and to a relay such as a motor control relay shall change as the result of a command manually entered at one of the operator terminals. When an output is in the BMS manual control mode, there shall be no means by which it can switch to the BMS software control mode or by which the value or state of the BMS output can change without operator intervention.
8.5.4.2 In the BMS software control mode, the signal to the final control element or relay shall be changed automatically as the result of software such as a schedule, operating sequence or Applications Package such as the Optimized Scheduling feature.
8.5.5 The operator shall be able to select the mode of output control for each analogue and digital output.
8.5.6 The operator shall be able to define the minimum time delay between the stopping of a piece of equipment and its subsequent restart. This time delay shall be in effect for motors in the BMS software control mode and for motors in the BMS manual control mode.
8.5.7 If there is a discrepancy between the actual and BMS commanded state of a motor then, unless the discrepancy arises because of control of the motor by the fire alarm system or because of a power failure, the motor control relay shall be set automatically to the OFF state, an alarm shall be generated and the motor shall be placed in the BMS manual control mode. If the discrepancy has arisen because of override control by the fire alarm system, then the motor shall be restarted by the BMS in accordance with the procedure detailed in the paragraph titled "Equipment

Restart Following a Fire Alarm". If the discrepancy has arisen because of a power failure, then the motor shall be restarted by the BMS in accordance with the procedure detailed in the paragraph titled "Equipment Restart Following a Power Failure". In all cases a motor shall only restart following an operator manually entered command

8.5.8 The BMS shall not override any hardwired interlocks such as those provided at motor starters for overload protection, damper interlock, pressure interlock, etc. and those provided to facilitate control by the Fire Detection, Alarm and Communication System regardless of the BMS output control mode.

8.5.9 Unless stated otherwise elsewhere in these Specifications, the modulation of final control elements

by the BMS in the BMS software control mode shall be based on a Proportional-Integral-Derivative (PID) control algorithm. The control constants for the PID algorithm shall be definable by the operator. If self-tuning algorithms are provided, it shall still be possible for the operator to manually tune the control loops. The software shall incorporate facilities to enable the bumpless transfer of a modulating output from BMS manual control to BMS software control and vice versa and the prevention of integral wind-up. PID algorithms shall maintain the system operation within the desired tolerance around the set point. Set point tolerances shall be as follows:

8.5.9.1 Supply air temperature control, + or - 0.5 Deg. C.

8.5.9.2 Space temperature control, + or - 0.5 Deg. C.

8.5.9.3 Duct static pressure control, + or - 50 Pa

8.5.9.4 Water differential pressure, + or - 15 kPa.

8.5.9.5 Space static pressure control, + or - 10 Pa

8.5.9.6 Relative humidity, + or - 5%

8.5.10 Software shall automatically inhibit the generating of an alarm on an analogue input when the status of an associated digital input indicates that an alarm condition is to be expected. Such would be the case, for example, when an air handling unit is off as it would be expected that the supply air temperature would be outside the alarm limits established for the operating state. An interactive procedure shall enable the operator to link any analog value to a digital input so as to inhibit unnecessary alarms. Points with their alarms locked out shall continue to be displayed on reports and GUI displays. The alarms shall remain locked out for an operator defined time delay following the start-up of the associated equipment

8.5.11 If for any reason the operator wishes to terminate the monitoring of a particular digital or analogue input, then it shall be possible to take the point out of service via an interactive procedure. If the point is the monitored variable in a control loop, then the control loop shall be disabled, any sequence dependent on the point shall also be disabled and all associated BMS outputs shall go to the BMS manual control mode.

8.5.12 An interactive procedure shall enable the operator to add, delete and modify points monitored and controlled by the BMS.

8.5.13 An interactive procedure shall enable the operator to configure control loops. The operator shall define Set points for control loops or they shall be derived from software logic as detailed in Part 3 of this Section of the Specifications.

8.6 OPERATING SEQUENCES

8.6.1 The sequences of operation shall be as detailed in the drawings and documents and can be as per site requirement.

8.7 GUI SYSTEM DIAGRAM DISPLAY PACKAGE

8.7.1 Provide a software package to enable the operator to configure, modify and delete system diagrams similar in scope to those on the control diagrams that form part of these contract documents. Real-time data shall be superimposed on the system diagrams and shall be updated at intervals between 10 and 20 seconds. The data shall be positioned on the display at points indicative of the instrumentation locations on the system.

8.7.2 Provide a library of commonly used symbols in accordance with CIBSE standards including all symbols used in the compilation of the system diagrams for this project.

8.7.3 Each system diagram shall indicate real-time data including analogue and digital input and output points, setpoints and calculated values of the associated system. The BMS Field

Termination Schedules and System Diagrams detailed on the control diagrams shall provide a guideline for the selection of data to be displayed on a particular system diagram. Preferably the status of motors, e.g. on, off, failed, etc., shall be indicated by colour changes such as green for on, blue for off and red for failed. The system diagrams shall also distinguish between outputs in the BMS manual control mode and in the BMS software control mode. Where necessary to enhance the understanding of the data displayed use alphanumeric text. The graphics shall be fully animated.

8.7.4 Provide a hierarchy of GUI displays that will enable an operator, for example, to progress from a diagram of the building, to a particular floor in the building and to a particular zone on the floor. The selection at each stage shall be by cursor control using a mouse or keyboard arrow buttons.

8.7.5 Provide icons on displays to enable easy access from one display to a related display. For example, provide a target box on the system diagram for a group of fan powered terminal units that will enable one-step access to the associated air handling unit.

8.7.6 A system diagram shall be provided, at minimum, for each of the systems detailed in the point definitions of these contract documents.

8.7.7 The BMS contractor shall submit a complete set of the proposed system diagrams at the shop drawing stage of the project. The BMS contractor shall modify the system diagrams as requested by the Engineer following shop drawing review at no additional cost to the Employer.

8.8 REAL-TIME PLOTTING

8.8.1 Provide a software package that emulates, at minimum, a 3No. point strip chart recorder. This program shall concurrently display 3No. or more (maximum of 6) plots of variables in a graphical format. The graphs shall be plotted as the values are sampled in a similar fashion to a chart recorder and when the plot reaches the right hand side of the X-axis, the X-axis shall scroll to the left so as to accommodate newly sampled data.

8.8.2 The variables to be plotted shall be selected by the operator from any input, output point, BMS calculated value or any setpoint. It is envisaged that the primary use of this facility will be for the tuning of control loops and the observance of control loop performance. Typically this would require, for example, the concurrent plotting of the loop setpoint, the monitored variable and the BMS output to the final control element.

8.8.3 Each of the plotted variables shall be uniquely and clearly identified using a means of differentiation such as different colors for each variable or different symbol for the plotted points for each variable.

8.8.4 The X-axis shall be the time axis and shall have a scale selected by the operator using an interactive procedure or shall be scaled automatically to accommodate a minimum of 30 plotted points for each variable. The plot rate shall be selected by the operator using an interactive procedure and shall have the following minimum ranges:

8.8.4.1 Plot rates for monitored variables shall range from their BMS scan rate to at least once per day.

8.8.4.2 Setpoints shall be plotted at the same rate as the associated variable.

8.8.4.3 Plot rates for BMS outputs shall range from their BMS update rates to at least once per day.

8.8.4.4 Plot rates for calculated points shall range from the rate at which the calculation is performed to at least once per day.

8.8.5 The Y-axis shall be the value of the plotted variable. If plotted variables have different ranges then provide separate Y-axes. The Y-axis for each plotted variable shall be defined by the operator using an interactive procedure or shall be scaled automatically using a technique that displays the data in an optimum manner.

8.9 HISTORICAL DATA TRENDS

8.9.1 Provide a software facility for the collection and storage of data and its subsequent retrieval and display in tabular and graphical form as selected by the operator.

8.9.2 The operator shall be able to assign on-line, using an interactive procedure, any BMS input or output point, calculated variable or set point to the historical data trend facility. It shall be possible to have data collection and storage concurrently, at minimum, for one thousand (2000) variables.

8.9.3 Each variable shall be sampled at an operator defined frequency using an interactive procedure. The sampling frequencies shall be in the following ranges at minimum:
8.9.3.1 For BMS monitored points the sample rate shall be the scan rate to at least once per day.
8.9.3.2 Setpoints shall be sampled at the same rate as their associated variable.
8.9.3.3 For BMS outputs the sample rate shall be the update range to at least once per day.
8.9.3.4 For calculated points the sample rate shall be in the range of the calculation rate to once per day.
8.9.4 Storage shall be provided for at least two thousand (2,000) pieces of sampled data for each variable assigned to this feature. Recall of data shall be in either a tabular form or in a graphical form and shall be displayed on the GUI or output on one of the printers as selected by the operator. Whichever form of output is selected by the operator it shall be possible to concurrently output data for a minimum of 3No. variables. The time period to be covered by the data output shall be selected by the operator using an interactive procedure. When the storage capacity for a variable is full the newly sampled data shall over-write the data stored for that variable for the longest period of time.
8.9.5 Data output in tabular form shall clearly distinguish between the variables and shall indicate the time and date at which each piece of data was sampled.
8.9.6 Data output in graphical form shall meet the same requirements as detailed above for the realtime
plotting of data.
8.9.7 It shall be possible at any time to obtain a listing of which points have been assigned to this feature and their sampling rates.
8.9.8 It shall be possible to output the historical data in a Microsoft Excel format in a hardcopy and in an electronic format**.**
8.9.8 Resolution. Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.
Dynamic Update. Trends shall be able to dynamically update at operator-defined intervals.
Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and ' pan through' historical data by simply scrolling the mouse.
Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.
8.10 ELECTRICAL ENERGY USAGE AND DEMAND
8.10.1 Provide a software facility to monitor and report electrical energy usage and instantaneous energy demand. This feature shall also store data for recall via the historical data trend package.
8.10.2 The BMS shall monitor the demand kW, kVA and kWh.
8.10.3 The BMS shall provide a 15-minute interval counter for the metered inputs.
8.10.4 This software feature shall generate a report available on demand and on a scheduled basis.
8.11 PSYCHOMETRIC PROPERTIES
8.11.1 Provide a software package to determine the following properties of ambient air:
8.11.1.1 Wet bulb temperature.
8.11.1.2 Dew point temperature.
8.11.2 The above parameters shall be calculated using the monitored values of ambient air dry bulb temperature and relative humidity
8.14.3 This software package shall also calculate the enthalpy of ambient air and ducted return air on the basis of the dry bulb temperature and relative humidity monitored in ambient air and the ducted return air.
8.11.4 These psychometric calculations shall be based on sea level data and shall cover the dry bulb temperature range of +10 Deg. C. to +60 Deg. C.
8.11.5 The psychometric chart shall be displayed on the OIW GUI and shall be dynamic. With the input of any two variables all other psychometric data shall be automatically displayed on the psychometric chart.
8.12 EQUIPMENT OPERATING TIME

8.12.1 Provide a software package that will accumulate the operating times for motors as selected by the operator using an interactive procedure. Any piece of equipment that has its status monitored by the BMS shall be selectable for inclusion in this feature. It shall be possible to concurrently monitor the accumulated operating time for every item of equipment monitored and/or controlled by the BMS. Data shall be stored at the local controllers and shall be uploaded to the OIW at regular intervals. In the event of loss of communications between the OIW and the local controller the local controller shall continue to monitor and store data such that the data can be downloaded when the communication is restored. The number of starts and stops of motors shall also be accumulated.
8.12.2 The operator shall be able to establish on-line, using an interactive procedure, a value for the accumulated operating time at which a suitably worded message shall be output to the operator advising that the reporting limit has been reached for a specific motor. The message shall be output at the designated alarm printer.
8.12.3 The operator shall be able to change the accumulated total for any motor to any value.
8.12.4 The accumulated operating times shall be updated at least every 15 minutes.
8.12.5 The operator shall be able to obtain a report on demand and on a scheduled basis detailing the accumulated operating times.
8.13 EQUIPMENT SCHEDULING
8.13.1 Provide a program that will enable the BMS to automatically schedule an item of equipment on and off.
8.13.2 The equipment assigned to this program shall be selected by the operator using an interactive procedure. Any piece of equipment controlled by the BMS shall be assignable to this program and it shall be possible to have all controlled pieces of equipment concurrently assigned to this program.
8.13.3 The operator shall be able to assign a minimum of 4No. start and 4No. stop times to each piece of equipment for each day of the week and for holidays. These schedules shall only be in effect for a piece of equipment when it is in the BMS software control mode.
8.13.4 The operator shall be able to obtain a report detailing the schedules.
8.14 OPTIMISED SCHEDULING
8.14.1 Provide an adaptive software program that shall:
8.14.1.1 Start HVAC equipment at the latest possible time while ensuring that space in the building reaches setpoint conditions by the time occupancy commences.
8.14.1.2 Stop HVAC equipment at the earliest possible time while ensuring that space in the building shall still be within the setpoint dead band at the scheduled end of occupancy.
8.14.2 This program shall base the determined equipment start and stop times on monitored data such as space temperatures within the area served by the equipment and ambient conditions. If the BMS contractor requires information other than that provided by the monitoring detailed in the Field Termination Schedules, then the necessary additional instrumentation shall be provided within the base tender price.
8.14.3 The operator shall be able to assign limits to the start and stop times. Initially these limits shall be
set as follows:
8.14.3.1 BMS determined start times shall not be more than 3 hours before the scheduled occupancy.
8.14.3.2 BMS determined stop times shall not be more than 1 hour before the scheduled end of occupancy.
8.14.4 A report shall be available on demand and on a scheduled basis that provides the following information:
8.14.4.1 Occupancy schedules
8.14.4.2 Time of last equipment start and space conditions at scheduled occupancy time
8.14.4.3 Time of last equipment stop and space conditions at scheduled end of occupancy time
8.14.5 This feature shall only be implemented for equipment in the BMS software control mode.

8.15 EQUIPMENT RESTART FOLLOWING A FIRE ALARM
8.15.1 Provide a software program that will restart equipment following the return to normal condition that was shut down by the FAS or by the BMS as the result of a fire alarm.
8.15.2 Following the return to normal of the fire alarm the operator shall be able to initiate the restart of
all equipment shutdowns by the FAS and BMS with individual manually entered commands to each item of equipment and with a single command that shall restart all equipment scheduled to be operational at the time of the operator restart command. Prior to the return to normal of the fire alarm system the operator shall not be able to execute the restart command. The restart of the equipment shall be subject to all the software protection such as the minimum "off" time and the operator defined time delay requirements between
Successive equipment starts.
8.16 EQUIPMENT RESTART FOLLOWING A POWER FAILURE
8.16.1 Provide a program that will facilitate the restart of equipment following a power failure.
8.16.2 This program shall function in the same manner as the "Equipment Restart Following a Fire Alarm" except that it shall be based on the BMS detection of a power failure rather than on the BMS detection of a fire.
8.16.3 When there is a loss of normal power, the BMS shall de-energize all units under its control.
9.0 DAMPER INTERFACE UNITS
9.1 WORK OF THIS SECTION
9.1.1 This section of the specifications details the components to be provided by the
BMS contractor related to the following:
9.1.1.1 Actuators for Motorized dampers (MD)
9.2 GENERAL
9.2.1 Provide actuators for all motorized dampers motorized fire and/or smoke rated dampers.
9.2.2 Multiple section two position dampers shall be controlled by one BMS output unless indicated otherwise within the Field Termination Schedules or Sequences of Operation.
9.2.3 Multiple section modulating dampers shall be controlled in sequence unless indicated otherwise within the Field Termination Schedules or Sequences of Operation.
9.2.4 Actuators shall be mounted to allow complete access for maintenance and removal. Wherever possible provide damper actuators mounted on the exterior of the duct/damper section. The installation of actuators within air streams will be permitted only where damper configurations and site conditions require. Obtain approval for proposed installations of actuators within ductwork, plenums, airstreams, etc. Furnish access doors where required to allow access.
9.2.5 Damper actuators shall be configured for normal and failure positions as indicated in the operating sequences and as indicated in the MEP contractors Mechanical Drawings and Specifications.
9.2.6 Provide actuators sized in accordance with manufacturers recommendations and industry standards for accurate and stable control of airflow in each application.
9.2.7 Provide damper actuator installations to comply with the acoustical requirements for the project. Noise generated from damper actuators in air streams shall not be detectable in occupied building spaces.
9.2.8 Damper actuators shall be controlled by the BMS where necessary to meet the required sequences of operation. If the FAS also control a damper then the FAS control shall override the BMS control of the damper.
9.3 DAMPER ACTUATORS
9.3.1 Provide electric damper actuators for all motorized dampers. Electric actuators shall meet, at minimum, the following requirements:
9.3.1.1 Stroke by the rotating motion of a reversible, overload-protected synchronous motor. Actuators shall be directly coupled to damper drive blades with no intermediate
linkages or shall be rotary type actuators directly coupled to the damper drive shaft.
9.3.1.2 Protected against overload by an integral magnetic clutch or stall protection by nonoverloading impedance protected motor.
9.3.1.3 240 Vac + or - 10% 50 Hz or 24 Vac power supply.

9.3.1.4 One actuator for each damper section. Provide additional actuators to ensure sufficient torque to meet the specified close off leakage requirements. Damper actuators shall not be stacked.
9.3.1.5 Actuators shall be motorized/ driven in both the open and closed directions. Where required by the sequences of operation, actuators shall have a spring return to the deenergized position upon loss of power. Damper normal and failure positions shall be as identified within the sequences of operation.
9.3.1.6 BMS controlled actuators for modulating Motorized Dampers shall be controlled by a 0-10 Vdc, or 4-20mA signal. Provide actuators that are fully compatible with the BMS analogue output subsystem. BMS controlled actuators for two position dampers shall be controlled by 24Vac, 24Vdc or single-phase 240 Vac power switched by the BMS.
9.3.1.7 Complete with mounting brackets suitable for extended shaft mounting or direct damper drive shaft mounting.
9.3.1.8 Stroke dampers from fully closed to fully open in accordance with the following:

Service	Timing Requirement
Two position normal service	75 seconds
Modulating normal service	120 seconds
Emergency service (stair pressurization, smoke containment, etc.)	15 seconds

9.3.1.9 Actuators for non fire and/or smoke rated dampers shall be rated for operation at ambient temperatures of minus 40 Deg.C. to 50 Deg.C. (-40 Deg. F. to 122 Deg. F.).
9.3.1.10 Complete with damper/actuator stroke position indicator.
9.3.1.11 Manual drive release mechanism and manual positioning mechanism.
9.3.2 Actuators shall be quiet in operation such that noise from actuator operation is not detectable in any occupied spaces.
9.3.3 Actuators shall be Invensys, Belimo, Honeywell, Nailor, or equal and approved.
9.4 HARDWIRED INTERLOCKS
9.4.1 Provide all required hardwired interlocks between fans and any motor actuated dampers as identified within these contract documents.
9.4.2 Power for interlocked dampers shall be obtained from the associated air handling fan motor control circuit. Coordinate actuator power supply wiring and fire alarm system override control of dampers with MEP contractors.
9.4.3 Where dampers are specified to be hard wire interlocked with fan motors the BMS contractor shall provide the damper position switches. Provide the damper end switch(s) hard wire interlocked to achieve the operational requirements as specified in the Field Termination Schedules and the sequences of operation in these specifications, and as indicated in the MEP contractors Drawings and Specifications. Provide damper end switches hard wire interlocked to prevent fan motor operation in both the hand and auto position of hand/off/auto motor control circuit. Damper position switches shall be set to indicate the open position when they are open by more than 80%.
9.4.4 Provide for each damper that is controlled by both the BMS and the FAS, a terminal strip and associated control relays such as to allow control and monitoring as follows (as applicable):
9.4.4.1 BMS two position open-closed control - contact closure of a BMS relay, thermostat or interlocking device shall open the damper. Contact opening shall close the damper.
9.4.4.2 BMS modulating control - modulating signal from the BMS of 0-10 vdc or 4-20 mA output to achieve the required sequence.
9.4.4.3 Damper open/closed status - allow FAS monitoring or interlock of damper open and damper close status.
9.4.4.4 Override open control - contact closure of a FAS command relay or localized smoke detector shall override any BMS modulating or open/closed control to open the damper.
9.4.4.5 Override closed control - contact closure of a FAS command relay or localized smoke detector shall override any BMS modulating or open/closed control to close the damper.
9.4.4.6 Furnish and terminate cabling as follows:
9.4.4.6.1 Between all damper actuators and the associated damper terminal strip.

9.4.4.6.2 Between the BMS and the damper terminal strip for any damper monitored and/or controlled by the BMS.
9.4.4.6.3 Between the damper terminal strip and interlocked motors, thermostats, pressure switches, generators, pumps, etc.
9.4.4.7 Coordinate exact FAS interface requirements and terminal strip locations with the contractor.

10.0 VALVES

10.1 WORK OF THIS SECTION
10.1.1 This section of the specifications details the components to be provided by the BMS subcontractor related to the following:
10.1.1.1 Two-way and three-way control valves.
10.1.1.2 Linked butterfly valves.
10.1.1.3 Valves for instrumentation.
10.1.1.4 Valve actuators.
10.2 VALVES - GENERAL
10.2.1 Furnish all valves controlled by the BMS as detailed in the mechanical trade documents and as indicated on the control drawings which form part of these contract documents. Furnish all shutoff valves for instrumentation as detailed in the Section of these specifications titled “BMS Field Instrumentation”. The MEP contractors shall install valves, except those for instrumentation. All other valves such as check valves, relief valves, pressure reducing valves, self regulating valves, manually operated valves, etc. shall be furnished and installed by the MEP contractors. Provide details of the manufacturer's installation requirements to the MEP contractors. Coordinate the valve body type and pipe connections with the mechanical trade.
10.2.2 Refer to the Mechanical plans and drawings and to the control drawings which form part of these contract documents for the design conditions on which to base sizing and ratings of the valves and their actuators.
10.2.3 The complete valve (body and trim) shall be rated for a pressure that is at least 50% greater than the maximum pressure to which it will be exposed. Where noted in this Section, the valve shall be rated for a higher pressure. The complete valve shall be rated for a temperature that shall be at least 50 deg. C. (122 deg. F.) greater than the maximum temperature to which it will be exposed. The Manufacturer shall certify that each complete valve is suitable for and meets all relevant standards for the application.
10.2.4 All valves shall be rated appropriately for the fluid, temperature and pressure and, at minimum, shall have a 16 bar rating. Valves shall comply with BS 5793 and BS EN 60534.
10.2.5 Valves of similar types shall be by the same manufacturer.
10.2.6 Valves shall have the manufacturer's name and the pressure rating clearly marked on the outside of the body. Where this is not possible manufacturer's name and valve pressure rating shall be engraved on a minimum 50mm (2 inch) diameter stainless steel tag that shall be attached to the valve by a chain in such a manner that it cannot be unintentionally removed.
10.2.7 Valves 13mm to 50mm (0.5 inch to 2 inches) shall have screwed ends. Screwed ends shall comply with BS 21:1985 (Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads - metric dimensions). Valves 63mm (2.5 inches) and larger shall have flanged ends. Flanged valves shall be furnished complete with companion flanges, gaskets and bolting materials. Flanges, gaskets and bolting materials shall meet the appropriate BSI requirements.
10.2.8 Verify and certify that the materials of construction of the pipe, weld, flange, bolts and valve will not cause any galvanic corrosion.
10.2.9 Valves shall be suitable for continuous throttling.
10.2.10 Valve schedules shall be submitted for review and shall clearly show the following for each valve:
10.2.10.1 Associated system.
10.2.10.2 Manufacturer and model number.
10.2.10.3 Valve size and line size.
10.2.10.4 Flow rate, flow coefficient (CV) - and pressure drop at design conditions and Valve

authority, flow rate and pressure drop across the valve at design conditions and pressure drop across the associated mechanical equipment, e.g., coil, heat exchanger, etc., at design conditions.
10.2.10.5 Valve configuration (e.g. two way, three way, butterfly).
10.2.10.6 Leakage rate.
10.2.10.7 Maximum pressure shut-off capability.
10.2.10.8 Actuator manufacturer and model number.
10.2.10.9 Valve body pressure and temperature rating.
10.2.10.10 Normally open/closed and failure positions.
10.2.11 Where necessary to achieve the required performance and pressure drop a control valve may be sized up to two nominal sizes below line size.
10.2.12 Valve bodies shall be cast iron, carbon steel, stainless steel or bronze subject to requirements for
valve body pressure and temperature rating and suitability of material for application. Valve trim shall be stainless steel.
10.2.13 Valve seats shall be replaceable. Valve seats shall be metal, ceramic filled PTFE or equivalent and
must assure tight seating.
10.2.14 The BMS subcontractor shall certify that the materials of construction are appropriate for the application. In particular, valves used for the control of glycol solutions shall have a trim that is suitable for a glycol solution.
10.3 TWO-WAY CONTROL VALVES
10.3.1 Provide two-way globe control valves as indicated on the mechanical trade documents.
10.3.2 Pressure drop shall not exceed 35 kPa and shall confoalarmsrm to the following requirements:
10.3.2.1 Valves shall be selected such that the valve authority (N) shall not be less than 0.5 as defined by the relationship:
N=P1/ (P1+P2)
Where P1= pressure drop across the fully open valve, and
P2= pressure drop across the remainder of the circuit (e.g. a coil, DRV, isolation valves, strainers)
10.3.3 Valve shall be capable of tight shut-off when operating at system pressure with the system pump operating at shut-off head. Leakage rate shall not exceed 0.01% of the rated valve capacity
10.3.4 Valve shall be straight pattern type. Angle valves shall only be furnished where the piping configuration does not permit the use of a straight valve.
10.3.5 Valves shall be single seat globe type. Double seat valves shall not be furnished.
10.3.6 Two-port valves when used to control heater and cooler batteries shall have an equal percentage or modified parabolic characteristic. Two-port valves when used in liquid applications systems not detailed above shall have a linear / linear characteristic.
10.3.7 Actual valve kvs values shall not deviate from the quoted kvs value by more than ±10%.
10.3.8 The kv of the valve shall not deviate from the stated characteristic curve by more than ±10%.
10.3.9 Valve shall have a minimum range ability of 50:1.
10.3.10 Suitable for continuous throttling.
All control valves shall have position indication. All hot water control valves shall be Normally-Open arrangement; all chilled water control valves shall be Normally-Closed arrangement
10.4 THREE-WAY CONTROL VALVES
10.4.1 Provide three-way control valves as indicated on the mechanical trade documents.
10.4.2 Pressure drop shall not exceed 35 kPa and shall conform to the following requirements:
10.4.2.1 Valves shall be selected such that the valve authority (N) shall not be less than 0.5 for diverting valves and 0.3 for mixing valves as defined by the relationship:
N=P1/(P1+P2)
Where P1= pressure drop across the fully open valve
P2= pressure drop across the remainder of the circuit (e.g. a coil)

10.4.3 Three way control valves shall be of the mixing or diverting pattern type as indicated in the mechanical documents. The inner valve shall have a V-port parabolic or linear plug and stainless steel trim. Valves shall have metal-to-metal stainless steel seats to assure tight seating.
10.4.4 Mixing valves shall be capable of tight shut-off between each inlet port and the outlet port and diverting valves shall be capable of tight shut-off between each outlet port and the inlet port when operating at system pressure.
10.5 BUTTERFLY VALVES
10.5.1 Butterfly valves shall be the full lug type.
10.5.2 The pressure drop across modulating butterfly valves at maximum design flow shall not exceed 20 kPa .
10.5.3 Disc pins, where required to secure shaft to disc, shall be 316 stainless steel.
10.5.4 The butterfly valve manufacturer shall certify compliance with bubble tight shutoff requirements at a differential pressure not less than the full rated design working pressure and temperature specified with the downstream flange removed with flow in either direction.
10.5.5 Valve manufacturer shall guarantee zero leakage to the shaft.
10.5.6 Where indicated in the Mechanical Trade documents provide linked butterfly valves that shall comprise two butterfly valves meeting the above requirements mounted on a flanged cast iron tee with a single actuator which shall modulate one valve open as it closes the other such that when one is fully open the other is fully closed and vice versa.
10.6 VALVES FOR INSTRUMENTATION
10.6.1 Instrumentation, such as pressure sensors and flow rate monitors, which is provided for the monitoring of parameters associated with liquid in pipes or tanks, shall be removable and replaceable without the requirement to shut down a pump and without the requirement to drain the pipe or tank and without causing liquid to leak from the pipe or tank. To facilitate this, the BMS subcontractor shall furnish valves for installation by the mechanical trade.
10.6.2 Instrumentation that is mounted external to the pipe or tank and which is connected to the pipe or tank by one or more sampling lines shall have a manual two-way on/off valve in each sampling line meeting the following requirements:
10.6.2.1 Ball type valve
10.6.2.2 Valve body shall be 316 stainless steel
10.6.2.3 Ball and stem shall be 316 stainless steel
10.6.2.4 Zero leakage.
10.6.2.5 Rated for 1050 kPa or for a pressure 50% greater then the system working pressure, whichever is the greater.
10.6.2.6 Rated for a minimum of 50 deg. C (122 deg. F.) greater than the highest fluid temperature.
10.6.2.7 Brass or stainless steel trim.
10.6.2.8 Valve seats shall be metal, reinforced TFE or equivalent and must assure tight seating.
10.6.2.9 Valve shall be Whitey 40 Series or 80 Series or approved equal if it meets the requirements detailed above.
10.6.3 Valves for insertion flow meters shall be full port gate valves sized for the flow meter in accordance with the flow meter manufacturer’s instructions. If the flow meter manufacturer offers the valve as an accessory then it shall be purchased by the BMS subcontractor from the insertion flow meter manufacturer and shall be installed by the mechanical trade in accordance with the insertion flow meter manufacturer’s instructions. The valve shall meet the pressure and temperature requirements detailed for the control valves and shall have zero leakage at the system maximum pressure.
10.7 VALVE ACTUATORS - ELECTRIC
10.7.1 The BMS contractor shall provide actuators for valves that are furnished by the BMS contractor.
10.7.2 Actuator shall be motor driven type. Valve stem position shall be adjustable in increments of one (1) percent or less of full stem travel.
10.7.3 Actuator shall have an integral self-locking gear train, mechanical travel stops and two

adjustable travel limit switches with electrically isolated contacts.
10.7.4 Actuator gear assembly shall be made of hard-anodized aluminium or steel or material of equivalent durability. No plastic components shall be acceptable. Disassembly of the gears shall not be required to remove the motor.
10.7.5 Actuator shall be rated for continuous duty and have an input voltage of 240 Vac, 50 Hz or 24 V.
10.7.6 Actuator housing shall have a minimum IP 54 to BS 60529 rating. Actuators on valves located in mechanical rooms or outdoors shall have covers of aluminium or a material of equivalent strength and shall have captive bolts to eliminate loss of bolts when removing the cover from the base. Housings for valves located in a plenum and used for terminal unit or fan coil unit heating/cooling coils, may be constructed of reinforced plastic. Materials of construction for all actuator components shall be non-corroding.
10.7.7 Actuator motor shall be fully accessible for ease of maintenance.
10.7.8 Actuator shall be sized to meet the shut-off requirements when operating at the maximum system
differential pressure and with the installed system pump operating at shut-off head.
10.7.9 Actuator shall control against system maximum working pressures.
10.7.10 Actuator shall fail as indicated on the control drawings that form part of these contract documents. Provide spring return to de-energized position on loss of power or loss of control signal if so required by the sequences of operation.
10.7.11 Actuator shall accept control signals compatible with the BMS analogue or digital output subsystem as appropriate. The valve stem position shall be linearly
related to the control signal.
10.7.12 Actuator shall have visual mechanical position indication, showing output shaft and valve position.
10.7.13 Actuator shall operate the valve from the fully closed to the fully open position and vice versa in less than two minutes.
10.7.14 Actuator shall be constructed to withstand high shock and vibration without operations failure. Materials of construction shall be non-corroding.
10.7.15 Actuator shall be equipped with an integral position potentiometer to indicate the stem position
of the valve where required by the control sequences. All valve actuators shall have integral end position indicators.
10.7.16 Actuator and valve shall be mounted and installed only in the location/orientation approved by the manufacturer. Installation drawings shall clearly indicate the valve location.
10.7.17 Actuator shall have a manual declutch lever to enable manual operation of the valve. It shall be possible for an operator to manually modulate valves located in mechanical rooms in the event of loss of power. The operator shall be able to manually modulate the valves without having to climb a ladder or other nonpermanent structure. It shall be ensured that the valve installation is such that the valve cannot declutch under the influence of gravity and/or vibration.

11.0 FIELD INSTRUMENTATION

11.1 WORK OF THIS SECTION
11.1.1 This section of the specifications details the components to be provided by the BMS contractor relating to the field instrumentation.
11.1.2 Where there is reference to the control drawings these shall be the control drawings provided as part of the mechanical trade documents.
11.2 RTD TRANSMITTERS
11.2.1 Where reference is made in this Section to an RTD transmitter, it shall be
interpreted as follows:
11.2.1.1 If the RTD is 100 ohm Pt, provide a transmitter located at the RTD.
11.2.1.2 If the RTD is 1000 ohm Pt, provide a transmitter at the RTD:
11.2.1.2.1 if the I/O subsystem at the UC or DCP cannot interface directly to an RTD, or
13.2.1.2.2 if the distance between the RTD and the associated UC or DCP exceeds 50m (160 feet).

11.2.2 Transmitter output shall be 4 to 20mA proportional to temperature and shall cover a temperature
range as indicated in Part 2 of this Section. The analog to- analog conversion of the transmitter shall be such that the monitored temperature is reported by the BMS within the accuracy requirements detailed for the individual temperature sensors.
11.3 TEMPERATURE SENSOR - OUTSIDE AIR
11.3.1 Provide outside air temperature sensors as indicated control diagrams. Temperature sensors shall
meet, at minimum, the following requirements:
11.3.1.1 Ventilated white PVC sun screen.
11.3.1.2 Wall mounts weatherproof enclosure with conduit fitting.
11.3.1.3 100 or 1,000 ohm platinum RTD with a minimum temperature coefficient of resistance of 0.00375 ohm/ohm/Deg. C.
11.3.1.4 MCS shall report the monitored temperature with an accuracy of 0.5 Deg. C. (1.0 Deg.F.).
11.3.1.5 Provide a two wire 4-20 mA RTD transmitter where required with a temperature range of 10 Deg.C. to 60 Deg.C. Where necessary to meet monitoring accuracy requirements
provide a 3-wire or 4-wire configuration.
11.4 TEMPERATURE SENSOR - DUCT MOUNTED - SINGLE POINT
11.4.1 Provide duct mounted, single point, temperature sensor as follows:
11.4.1.1 In ducts less than 1 m2 in cross-sectional area.
11.4.1.2 In ducts greater than 1m2 in cross-sectional area if there is no heating coil and no cooling coil and no mixing of air flows of different temperatures upstream.
11.4.2 Temperature sensors shall meet, at minimum, the following requirements:
11.4.2.1 Stainless steel probe of length between one-third and two-thirds of the duct width.
11.4.2.2 100 or 1,000 ohm platinum RTD with a minimum temperature coefficient of resistance of 0.00375 ohm/ohm/Deg. C.
11.4.2.3 BMS shall report the monitored temperature with an accuracy of 0.5 Deg. C. (0.9 Deg. F.).
11.4.2.4 Provide a two wire 4-20 mA RTD transmitter where required with a temperature range of 0 Deg. C. to 50 Deg. C. (32 Deg. F to 122 Deg. F.). Where necessary to meet monitoring
accuracy requirements provide a 3-wire or 4-wire configuration.
11.4.2.5 Duct mounted moisture/waterproof housing with conduit fitting.
11.5 TEMPERATURE SENSOR - DUCT MOUNTED - AVERAGING
11.5.1 Provide duct mounted, single point, temperature sensor as follows:
11.5.1.1 In ducts greater than 1 m2 in cross-sectional area.
15.5.2 Temperature sensors shall meet, at minimum, the following requirements:
11.5.2.1 Probe length of 3.66m (12 feet) minimum or 3.25m per m2. (one linear foot per square foot) of duct cross-sectional area., whichever is greater.
11.5.2.2 Copper sheathed construction.
11.5.2.3 100 or 1,000 ohm platinum RTD with a minimum temperature coefficient of resistance of 0.00375 ohm/ohm/Deg. C.
11.5.2.4 BMS shall report the monitored temperature with an accuracy of 1.0 Deg. C. (1.8 Deg. F.) accuracy.
11.5.2.5 Provide a two wire 4-20 mA RTD transmitter where required with a temperature range of 0 Deg. C. to 50 Deg. C. (32 Deg. F to 122 Deg. F.). Where necessary to meet monitoring
accuracy requirements provide a 3-wire or 4-wire configuration.
11.5.2.6 Duct mounted moisture/waterproof housing with conduit fitting.
11.5.2.7 Suitable supports at all bends and at intermediate points to prevent movement in the air stream.
11.6 TEMPERATURE SENSOR - WALL MOUNTED - LOBBY AND PUBLIC SPACES
11.6.1 Provide wall mounted recessed temperature sensors for lobbies and lobby vestibule spaces as indicated within the control diagrams. Temperature sensors shall meet, at minimum, the following requirements:
11.6.1.1 Button type sensors of maximum diameter 51mm (2 inches).
11.6.1.2 Sensor shall be painted in accordance with the Engineer’s instructions with regard to

colour and quality and type of paint.
11.6.1.3 10,000 ohm at 25 Deg. C. (77 Deg. F.) thermistor or 100/1,000 ohm platinum RTD with a minimum temperature coefficient of resistance of 0.00375 ohm/ohm/Deg. C.
11.6.1.4 BMS shall report the monitored temperature with an accuracy of 0.5 Deg. C. (0.9 Deg. F.).
11.6.1.5 Provide a two wire 4-20 mA RTD transmitter where required with a temperature range of 10 Deg.C. to 60 Deg.C.
11.6.2 If it meets the above requirements, provide Seibe Model TS 8131 or equal and approved.
11.7 TEMPERATURE SENSOR - THERMOWELL MOUNTED
11.7.1 Provide thermowell mounted temperature sensors as indicated within the control diagrams. Temperature sensors shall meet, at minimum, the following requirements:
11.7.1.1 Rigid stainless steel probe of length which is, at minimum, 20% of the pipe width.
11.7.1.2 100 or 1,000 ohm platinum RTD with a minimum temperature coefficient of resistance of 0.00375 ohm/ohm/Deg. C.
11.7.1.3 BMS shall report the monitored temperature with an accuracy of 0.25 Deg. C. (0.45 Deg. F.) accuracy.
11.7.1.4 Provide a two wire 4-20 mA RTD transmitter where required with a temperature range that is appropriate for the application. Range for chilled water and condenser water applications shall be between 0 Deg.C. and +5 Deg.C. (+32 Deg.F. and +41 Deg.F.) at the low end and shall be between +40 Deg.C. and +50 Deg.C.(+104 Deg.F. and +122 Deg.F.) at the upper end. Range for hot water shall be selected such that it is between 30 Deg.C. and 50 Deg.C. (54 Deg.F and 122 Deg.F.) above and below the hot water temperature range. Where necessary to meet monitoring accuracy requirements provide a 3-wire or 4-wire configuration.
11.7.1.5 Moisture/waterproof housing with conduit fitting.
11.7.1.6 Stainless steel thermo well.
11.7.1.7 Provided with thermal grease to aid temperature sensing.
11.7.1.8 Sensors required for the determination of temperature differential shall be matched with a maximum variation over the entire temperature range of 0.1 Deg.C. (0.18 Deg.F.).
11.8 RELATIVE HUMIDITY SENSOR - OUTSIDE AIR
11.8.1 Provide outside air relative humidity sensors as indicated within the control diagrams. Humidity sensors shall meet, at minimum, the following requirements:
11.8.1.1 Non-corroding outdoors screen to minimize wind effects and solar heating.
11.8.1.2 Wall mount weatherproof enclosure with conduit fitting.
11.8.1.3 Two wire, 4-20 mA output proportional to relative humidity range of 0% to 100%.
11.8.1.4 2% accuracy (5 - 95% RH).
11.8.1.5 Humidity sensor shall be replaceable.
11.8.1.6 Operating temperature range shall be appropriate for the climate. Sensor and transmitter shall be rated for operation in ambient temperatures of, at minimum, 50 Deg.C. (122 Deg.F.) below and above the lowest and highest recorded temperatures for the location respectively.
11.9 RELATIVE HUMIDITY SENSOR - DUCT MOUNTED
11.9.1 Provide duct mounted relative humidity sensors as indicated within the control diagrams. Duct mounted relative humidity sensors shall meet, at minimum, the following requirements:
11.9.1.1 Duct mount moisture resistant enclosure with conduit fitting.
11.9.1.2 Two wire, 4-20 mA output proportional to relative humidity range of 0% to 100%.
11.9.1.3 Humidity sensor shall be replaceable.
11.9.1.4 2% accuracy (5 - 95% RH).
11.9.1.5 8 inch probe length.
11.9.1.6 Operating temperature range of O Deg. C. to 50 Deg. C. (32 Deg. F to 122 Deg. F.).
11.9.2 If it meets the above requirements, provide Honeywell HyCal model HYHT, Veris Industries Alta Labs HD series, Mamac series HU-224 or equal and approved.
11.10 COMBINATION RELATIVE HUMIDITY AND TEMPERATURE SENSORS

11.10.1 Where there is a requirement for the monitoring of both relative humidity and temperature at the
same location, the BMS Contractor may provide a combination relative humidity sensor and temperature sensor. The individual
sensors must each meet the specifications detailed above.
11.11 WET BULB TEMPERATURE AND DRY BULB TEMPERATURE TRANSMITTER
11.11.1 Provide a combination wet bulb temperature and dry bulb temperature sensor for interior or exterior wall mounting or duct mounting, as appropriate, as indicated control diagrams. We bulb temperature/dry bulb sensors shall meet, at minimum, the following requirements:
11.11.1.1 Stainless steel probe with an IP54 to BS 60529 transmitter housing for an interior application and an IP65 to BS 60529 housing for an exterior housing. Outside air sensor shall have a solar screen.
10.11.1.2 Two wire, 4-20 mA output proportional to minimum wet bulb temperature range of -7 Deg.C. to +49 Deg.C. (+20 Deg.F. to +120 Deg.F.).
11.11.1.3 Two wire, 4-20 mA output proportional to minimum dry bulb temperature range of -29 Deg.C. to +49 Deg.C. (-20 Deg.F. to +120 Deg.F.).
11.11.1.4 Probe shall be a minimum of 200mm for duct application.
11.11.1.5 BMS shall report the monitored dry bulb temperature with an accuracy of 0.5 Deg. C. (0.9 Deg. F.).
11.11.1.6 BMS shall report the monitored wet bulb temperature with an accuracy of 3% of reading.
11.12 CONTROL RELAYS - LATCHING
11.12.1 Provide latching control relays as indicated within the control diagrams and sequences of operation. Relays shall meet, at minimum, the following requirements:
11.12.1.1 Pickup rating, time and hold rating as required for individual applications.
11.12.1.2 Rated for a minimum of ten (10) million mechanical operations and a minimum of 500,000 electrical operations.
11.12.1.3 Provide complete isolation between the control circuit and the digital output.
11.12.1.4 Located in the DCP, UC or other local enclosures.
11.12.1.5 Malfunction of an BMS component shall cause the controlled output to fail to the positions identified in the failure procedure within the operating sequences.
11.12.1.6 10 amp contact rating.
11.12.1.7 Pin type terminals.
11.12.2 If it meets the above requirements, provide IDEC, RR Series or equal and approved.
11.13 CONTROL RELAYS - MOMENTARY
11.11.1 Provide momentary control relays as indicated within the control diagrams and sequences of operation. Relays shall meet, at minimum, the following requirements:
13.11.1.1 Coil ratings of 120 VAC, 50 mA or 10-30 VAC/VDC, 40 mA as suitable for the application.
13.11.1.2 Provide complete isolation between the control circuit and the digital output.
13.11.1.3 Located in the DCP, UC or other local enclosures.
13.11.1.4 10 amp contact rating.
13.11.1.5 LED status indication.
13.11.1.6 Incorporate electrical noise suppression techniques in relay control circuits.
11.14 STATIC PRESSURE SENSOR - DUCT MOUNTED
11.14.1 Provide duct mounted static pressure sensors as indicated within the control diagrams. Static pressure sensors shall meet, at minimum, the following requirements:
11.14.1.1 Input range shall be appropriate for the application. Select range such that it covers from zero duct static pressure relative to the exterior of the duct up to a static pressure of between 20% and 50% in excess of the maximum static pressure that could be encountered in the duct relative to the duct exterior. Typically, for low pressure commercial duct consider using a range of 0 to 500Pa (0 to 2 inches w.g.), for medium pressure duct use a range of 0 to 1500Pa (0 to 6 inches w.g.) and for high pressure duct use a range of 0 to 2500Pa (0 to 10 inches w.g.)

11.14.1.2 4-20 mA output proportional to pressure input range.
11.14.1.3 5% accuracy.
11.14.1.4 Operating temperature range of -7 Deg. C. to 49 Deg. C. (20 Deg. F. to 120 Deg. F.)
11.14.1.5 Easily accessible, integral non-interacting zero and span adjustment.
11.14.1.6 Minimum over pressure input protection of five times rated input.
11.14.1.7 It shall be possible to remote “zero” the pressure sensor.
11.15 CURRENT SENSING RELAY
11.15.1 Provide current sensing relays as indicated in the control diagrams. Current metering transformers
and relays shall meet, at minimum, the following specifications:
11.15.1.1 Rated for the applicable load.
11.15.1.2 The output relay shall have an accessible trip adjustment over its complete operating range. Provide LED indication of relay status.
11.15.1.3 Long term drift shall not exceed 5% of full range per 6 months.
11.15.1.4 Current transformer and relay shall have over current and over voltage protection.
11.15.1.5 Donut shall be sized for the application.
11.15.1.6 Relay shall be in a dustproof housing.
11.15.1.7 Accuracy- 2% of reading from 10% to 100% of full scale range, 2% full scale from 0 to 10% of full scale range.
13.15.1.8 Temperature range of -15 Deg. C. to 60 Deg. C. (5 Deg. F. to 140 Deg. F.).
11.15.2 Wherever the status of a single speed motor is monitored it shall be done via a current sensing relay. Differential pressure switches shall not be used for this purpose and flow switches shall not be used for this purpose. Current sensing relays shall be provide at MCC starters by the MEP contractors. The BMS contractor shall provide the current sensing relays for motors with local starters and no MCC starter.
11.16 VOLTAGE SENSING RELAY
11.16.1 Provide voltage sensing relays as identified within the control diagrams. Voltage sensing relays shall continuously monitor 3-phase power lines for phase loss, phase reversal and low voltage. Voltage sensing relays shall meet, at minimum, the following requirements:
11.16.1.1 Dustproof ABS plastic housing.
11.16.1.2 The output relay shall have an accessible trip adjustment over its complete operating range.
11.16.1.3 Relay shall have over current and over voltage protection.
11.16.1.4 Automatic reset with adjustable reset delay.
11.16.1.5 Adjustable trip delay.
11.16.1.6 Transient protection - 2500 VRMS for 10 ms.
11.16.1.7 Accuracy - 0.1% of setpoint.
11.16.1.8 Operating temperature range of -29 Deg. C. to 49 Deg. C. (-20 Deg. F. to 120 Deg. F.).
11.17 CURRENT METERING
11.17.1 Provide monitoring of the current as identified in control drawings. Current monitoring shall meet,
at minimum, the following requirements:
11.17.1.1 4-20 mA output proportional to current draw.
11.17.1.2 Reverse polarity protected.
11.17.1.3 50 Hz operation.
11.17.1.4 Accuracy of 0.5%.
11.17.1.5 Operating temperature range of -29 Deg. C. to 49 Deg. C. (-20 Deg. F. to 120 Deg. F.).
11.18 kW AND kWh TRANSDUCERS
11.18.1 Provide kW and kWh transducers as identified in the control drawings. Transducers shall include, at
minimum, the following:
11.18.1.1 An IP54 to BS 60529 transmitter housing for an interior application and an IP65 to BS 60529 housing for an exterior housing enclosure.
11.18.1.2 4-20 mA proportional to KW demand output.

11.18.1.3 Selectable under-voltage protection level.
11.18.1.4 Low voltage/phase loss alarm contact.
11.18.1.5 Accuracy - 0.75% of full scale.
11.18.1.6 Operating temperature of -29 Deg. C. to 49 Deg. C. (-20 Deg. F. to 120 Deg. F.).
11.19 WATER METER / TOTALIZER
11.19.1 Provide water meters as indicated in the control diagrams. Water meters for monitoring of incoming domestic water usage shall meet, at minimum, the following requirements:
11.19.1.1 Internal materials of the flow meter shall be suitable for the application.
11.19.1.2 Output signal of 4-20mA proportional to flow transmitted to the BMS and to the local totalizer.
11.19.1.3 Minimum operating pressure of 1050 kPa.
11.19.1.4 Stainless steel wetted components.
11.19.1.5 Flanged connections.
11.19.1.6 Negligible pressure loss.
11.19.1.7 Accuracy of 5 %.
11.19.1.8 Local display totalizer to provide totaliser flow with reset capabilities.
11.20 WATER DIFFERENTIAL PRESSURE SENSOR
11.20.1 Provide water differential pressure sensors as indicated in the control diagrams. Water differential
pressure sensors shall meet, at minimum, the following requirements:
11.20.1.1 Cast aluminium an IP54 to BS 60529 transmitter housing for an interior application and an IP65 to BS 60529 housing for an exterior housing.
11.20.1.2 Output of 4-20 mA proportional to the pressure sensed.
11.20.1.3 Over pressure protection of five times the rated input.
11.20.1.4 Easily accessible, integral non-interacting zero and span adjustment.
11.20.1.5 Operating range shall be suitable for the application. Select range such that it covers from zero differential pressure up to a differential static pressure of between 20% and 50% in excess of the maximum static pressure that could be encountered. Remember that if the sensor is used for the control of a chilled water bypass and is located across, for example, a chilled water AHU coil, the pressure drop of both the coil and the associated valve at full design flow have to be taken into account.
11.20.1.6 Accuracy of 2% of full-scale reading.
11.20.1.7 Valved tappings shall be installed by the Mechanical contractor. Furnish the valves to the Mechanical contractor.
11.21 DIFFERENTIAL PRESSURE SWITCH - AIR
11.21.1 Provide air differential pressure sensors as indicated in the control diagrams. Air differential pressure sensors shall meet, at minimum, the following requirements:
11.21.1.1 An IP54 to BS 60529 transmitter housing for an interior application and an IP65 to BS 60529 housing for an exterior housing.
11.21.1.2 SPDT switch rated for 10 amps minimum at 120 Vac.
11.21.1.3 Setpoint trip adjustment with scale to indicate setting. Switches used for filter differential pressures shall also have a display of the monitored differential pressure.
11.21.1.4 Dead band adjustment.
11.21.1.5 Select range such that it covers from zero duct static pressure relative to the exterior of the duct up to a static pressure of between 20% and 50% in excess of the maximum static pressure that could be encountered in the duct relative to the duct exterior. Typically, for low pressure commercial duct use a range of 0 to 500pa (0 to 2 inches w.g.), for medium pressure duct use a range of 0 to 1500Pa (0 to 6 inches w.g.) and for high pressure duct use a range of 0 to 2500Pa (0 to 10 inches w.g.)
11.23.1.6 Temperature range of -18 Deg. C. to 71 Deg. C. (0 Deg. F. to 160 Deg. F.).
11.23.1.7 Manual reset.
11.22 DIFFERENTIAL PRESSURE SWITCH - WATER
11.22.1 Provide water differential pressure switches as indicated in the control diagrams. Water differential pressure switches shall meet, at minimum, the following requirements:

11.22.1.1 316 stainless steel body.
11.22.1.2 Local display gauge.
11.22.1.3 End to end accuracy not to exceed 1.0% over entire range.
11.22.1.4 Easily accessible, integral non-interacting zero an span adjustment.
11.22.1.5 Over pressure input protection to a minimum of five (5) times rated input.
11.22.1.6 The differential pressure transducer shall be rated to withstand the maximum rated. pressure of the system in which it is installed.
11.22.1.7 Range to be coordinated with the chilling unit manufacturer.
11.22.1.8 Valved tappings shall be installed by the Mechanical contractor. Furnish the valves to the Mechanical contractor.
11.23 WATER PRESSURE SENSOR
11.23.1 Provide water pressure sensors as indicated within the control diagrams. Pressure sensors shall meet the following requirements:
11.23.1.1 Input range of 0 to 1400 kPa.
11.23.1.2 4-20 mA output proportional to water pressure.
11.23.1.3 0.5% accuracy of range.
11.23.1.4 Temperature range of 0 Deg. C. to 38 Deg. C. (32 Deg. F to 100 Deg. F.).
11.23.1.5 Easily accessible, integral non-interacting zero and span adjustment.
11.23.1.6 Over pressure input protection of two times rated input.
11.23.1.7 An IP54 to BS 60529 transmitter housing for an interior application and an IP65 to BS 60529 housing for an exterior housing.
11.23.1.8 Stainless steel wetted parts.
11.23.1.9 Burst pressure of 5 times rated input
11.23.1.10 Long-term stability of .25 percent of full scale.
11.23.1.11 Construction of pressure transmitter and associated components shall be rated for at least twice the maximum static pressure.
11.24 LIQUID LEVEL FLOAT SWITCH
11.24.1 Provide liquid level float switches as indicated in the control diagrams. Liquid level float switches
shall meet, at minimum, the following requirements:
11.24.1.1 Polypropylene float, PVC cable, hermetically sealed mercury switch.
11.24.1.2 13 amp running current @ 120 VAC, 11 amp current @ 240 VAC.
11.24.1.3 SPDT type.
11.24.1.4 Operating temperature of 0 Deg. C. to 71 Deg. C. (32 Deg. F. to 160 Deg. F.).
11.24.1.5 Operating pressure of 180 kPa.
11.25 LIQUID LEVEL FLOAT SWITCH - FUEL SERVICE
11.25.1 Provide liquid level float switches as indicated in the control diagrams. Liquid level float switches
shall meet, at minimum, the following requirements:
11.25.1.1 Polypropylene float, PVC cable, hermetically sealed mercury switch.
11.25.1.2 4 amp current @ 240 VAC.
11.25.1.3 SPDT type.
11.25.1.4 Suitable for use in diesel fuel applications.
11.26 CONTINUOUS LIQUID LEVEL SENSOR
11.26.1 Provide continuous liquid level sensors as indicated in the control diagrams. Continuous liquid level sensors shall meet, at minimum, the following requirements:
11.26.1.1 Corrosion resistant, 316 stainless steel.
11.26.1.2 Solid-state float actuated sensor.
11.26.1.3 Output range 4 to 20 mA.
11.26.1.4 Temperature range of 0 Deg. C. to 50 Deg. C. (32 Deg. F. to 122 Deg. F.)
11.26.1.5 Pressure range of 0 to 3500 kPa.
11.27 AMBIENT LIGHT LEVEL SENSOR
11.27.1 Provide ambient light level sensors as indicated within the control diagrams. Light level sensor shall

meet, at minimum, the following requirements:
11.27.1.1 Non-corroding and weatherproof housing with sensor screen suitable for exterior installations. Housing to be a minimum of IP65 to BS 60529.
11.27.1.2 4-20 mA output proportional to the ambient light level.
11.27.1.3 Accuracy at room temperature: 1%, 38 Deg. C. (100 Deg. F.) temperature: 2.5%
11.27.1.4 Solid-state photo diode circuitry and transducer as required.
11.27.1.5 Mounted on the exterior of a North wall on the roof.
11.27.1.6 Sensor reading from 0 to 750 foot candles.
11.27.1.7 Temperature and humidity independent.
11.27.1.8 Temperature range of -12 Deg. C. to 60 Deg. C.
11.28 FLOW SWITCH
11.28.1 Furnish paddle type flow switches to monitor flow status in the water lines. Installations shall be by
the MEP contractors.
11.28.2 The flow switches shall meet the following requirements:
11.28.2.1 Rated for minimum 150 psig service.
11.28.2.2 Materials of construction suitable for continuous contact with water.
11.28.2.3 Switch actuation initiated on less than 0.6 l/s flow (adjustable).
11.28.2.4 Switch assembly sealed from water line.
11.28.2.5 SPDT switch.
11.28.2.6 Water temperature range of 2 Deg. C. to 50 Deg. C.
11.28.2.7 Ambient temperature range of 1 Deg. C. to 100 Deg. C.
11.29 CARBON MONIXIDE DETECTION SENSOR
11.29.1 Provide CO monitoring systems for the enclosed levels of the parting garage. Provide complete coverage of the enclosed levels of the parking garage and provide systems for each level. A CO monitoring system shall not cover an area on more than one level and the failure of any component shall not affect more than one level.
11.29.2 System shall be of the multi-point sequential extraction type or shall have distributed sensors. Sensors shall be of the metal oxide semiconductor or the electrochemical type, if the multi-point extraction type is used, the time to sequence through all sampling point shall not exceed 15 minutes and each point shall be sampled for between 30 and 60 second. Vacuum pup shall draw samples from all sensing points at all times to ensure that a fresh sample is sensed immediately it is reached in the sequence.
11.29.3 Locate sensing points on walls and columns at 1.5 to 2m above floor level. Extraction type systems shall have no sensing point more than 125m from the sensor. Locate on sensing point per 450m2. Do not locate sensing points closer than 2m to traffic lanes. Locate the system panels in the garage electrical closets.
11.29.4 Sampling tube for extraction type systems shall be 6mm copper tubing and shall be run on the underside of the slab. Cabling for distributed point sensors shall be in conduit run on the slab. Do not run conduit or tubing above traffic lanes or areas where damage may occur.
11.29.5 Sensor range of 0 to 400ppm. Sensor reading speed shall not exceed 10 seconds and sensor life shall be a minimum of 2 years.
11.29.6 Provide relay contacts, at minimum, to indicate CO warning level (initially set at 50ppm) and CO alarm level (initially set at 100 ppm) for each sensing point and a sensor fail alarm relay for each sensor.
11.29.7 The proposed sensor locations shall be submitted at the shop drawing stage and shall be amended as directed by the Owner and/or Engineer. H. No maintenance or periodic sensor replacement shall be needed.
11.29.8 Provide a sample gas for calibration. Supply shall be adequate for calibration at manufacturer's recommended frequency for a 10-year period.
11.30 BTU METERS
Provide BTU meters as indicated in the control diagram if required. BTU meters for monitoring Ton-Hours
shall meet, at minimum the following requirements:

11.30.1.1 Internal materials of the flow meter shall be suitable for the application.
11.30.1.2 Output signal of 4-20mA proportional to flow transmitted to the BMS and to the local totalizer.
11.30.1.3 Minimum operating pressure of 1050 kPa.
11.30.1.4 Stainless steel wetted components.
11.30.1.5 Flanged connections.
11.30.1.6 Negligible pressure loss.
11.30.1.7 Accuracy of 5 %.
11.30.1.8 Local display totalizer to provide totalizer flow with reset capabilities.
Btu meter shall have the interface with BMS over Bacnet Protocol
11.31 INSTALLATION
11.31.1 Install sensors in accordance with the manufacturers' recommendations to sense the variables specified.
11.31.2 Mount sensors securely. Mountings shall be suitable for the environment within which the sensor operates.
11.31.3 Install sensors as required to properly sense the controlled medium. Sensor locations shall be such that access to the instruments can be obtained for service and removal. If the installation location is found to be unacceptable by the Engineer, then the sensors shall be relocated as directed at no additional cost to the Employer.
11.31.4 Sensors mounted on water lines shall have isolation valves that shall enable the sensor to be easily removed without the need to drain any lines or portions of lines.
A. Current Sensitive Switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.
B. Differential Analog (duct) Static Pressure Transmitters Provide a pressure transmitter with integral capacitance type sensing and solid-state circuitry. Accuracy shall be plus or minus 1% of full range; range shall be selected for the specific application. Provide zero and span adjustment capability. Device shall have integral static pickup tube.
C. Differential Air Pressure Switches: Provide SPDT type, UL-approved, and selected for the appropriate operating range where applied. Switches shall have adjustable setpoints and barbed pressure tips.
D. Water Flow Switches: Provide a SPST type contact switch with bronze paddle blade, sized for the actual pipe size at the location. If installed outdoors, provide a NEMA-4 enclosure. Flow switch shall be UL listed.
E. Transducers: Differential pressure transducers shall be electronic with a 4-20 mA output signal compatible to the Direct Digital Controller. Wetted parts shall be stainless steel. Unit shall be designed to operate in the pressure ranges involved.
F. Control Power Transformers: Provide step-down transformers for all DDC controllers and devices as required. Transformers shall be sized for the load, but shall be sized for 50 watts, minimum. Transformers shall be UL listed Class 2 type, for 120 VAC/24 VAC operation.
G. Line voltage protection: All DDC system control panels that are powered by 120 VAC circuits shall be provided with surge protection. This protection is in addition to any internal protection provided by the manufacturer. The protection shall meet UL, ULC 1449, IEEE C62.41B. A grounding conductor, (minimum 12 AWG), shall be brought to each control panel.

12.0 BMS SEQUENCES OF OPERATION

12.1
12.1.1 This section of the Specifications details the components to be provided by the BMS contractor relating to the following:
12.1.2 Sequences of operation
12.2 OPERATOR CHANGES
12.2.1 Where terms are used, such as "operator determined", "operator changeable", etc., which indicate an operator originated decision; it shall mean that an operator shall be able to amend a

value, such as a setpoint, alarm limit, time delay, etc. through an interactive approach. The term "interactive" is used to mean that the system shall operate in a conversational mode whereby the operator shall receive English language prompts in the form of:
12.2.1.1 Tables into which the operator enters data.
12.2.1.2 Questions that are responded to by the operator.
12.2.1.1 Selections that are made by the operator based on a list of suggested alternatives that is generated by the BMS.
12.2.2 The procedure by which an operator amends a value or implements a selection shall be such that the operator can readily execute the task without reference to instruction manuals and without knowledge of the BMS control language.
12.2.3 All set points, alarms limits, deadbands, software time delays, report configuration and requests, operating time limits, schedules, etc. shall be operator definable through an interactive procedure via the OIW, OIW, ROW and HHT.
12.3 SYSTEM OPERATION UNDER EMERGENCY POWER CONDITIONS
12.3.1 The equipment that is fed from emergency power and which is controlled by the BMS shall operate normally under emergency power conditions and shall be monitored and controlled by the BMS under emergency power conditions. Ensure that all equipment furnished under this contract that is associated with the control of equipment on emergency power is fed from the emergency power service and can maintain normal equipment operations when the equipment is on emergency power. Following a loss of normal power, the BMS shall resume normal equipment control and monitoring functions for that equipment on emergency power within 20 seconds of the availability of emergency power and similarly when there is a return to normal power. If necessary provide an uninterruptible power source in order to meet this 20 seconds resumption of operation requirement.
12.3.2 The BMS contractor shall identify on the cable and containment shop drawings which components are to be fed from emergency power and which components are to be fed from a UPS source.
12.4 OPERATING SEQUENCES - GENERAL
12.4.1 The BMS contractor shall provide an easy to use means of defining the operating sequences such as a high-level control language or a graphical/flowcharting facility.
12.4.2 The means provided for the creation of the operating sequences shall be suitable for the implementation of the sequences detailed on the control diagrams that form a part of these contract documents.
12.4.3 If the BMS contractor requires additional instrumentation to that indicated in the BMS Field Termination Schedules and Diagrams in order to implement the operating sequences as detailed on the control drawings or these specifications then the BMS contractor shall include such additional instrumentation within the tender price. Such instrumentation shall meet the requirements detailed in the Section titled "BMS Field Instrumentation" or, where specifications are not provided, details of such instrumentation shall be submitted to the Engineer for approval.
12.4.4 The operating sequences shall be written in a readily understandable high level control language such as Pascal, Basic, C or equivalent or they shall be constructed using an easily understood graphics interface package. Provide adequate English language notation in the software to assist the operator understand the intent of the programmed sequences.
12.4.5 The control language shall be capable of implementing 32-bit floating point calculations using. At minimum, the following arithmetic operators:
12.4.5.1 Addition
12.4.5.2 Subtraction
12.4.5.3 Multiplication
12.4.5.4 Division
12.4.5.5 Roots
12.4.5.16 Exponentials
12.4.6 The control language shall, at minimum, be able to implement the following logic operations and relational operations:
12.4.6.1 and

12.4.6.2 or
12.4.6.3 not
12.4.6.4 and
12.4.6.5 nor
12.4.6.6 If then else statement
12.4.6.7 less than
12.4.6.8 less than or equal to
12.4.6.9 equal to
12.4.6.10 greater than or equal to
12.4.6.11 greater than
12.4.6.12 not equal to
12.4.7 The BMS contractor shall be responsible for the stable operation of all control loops. The BMS contractor shall provide self-tuning PID control algorithms. Verify that the control loops are stable.
12.4.8 If any BMS or system component should fail during the operation of a system, then the BMS shall execute the procedure detailed in the sequences of operation. Where a failure mode is not provided for a BMS controlled item of equipment the BMS contractor shall obtain details of the required failure mode from the Employer.
12.4.9 Where there are multiple filter banks the BMS contractor shall furnish a differential pressure switch
across each filter bank. The BMS contractor may elect to monitor each filter alarm individually or may elect to wire the differential pressure switches such that if either filter is in alarm a general filter alarm shall be monitored by the BMS. The point definition sheets indicate a single alarm.
12.4.10 Any information required by the BMS contractor for the implementation of the software shall be requested in writing from the Engineer at least four (4) weeks prior to the time it is required. Submit the request for information in the form of tables or forms for the Employer's personnel to complete and return.
12.4.11 The operating sequences detailed on in this section shall only apply when the BMS is controlling and monitoring the system in the BMS software control mode.
12.4.12 In cases where outside air duct cross-sectional area exceeds a certain amount, multiple damper sections rather than a single section shall be furnished and shall be controlled in groups. Refer to the mechanical trade documents to determine the number of damper sections and the number of actuators.
12.4.13 Where indicated on the control diagrams, the BMS contractor shall interlock motorized dampers
with fans such that when the dampers are closed the associated fans stop.
12.4.14 The BMS contractor shall provide any modifications to the operating sequences as requested by the Engineer without additional costs until the substantial completion of the entire BMS.
12.5 STANDARD OPERATING SEQUENCES
All plant room equipment as well as equipment is scheduled in the BMS drawings. For operating sequences of various items / subsystems refer to relevant operating sequences as shown in the schedules.
The standard operating sequences are as follows:
12.5.1 PRIMARY AIRHANDLING UNITS AND HEAT RECOVERY SYSTEM
The control scheme shall provide for the following as shown in the drawings:
12.5.1.1 Monitoring of filter banks and generating dirty filter alarms.
12.5.1.2 Starting and stopping of Fresh Air and Exhaust Fans and monitoring of Fan Pressure.
12.5.1.3 Monitoring Return, Exhaust and Fresh Air enthalpies to evaluate Heat recovery performance.
12.5.1.4 Operating Cooling Coils to maintain Air temperature set points.
For other AHUs shown on the drawings similar requirements apply.
Based on the above the Contractor shall develop a detailed operating sequence for the consultant approval.
12.5.2 DOMESTIC WATER SUPPLY BOOSTER UNIT (TYPICAL)
The control scheme shall provide for the following:
12.5.2.1 Monitoring of line pressure from the booster unit.

12.5.2.2 Supervision of valves for inlet (via transfer pump) based on input from level controller.
12.5.2.3 Indication of water level.
12.5.2.4 Metering of water supplies flowing into the tank.
12.5.3 DOMESTIC WATER TRANSFER PUMP
The control scheme shall provide for the following:
12.5.3.1 Supervision of valves for inlet (via transfer pump) based on input from level controller.
12.5.3.2 Indication of water level.
12.5.3.3 Metering of water supplies flowing into the tank.
12.5.4 FIRE PUMPS
The control scheme shall provide for the following:
12.5.4.1 Monitoring level of Fire Reserve Tank.
12.5.4.2 Supervision of valves for inlet (via transfer pump) based on input from level controller.
12.5.4.3 Indication of water level.
12.5.4.4 Metering of water supplies flowing into the tank.
12.5.5 EXHAUST AND VENTILATION FANS
The control scheme shall provide for the following:
12.5.5.1 Start / Stop of Fan
12.6.5.2 Alarm on Fan Failure
12.5.6 PARKING EXHAUST FANS
The control scheme shall provide for the following:
12.5.6.1 Start / Stop of Fan.
12.5.6.2 In case of Fire the Fire Zone Supply Fan shall stop.
12.5.6.3 In case of Fire Exhaust Fans shall operate at High Speed.
12.5.6.4 Co sensors shall modulate fans between two speeds in response to Co Levels.
12.5.7 FAN COIL UNITS
The control scheme shall provide for the following:
12.5.7.1 Maintain return Air Set points by Control of Chilled Water Valve.
12.5.7.2 Start / Stop Units.
12.5.8 SUMP PUMPS (TYPICAL)
The control scheme shall provide for the following:
12.5.8.1 Level meter shall operate sump pump in response to a rise in water level up to a preset limit.
12.5.8.2 Pump running hours will be totalized and run times equalized.
12.5.8.3 Failure of Sump pump will cause stand by pump to start
12.5.9 STAIRWELL PRESSURIZATION
The control scheme is required to accomplish the following:
12.5.9.1 Stairwell pressurization fan shall start on a signal from the FACP.
12.5.9.2 On startup of fan motorized damper shall open.
12.5.9.3 The differential pressure sensor shall modulate the variable speed drive to maintain DP set point.
12.5.9.4 Fan status shall be monitored.
The contractor shall provide a detailed sequence for approval by the consultant.
12.5.10 EXPANSION TANKS
The coil scheme requires:
12.5.10.1 Monitoring of pressure in the expansion tanks.
12.5.10.2 Monitoring and totaling the make up water inflow to the plant.
12.5.11 CENTRAL BATTERY SYSTEM
The CBS interface shall be BACnet compliant for display at BMS O.W of the following:
12.5.11.1 Usage / pattern / trends
12.5.11.2 Available capacity
12.5.11.3 Mode of operation i.e. charge / discharge / standby
12.5.11.4 Faults
12.5.11.5 Alarms
12.5.11.6 Enable / Disable
12.5.12 ACCESS CONTROL PANEL INTERFACE

12.5.12.1 Monitoring of door status
12.5.12.2 Unlatching of Door lock
12.5.13 FIRE ALARM CONTROL PANEL INTERFACE
The FACP interface shall be BACnet compliant for display at BMS OIW of the following:
12.5.13.1 Fault conditions (number and location).
12.5.13.2 Alarm conditions (number and location) including apartment numbers.
12.5.13.3 Panel power status.
12.5.13.4 Panel operational status.
12.5.14 LIFT CONTROL PANEL
The LCP interface shall be BACnet compliant and shall map the following information from the lift control
panel and have the following features:
12.5.14.1 Lift status (operation / standby / in use / location / under maintenance).
12.5.14.2 Enable / disable lift operation.
12.5.14.3 Trouble alarms
12.5.14.4 Interface with FACP for operation in fire mode.
12.5.15 TYPICAL AIR HANDLING UNITS
The control scheme requires:
12.5.15.1 Control of space returns air temperature by modulating the chilled water valve.
12.5.15.2 The supply air temperature shall be scheduled to provide close control of space return air temperature.
12.5.15.3 Dampers shall close on shut down of units.
12.5.15.4 BMS shall stop start units.
12.5.15.5 Filter and fan alarms shall be provided.
12.5.16 WATER BODIES
The control scheme shall provide for the following:
12.5.16.1 Start Stop of Pumps
12.5.16.2 Start Stop Lights
12.5.17 SECONDARY CHILLED WATER PUMPS
12.5.17.1 The control scheme is required to accomplish the following:
_ Startup a Secondary pump when any of the AHU's served is started up.
_ The pumps shall be started in manner to equalize run times.
_ The VSD's shall modulate pump speed to maintain a preset differential pressure. The set point shall be provided by the MEP contractors on the basis of his pressure drop calculations.
_ Chilled water pressures and temperatures shall be monitored as shown.
_ In case of pump failure the standby pump shall be started.
12.5.18 DOMESTIC HOT WATER SYSTEM
_ Control of storage tank temperature by operating heat pump.
_ Operation of circulation pumps with changeover every 24 hours.
_ Monitoring status of hot water circulators.
BMS contractor shall prepare a detailed sequence of operation for approved by the consultant.

OPERATOR TRAINING

A. During system commissioning and at such time acceptable performance of the Control System hardware and software has been established, the Control System Contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.
B. The Control System Contractor shall provide 80 total hours of comprehensive training in multiple sessions (80 hours total) for system orientation, product maintenance and troubleshooting, programming and engineering, if not provided under a previous contract at the site using the same brand and type of controllers within the previous 3 years. These classes are to be spread out during the 1st year warranty period. The first class starting after final commissioning and the last class is to be in the last month of 1-year warranty period.

C. The Control System Contractor shall provide 16 hours (total) of instruction to the owner's designated personnel on the operation of the BMS and describe its intended use with respect to the programmed functions specified. Operator orientation of the BMS shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories and appropriate operator intervention required in responding to the System's operation

SPECIAL REQUIREMENTS FOR BMS DIVISION

PART ONE GENERAL

1.1 REFERENCE

1.1.1 Conform to General Requirements and Conditions for MEP Works, Division 1 Section 01 00 00.

PART TWO PRODUCTS

2.1 GENERAL

2.1.1 The Building Management System (BMS) shall consist of Network Server / Controllers a family of Standalone Digital Control Units, Administration and Programming Workstations, and Web-based Operator Workstations the BMS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility.

2.1.2 The BMS shall consist of Network Servers, which enable all graphics, alarms, schedules, trends, programming, and configuration to be accessible from a single Workstation simultaneously for operations and engineering tasks.

2.1.3 The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP, protocol.

2.1.4 Webservices shall be native to the Network Controller. There shall not be a need to provide multiple Network Controllers to support all the different network protocols, nor should have be a need to supply additional software to allow all protocols to be natively supported.

2.2 STANDARD NETWORK SUPPORT

2.2.1 All Network Controllers, Workstation(s) and Servers shall be capable of residing directly on the owner’s Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the Network Controllers, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system.

2.3 SYSTEM EXPANSION

2.3.1 The BMS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.

2.3.2 Web-based operation shall be supported directly by the Network Controllers and require no additional software, other than a Java supported network browser.

2.3.3 The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.

2.4 SUPPORT FOR OPEN SYSTEMS PROTOCOLS

2.4.1 Network Server Controllers must natively support the BACnet IP, BACnet MS/TP.

8. Bill of Quantity

Note:
The recommended brands are Centraline by Honeywell, Johnson control, Siemens and Schneider

SECTION II/I: HVAC CONTROL & MONITORING SYSTEMS

Item	Item Description	Qty	Unit	Supply Rate	Install Rate	Total Amount
	Air-Cooled Chillers					
A	Supply, Installation and Commissioning of complete control sets for Air-Cooled Chiller including water BTU meters and monitoring system as per specifications, drawings, and system requirements complete in all respects.	**2**	Nos.			
B	Mixed Expansion I/O Module for Plant Controller	**1**	Job			
C	Chilled Water Flow Switch (Paddle type, 150 psig)	**2**	Nos.			
D	Integration of Chiller Control Panel for monitoring of parameters on BMS (High-level BACnet interface)	**2**	Nos.			
E	Mapping of all available chiller data points on BMS dynamic GUI	**1**	Job			
	Primary Chilled Water Pumps					
I	Supply, Installation and Commissioning of complete control set for Primary Chilled Water Pumps complete in all respects as per drawings and specifications.	**2**	Nos.			
J	Relays for Primary Pump On/Off Command	**2**	Nos.			
K	Current Switch for Primary Pump On/Off Status	**2**	Nos.			
L	Chilled Water Inlet & Outlet Temperature Sensor (Immersion type with SS thermowell)	**4**	Nos.			
	Secondary Chilled Water Pumps (VFD Driven)					
A	Supply, Installation and Commissioning of complete control set for Secondary Chilled Water Pumps complete in all respects as per drawings and specifications (All Pumps are VFD driven).	**3**	Nos.			
B	Relays for Secondary Pump On/Off Command	**3**	Nos.			
C	Current Switch for Secondary Pump On/Off Status	**3**	Nos.			
D	Pressure Transmitter FOR INLET AND OUTLET	**2**	Nos.			
	Fresh Air Handling Units (FAHU)					
B	Supply, Installation and Commissioning of complete control sets for Fresh Air Handling Units including all sensors, actuators, etc. as per specifications and drawings complete in all respects.	**1**	Nos.			
C	DDC Controller (BACnet Compliant, Freely Programmable)	**1**	Job			
D	Duct Type Temperature Sensor	**2**	Nos.			

Item	Item Description	Qty	Unit	Supply Rate	Install Rate	Total Amount
E	Immersion Type Temperature Sensor	**1**	Nos.			
F	Duct Type Smoke Detector, Photoelectric	**1**	Nos.			
G	Differential Pressure Switch (Filter dirty status)	**1**	Nos.			
H	Modulating Type Chilled Water Control Valve and Electric Actuator	**1**	Nos.			
I	Modulating Type Damper Actuator for Fresh Air Dampers	**1**	Nos.			
J	Fan Speed Controlling interface (VFD speed reference)	**1**	Nos.			
K	Relays for Supply Air Fan On/Off Command	**1**	Nos.			
L	Wall Mounted Powder-Coated DDC Enclosure with key lock	**1**	Nos.			
M	Variable Air Volume (VAV) Terminal Units Control & Monitoring sets	**63**	Nos.			
	Air Handling Units (AHUs)					
A	Supply, Installation and Commissioning of complete control sets for Air Handling Units including all sensors, actuators, etc. as per specifications and drawings complete in all respects.	**15**	Nos.			
B	DDC Controller (BACnet Compliant, Freely Programmable)	**15**	Nos.			
C	Duct Type Temperature Sensor	**30**	Nos.			
D	Duct Type Relative Humidity Sensor	**15**	Nos.			
E	Immersion Type Temperature Sensor with SS Thermowell	**15**	Nos.			
F	Duct Type Smoke Detector, Photoelectric	**15**	Nos.			
G	Differential Pressure Switch for Filter status	**15**	Nos.			
H	Modulating Type Chilled Water Control Valve and Actuator	**15**	Nos.			
I	Modulating Type Damper Actuator	**15**	Nos.			
J	Air Flow Station / Sensor	**15**	Nos.			
K	Fan Speed Controlling interface for VFD modulation	**15**	Nos.			
L	Relays for Supply Air Fan On/Off Command	**15**	Nos.			
M	Wall Mounted DDC Control Enclosures	**15**	Nos.			

SECTION II/IV TO II/VII: SYSTEM HEADEND, TESTING, GUI & MISCELLANEOUS

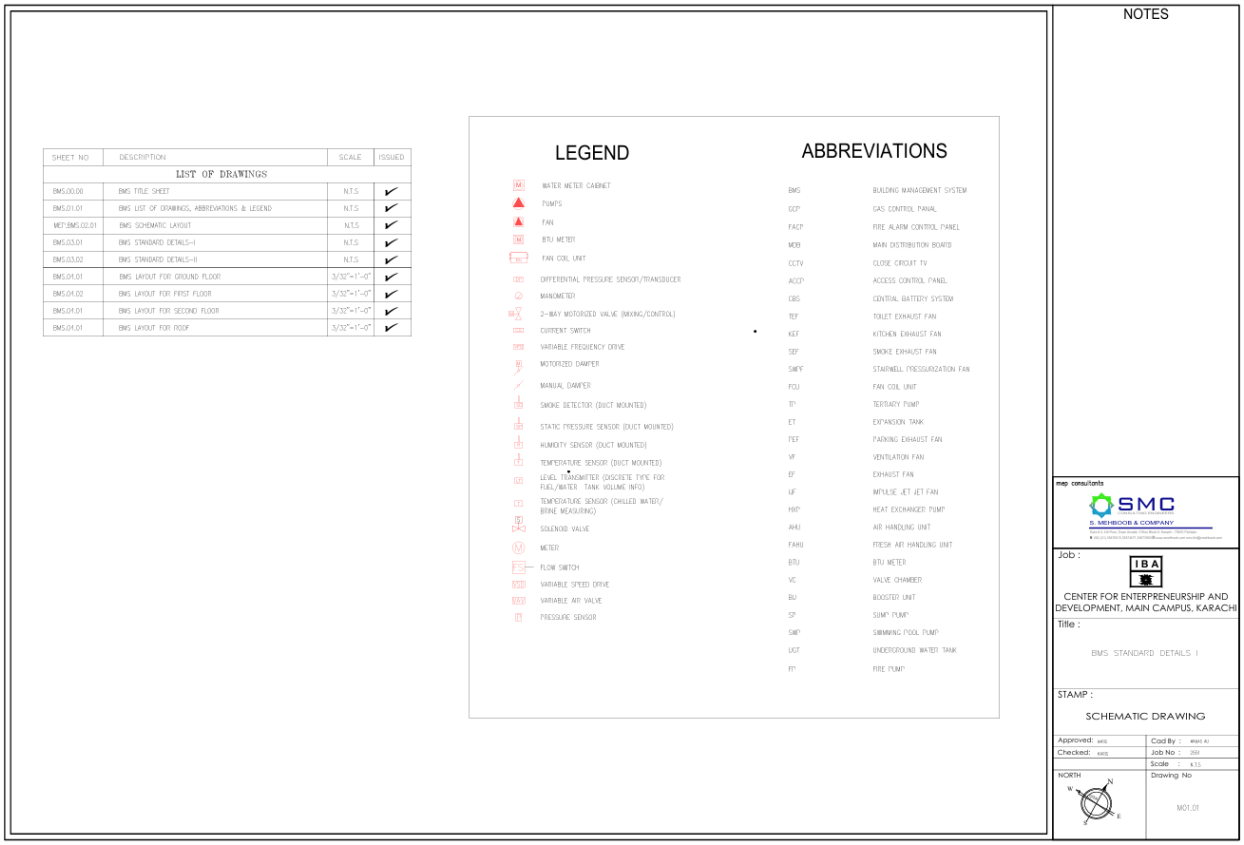
Item	Item Description	Qty	Unit	Supply Rate	Install Rate	Total Amount
	Section II/IV: Building Management System Headend					
A	Central Building Management System Headend including dual redundant Network Data Servers, Operator Workstations (OIW), high-resolution monitors, alarm/report printers, central print server, core BMS operating software, and unlimited third-party integration driver licenses.	**1**	Job			
	Section II/V: Testing & Commissioning					
A	Comprehensive testing, pre-commissioning, loop checking, point-to-point end-to-end testing, dynamic sequence tuning, and final commissioning of all integrated BMS subsystems including Supply, Installation, laying, and termination of all low-voltage control cables (<240VAC), screened communication cable, Fiber Optic backbone patch cords, conduits, cable trays, and containment accessories for the complete BMS.	**1**	Job			
	Section II/VI: Dynamic GUI Development					
A	Complete software and hardware points mapping, 3D animated floor layouts, equipment schematics, alarm consoles, reporting engine, and custom GUI development approved by Consultant/Employer.	**1**	Job			
	Section II/VII: Miscellaneous Works & Site Integration					
A	Reuse & Integration of Existing BMS Wiring and Field Devices: Comprehensive survey, assessment, insulation testing, and reuse of existing BMS wiring, sensors, actuators, controllers, control valves, dampers, and field devices where technically feasible. Includes compatibility verification, minor modifications, re-termination, re-addressing, recalibration, software integration, testing, and recommissioning. Submission of detailed inventory list of reused items is mandatory.	**1**	Job			
B	Provision of all ancillary accessories, relays, power supplies, patch cords, brackets, and appurtenances left or required for a smooth, fully operational, turnkey Integrated BMS.	**1**	Job			
GRAND TOTAL FOR BMS WORKS (Inclusive of all Taxes, Duties & Levies)						

Total Amount Rupees (in words) _____

_____

Stamp & Signature

Drawings



SHEET NO	DESCRIPTION	SCALE	ISSUED
	LIST OF DRAWINGS		
BMS.00.00	BMS TITLE SHEET	N.T.S	✓
BMS.01.01	BMS LIST OF DRAWINGS, ABBREVIATIONS & LEGEND	N.T.S	✓
MEP/BMS.02.01	BMS SCHEMATIC LAYOUT	N.T.S	✓
BMS.03.01	BMS STANDARD DETAILS-I	N.T.S	✓
BMS.03.02	BMS STANDARD DETAILS-II	N.T.S	✓
BMS.04.01	BMS LAYOUT FOR GROUND FLOOR	3/32"=1'-0"	✓
BMS.04.02	BMS LAYOUT FOR FIRST FLOOR	3/32"=1'-0"	✓
BMS.04.01	BMS LAYOUT FOR SECOND FLOOR	3/32"=1'-0"	✓
BMS.04.01	BMS LAYOUT FOR ROOF	3/32"=1'-0"	✓

LEGEND

- WATER METER CABINET
- PUMPS
- FAN
- BTU METER
- FAN COIL UNIT
- DIFFERENTIAL PRESSURE SENSOR/TRANSDUCER
- MANOMETER
- 2-WAY MOTORIZED VALVE (MIXING/CONTROL)
- CURRENT SWITCH
- VARIABLE FREQUENCY DRIVE
- MOTORIZED DAMPER
- MANUAL DAMPER
- SMOKE DETECTOR (DUCT MOUNTED)
- STATIC PRESSURE SENSOR (DUCT MOUNTED)
- HUMIDITY SENSOR (DUCT MOUNTED)
- TEMPERATURE SENSOR (DUCT MOUNTED)
- LEVEL TRANSMITTER (DISCRETE TYPE FOR FUEL/WATER TANK VOLUME INFO)
- TEMPERATURE SENSOR (CHILLED WATER/ BRINE MEASURING)
- SOLENOID VALVE
- METER
- FLOW SWITCH
- VARIABLE SPEED DRIVE
- VARIABLE AIR VALVE
- PRESSURE SENSOR

ABBREVIATIONS

BMS	BUILDING MANAGEMENT SYSTEM
GCP	GAS CONTROL PANAL
FACP	FIRE ALARM CONTROL PANEL
MDB	MAIN DISTRIBUTION BOARD
CCTV	CLOSE CIRCUIT TV
ACCP	ACCESS CONTROL PANEL
CBS	CENTRAL BATTERY SYSTEM
TEF	TOILET EXHAUST FAN
KEF	KITCHEN EXHAUST FAN
SEF	SMOKE EXHAUST FAN
SWPF	STAIRWELL PRESSURIZATION FAN
FCU	FAN COIL UNIT
TP	TERTIARY PUMP
ET	EXPANSION TANK
PEF	PARKING EXHAUST FAN
VF	VENTILATION FAN
EF	EXHAUST FAN
JF	IMTUISE JET JET FAN
HXP	HEAT EXCHANGER PUMP
AHU	AIR HANDLING UNIT
FAHU	FRESH AIR HANDLING UNIT
BTU	BTU METER
VC	VALVE CHAMBER
BU	BOOSTER UNIT
SP	SUMP PUMP
SWP	SWIMMING POOL PUMP
UGT	UNDERGROUND WATER TANK
FP	FIRE PUMP

NOTES

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SMC
S. MEHBOOB & COMPANY

Job :

IBA
CENTER FOR ENTERPRENEURSHIP AND DEVELOPMENT, MAIN CAMPUS, KARACHI

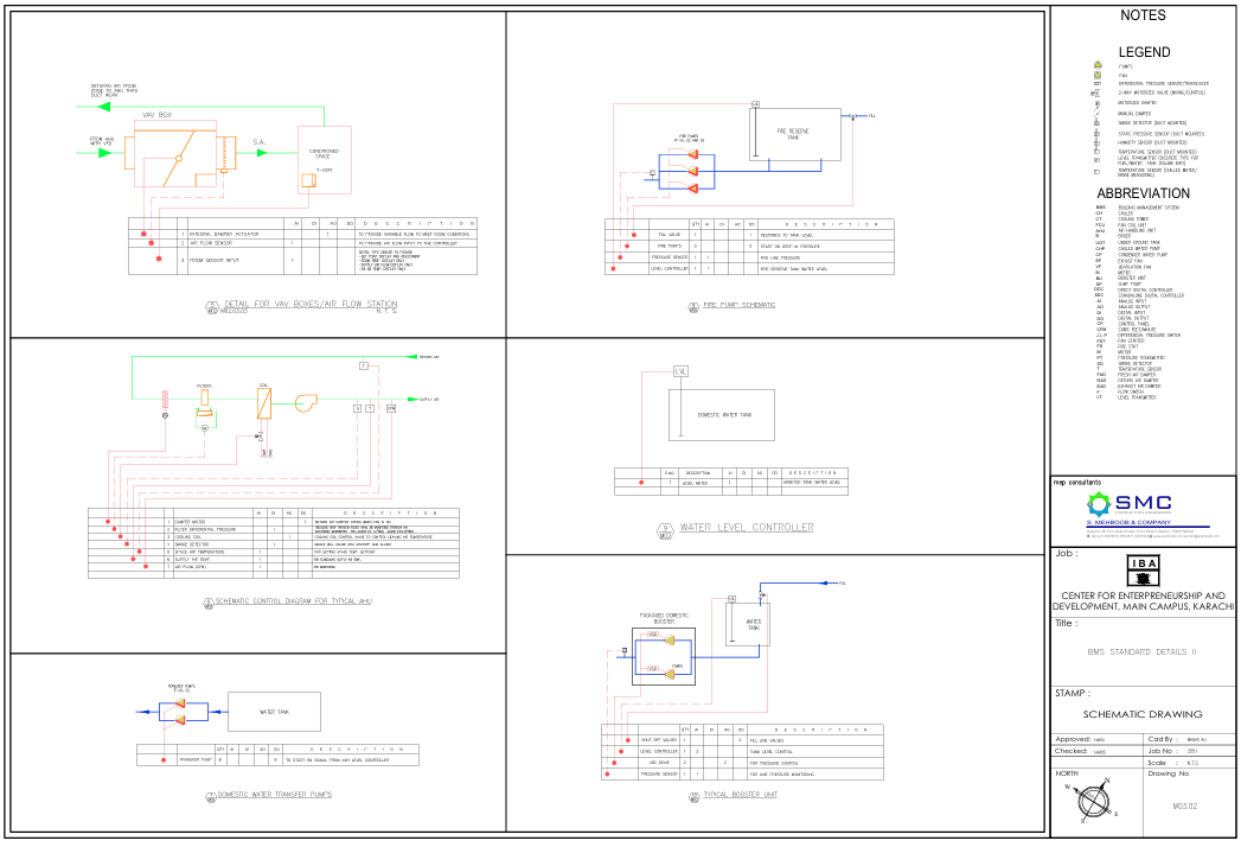
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BMS STANDARD DETAILS I

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NORTH	Drawing No
	M01.01



NOTES

LEGEND

ABBREVIATION

mep consultants

SMC
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Job :

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CENTER FOR ENTERPRENEURSHIP AND DEVELOPMENT, MAIN CAMPUS, KARACHI

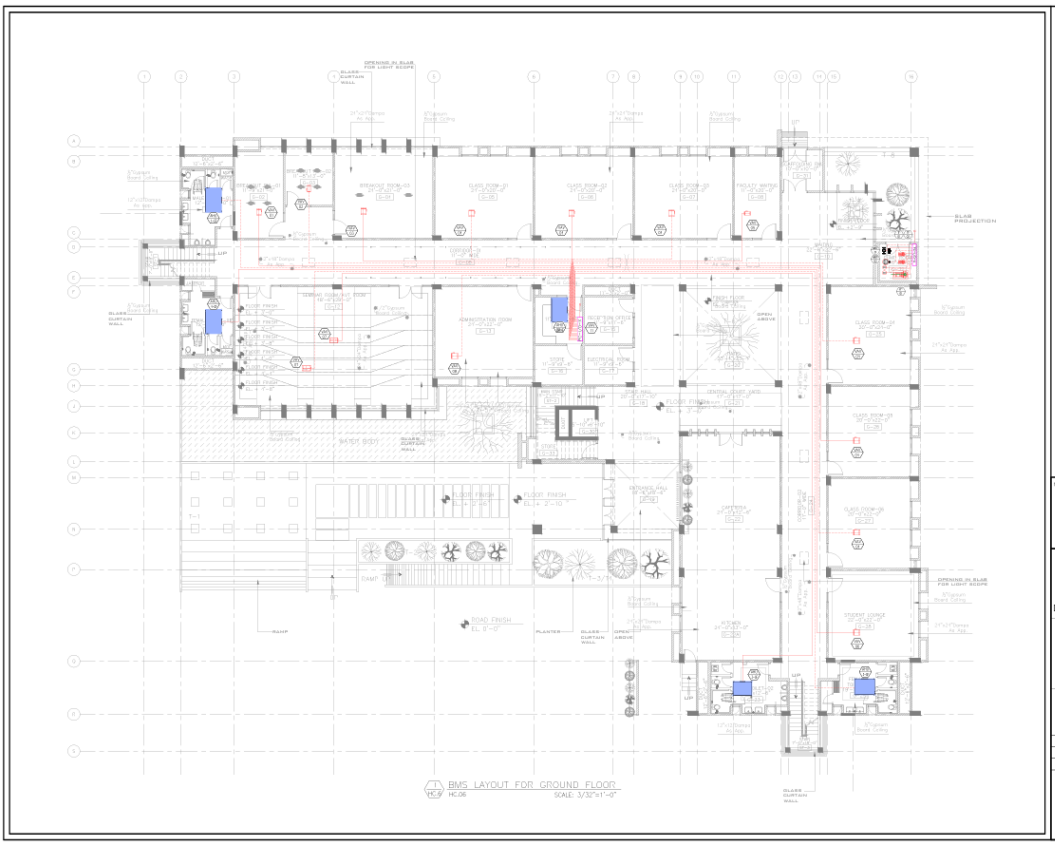
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NOTES

1. CABLE CONNECTION FROM DDC TO EQUIPMENT ARE SHOWN FOR ILLUSTRATIVE PURPOSE ONLY.
2. BMS CONTRACTOR TO MAKE SURE ALL NECESSARY CONTROL REQUIREMENTS ARE MET AS PER STANDARD DETAILS AND SPECIFICATION FOR ALL ITEM INCLUDED IN BOQ.

LEGEND

- DDC — DIRECT DIGITAL CONTROL PANEL
- PC — PLANT CONTROLER
- PC-I/O — PLANT CONTROLLER I/O MODULE
- I/O MODULE COMMUNICATION WIRE
- CONTROL WIRE

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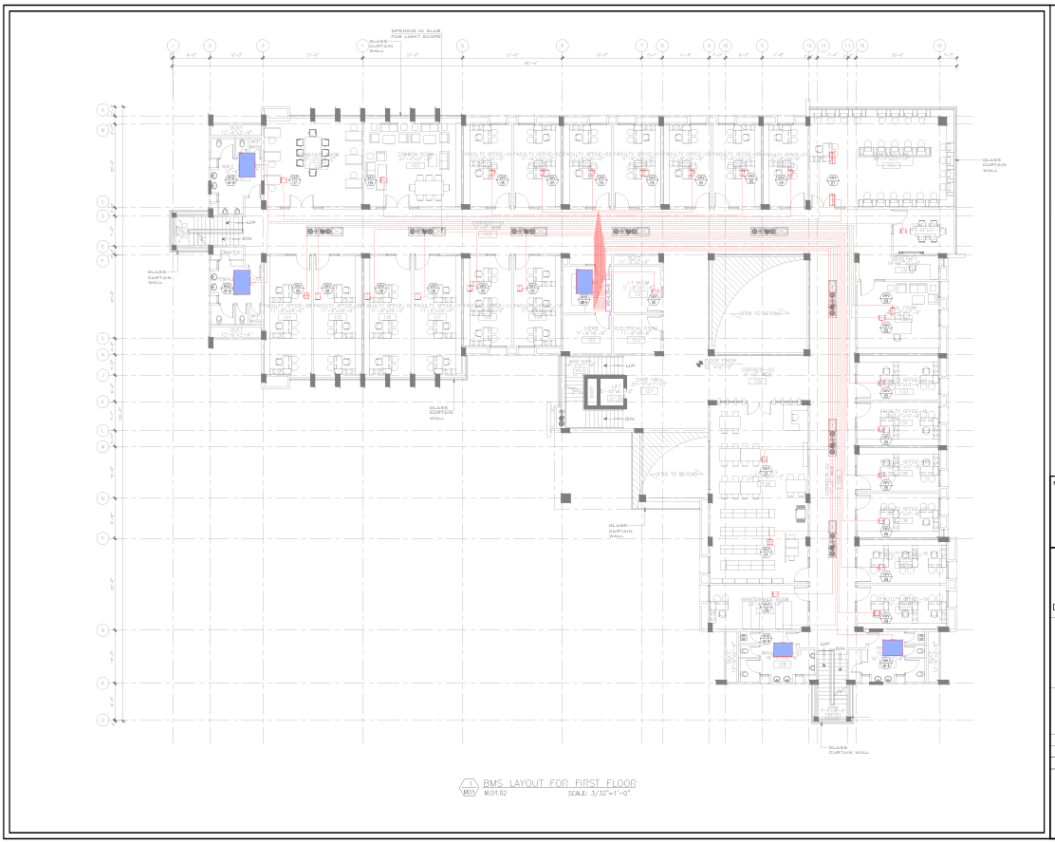
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BMS LAYOUT FOR GROUND FLOOR

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NOTES

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2. BMS CONTRACTOR TO MAKE SURE ALL NECESSARY CONTROL REQUIREMENTS ARE MET AS PER STANDARD DETAILS AND SPECIFICATION FOR ALL ITEM INCLUDED IN BOQ.

LEGEND

- DDC — DIRECT DIGITAL CONTROL PANEL
- PC — PLANT CONTROLER
- PC-I/O — PLANT CONTROLLER I/O MODULE
- I/O MODULE COMMUNICATION WIRE
- CONTROL WIRE

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Job :

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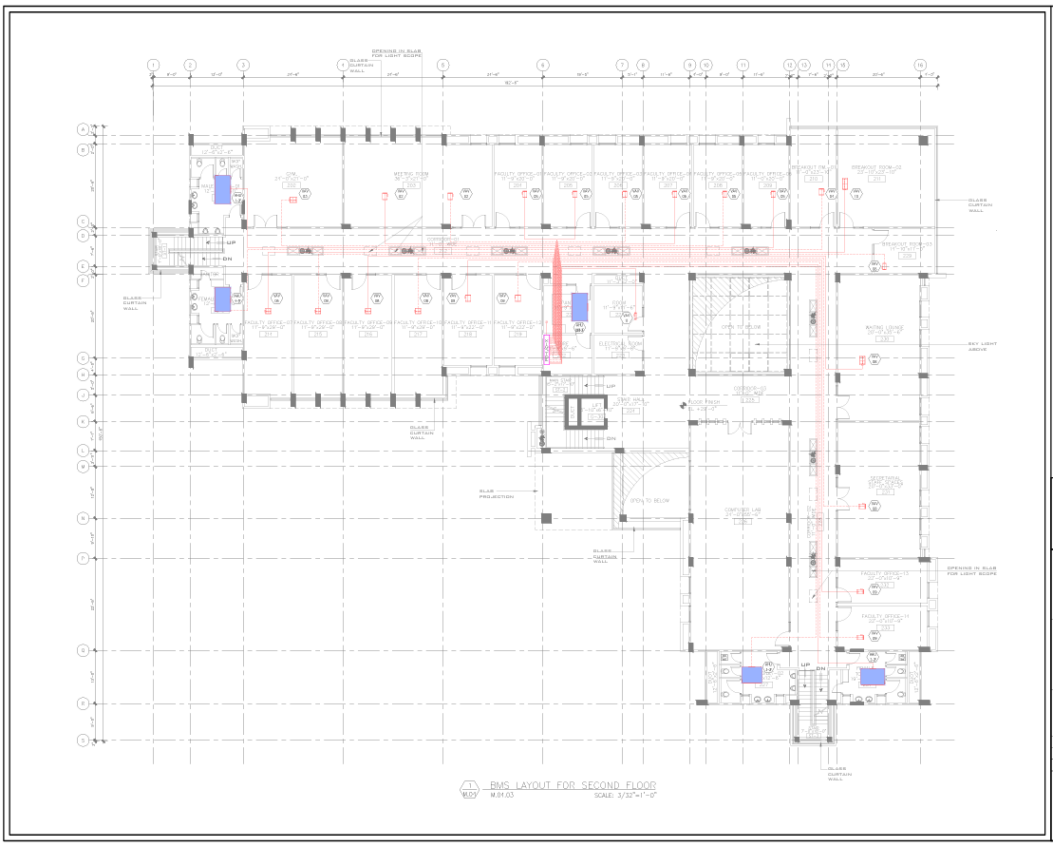
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BMS LAYOUT FOR FIRST FLOOR

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NORTH	Drawing No
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NOTES

1. CABLE CONNECTION FROM DDC TO EQUIPMENT ARE SHOWN FOR ILLUSTRATIVE PURPOSE ONLY.
2. BMS CONTRACTOR TO MAKE SURE ALL NECESSARY CONTROL REQUIREMENTS ARE MET AS PER STANDARD DETAILS AND SPECIFICATION FOR ALL ITEM INCLUDED IN BOQ.

LEGEND

- DDC — DIRECT DIGITAL CONTROL PANEL
- PC — PLANT CONTROLER
- PC-I/O — PLANT CONTROLLER I/O MODULE
- I/O MODULE COMMUNICATION WIRE
- CONTROL WIRE

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Job :

IBA
CENTER FOR ENTERPRENEURSHIP AND DEVELOPMENT, MAIN CAMPUS, KARACHI

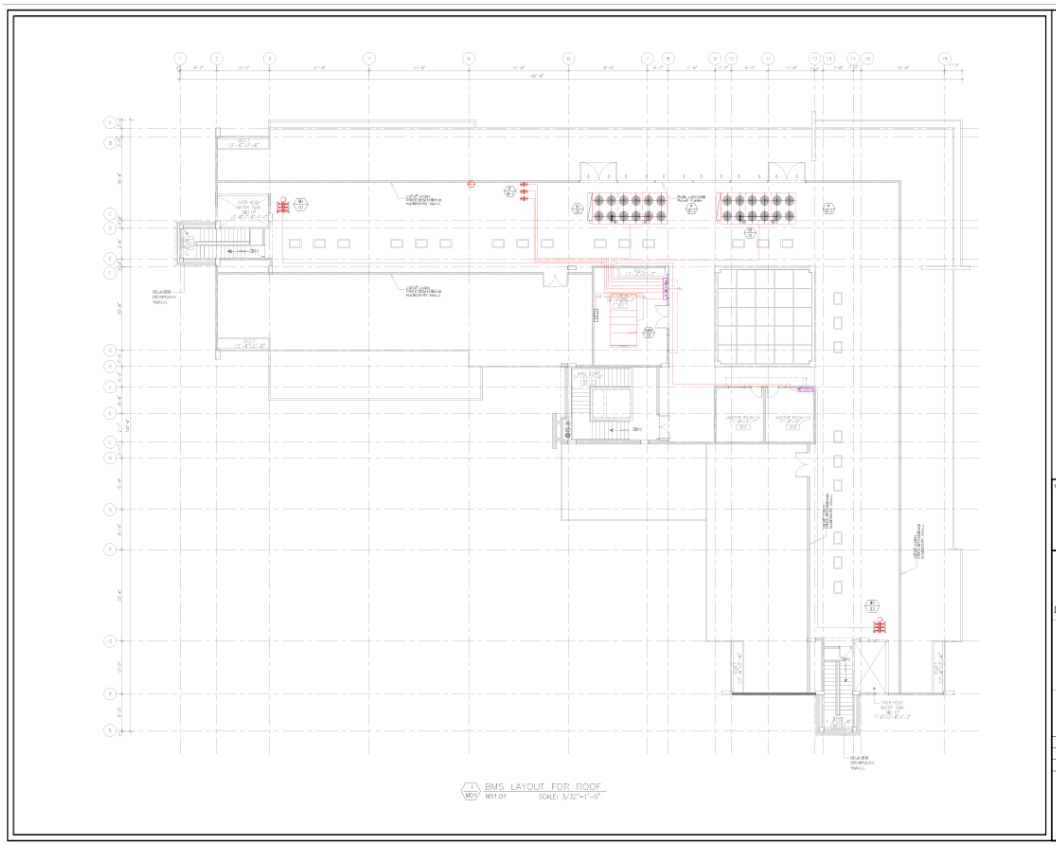
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BMS LAYOUT FOR SECOND FLOOR

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Checked:	Job No :
	Scale : 3/32"=1'-0"
NORTH	Drawing No
	M.04.03



NOTES

1. CABLE CONNECTION FROM DDC TO EQUIPMENT ARE SHOWN FOR ILLUSTRATIVE PURPOSE ONLY.
2. BMS CONTRACTOR TO MAKE SURE ALL NECESSARY CONTROL REQUIREMENTS ARE MET AS PER STANDARD DETAILS AND SPECIFICATION FOR ALL ITEM INCLUDED IN BOQ.

LEGEND

- DDC — DIRECT DIGITAL CONTROL PANEL
- PC — PLANT CONTROLER
- PC-I/O — PLANT CONTROLLER I/O MODULE
- I/O MODULE COMMUNICATION WIRE
- CONTROL WIRE

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Job :

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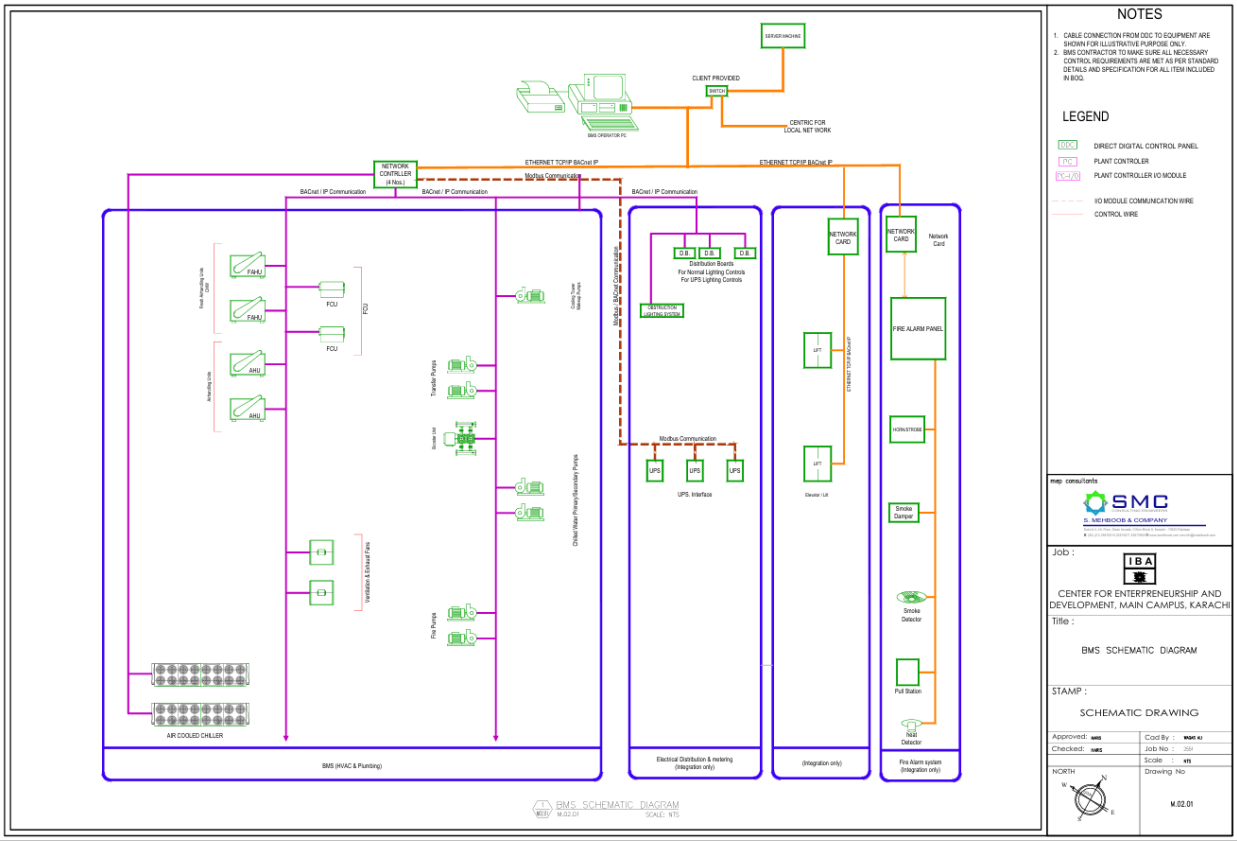
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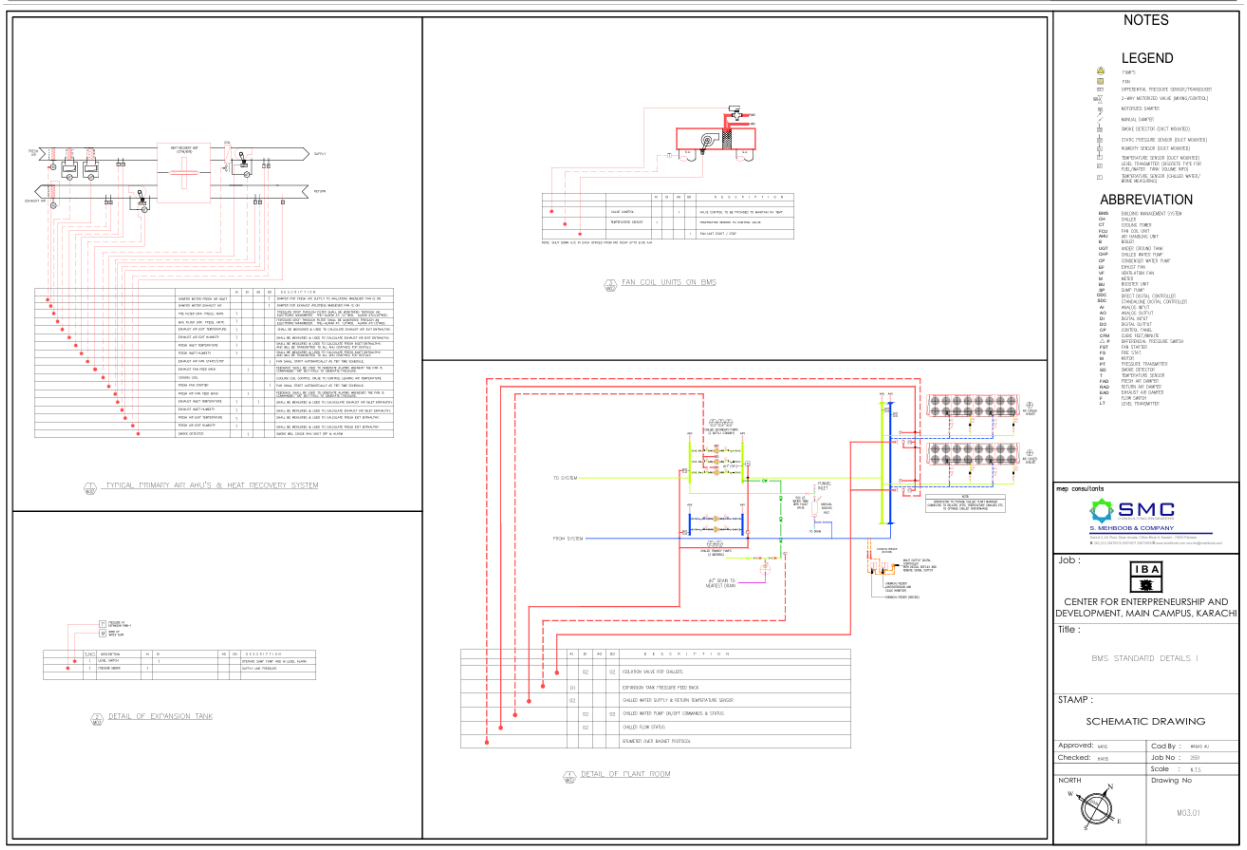
BMS LAYOUT FOR ROOF

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NOTES
1. CABLE CONNECTION FROM DDC TO EQUIPMENT ARE SHOWN FOR ILLUSTRATIVE PURPOSE ONLY.
2. BMS CONTRACTOR TO MAKE SURE ALL NECESSARY CONTROL REQUIREMENTS ARE MET AS PER STANDARD DETAILS AND SPECIFICATION FOR ALL ITEM INCLUDED IN BOQ.
LEGEND
DDC DIRECT DIGITAL CONTROL PANEL
PC PLANT CONTROLLER
PC-I/O PLANT CONTROLLER I/O MODULE
I/O MODULE COMMUNICATION WIRE
CONTROL WIRE
CLIENT PROVIDED
CENTRIC FOR LOCAL NET WORK
NETWORK CONTROLLER
ETHERNET TCP/IP BACnet IP
BACnet / IP Communication
Modbus Communication
FCU
AHU
Transfer Pumps
Chilled Water Primary/Secondary Pumps
Fire Pumps
Distribution Boards
For Normal Lighting Controls
For UPS Lighting Controls
UPS
UPS. Interface
NETWORK CARD
Network Card
FIRE ALARM PANEL
HORN/STROBE
Smoke Damper
Smoke Detector
Pull Station
AIR COOLED CHILLER
BMS (HVAC & Plumbing)
Electrical Distribution & metering (Integration only)
(Integration only)
Fire Alarm system (Integration only)
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SMC
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Job :
IBA
CENTER FOR ENTERPRENEURSHIP AND DEVELOPMENT, MAIN CAMPUS, KARACHI
Title :
BMS SCHEMATIC DIAGRAM
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Cad By :
Job No :
Scale : NTS
NORTH
Drawing No
M.02.01
BMS SCHEMATIC DIAGRAM
M.02.01
SCALE: NTS


TYPICAL PRIMARY AIR AHU'S & HEAT RECOVERY SYSTEM
FAN COIL UNITS ON BMS
DETAIL OF EXPANSION TANK
DETAIL OF PLANT ROOM
NOTES
LEGEND
ABBREVIATION
mep consultants
SMC
S. MEHBOOB & COMPANY
Job :
IBA
CENTER FOR ENTERPRENEURSHIP AND DEVELOPMENT, MAIN CAMPUS, KARACHI
Title :
BMS STANDARD DETAILS I
STAMP :
SCHEMATIC DRAWING
Approved:
Checked:
Cad By :
Job No :
Scale :
NORTH
Drawing No
M03.01

It is hereby certified that the terms and conditions have been read, agreed upon and signed.

M/s _____

Contact Person_____

Address_____

Tel #_____Fax _____

Mobile_____email_____

_____
Stamp & Signature

8. General Conditions of Contract

Provide, Supply, Install, Commissioning & Testing of Building Management System

THIS AGREMENT is executed at KARACHI, on this day _____, 2026.

BETWEEN

M/s. Institute of Business Administration, Karachi through its Registrar, located at Main Campus, University Enclave, Karachi, hereinafter called and referred to as "IBA" (which expression shall wherever the context so permits, be deemed to include its legal representatives, executors, successors and assigns) of the FIRST PART.

AND

M/s._____, having its office at _____, hereinafter referred to as "THE SUPPLIER" (which expression shall wherever the context so permits be deemed to include its legal representatives, executors, successor and assign), through its proprietor Mr./Ms._____, holding CNIC No. _____ on the SECOND PART.

WHEREAS "IBA" intends to obtain Provide, Supply, Install, Commissioning & Testing of Building Management System vide tender # ME/05/26-27 (IBA requirement) up to the satisfaction and handing over the material(s) to the "IBA" having accepted the offer in a finished form complete in all respect.

NOW IT IS HEREBY AGREED & DECLARED BY AND BETWEEN THE PARTIES AS FOLLOWS:

WITNESSETH

"IBA" hereby offers to appoint "THE SUPPLIER" as their supplier for the specific purpose of "Provide, Supply, Install, Commissioning & Testing of Building Management System". "THE SUPPLIER" hereby agrees to the offer of the "IBA" in acceptance of the terms and conditions herein below forth.

Article I
DUTIES & SCOPE OF SUPPLY AND AGREEMENT

1.1 This Agreement includes, the "Provide, Supply, Install, Commissioning & Testing of Building Management System", discussions with "IBA" before the determination of scope of supply with any/all other relevant details to "IBA".

1.2 "THE SUPPLIER" agrees to provide any/all kind of required Provide, Supply, Install, Commissioning & Testing of Building Management System to "IBA" whenever and wherever form is required as per the terms & conditions of this Agreement.

1.3 "THE SUPPLIER" will coordinate their work with Sr. Manager Security, of the "IBA" who will assist "THE SUPPLIER" in supervision of proposed Provide, Supply, Install, Commissioning & Testing of Building Management System.

1.4 "THE SUPPLIER" will visit the Purchase Offices located at Main Campus, University Road, University Enclave, Karachi as & when required with prior appointment.

1.5 Life Insurance / Security of worker will be the responsibility of supplier. IBA will not be responsible for any mishap.

1.6 All staff must have CNIC and clearly mentioned to discourage work through child labor.

1.7 All logistic charges will be borne by "THE SUPPLIER".

Article II
SCOPE OF PROFESSIONAL SUPPLIES

2.1 "THE SUPPLIER" hereby agrees and acknowledges to 'Provide, Supply, Install, Commissioning & Testing of Building Management System in accordance with the Description & Specification in Bill of Quantity.

2.2 "THE SUPPLIER hereby agrees and acknowledges the acceptance of attending the meetings with the Head of Procurement "IBA" as & when required.

2.3 Delivery on or before XXXX XX, 2026.

2.4 All staff must have CNIC and clearly mentioned to discourage work through child labor.

2.5 "THE SUPPLLIER", will provide all required/necessary labor(s) / transportation(s) / machinery(s) whatsoever required to complete the procurement at the cost/charges amount offered in the tender vide # ME/05/26-27.

Article III
REMUNERATION

3.1 The cost offered by the Supplier is Rs._____ (inclusive of all taxes) 'Provide and Supply of Spare Parts for Fire Alarm & Control Panel System' vide tender # ME/05/26-27 variation may occurred. The cost is inclusive of labor/transportation/supplies/etc.

3.2 A liquidity damages @ 2% per month, of the total agreed payment as per the Letter of Intent/Acceptance, of the total cost will be imposed in case of delayed delivery. Liquidity damages will be imposed after 30 days subject to final proof sample material handed over by supplier to IBA before the starting date mentioned on the Letter of Intent/Acceptance. Purchase will be deemed completed in finished form as per specification and "THE SUPPLIER" have to deliver the required number of Provide, Supply, Install, Commissioning & Testing of Building Management System.

3.3 All payments will be made after complete delivery and services required as per BoQ and scope of work within 30 working days after submission of commercial invoice.

3.4 Performance Security 5% of total amount of the Letter of Intent/Acceptance will be provided by the party.

3.5 Stamp Duty @ 0.35% of the cost of transaction / work order will be deposited in Government treasury by the SUPPLIER. This paid Stamp papers challan would be submitted along with the Bill / Invoice.

3.6 Tax(es)/Challan(s)/Levy(ies), if any or additional will be paid/borne by SUPPLIER as per SRO/Notification.

Article IV

ARBITRATION

4.1 In case of any dispute, difference, or question which may at any time arise between the parties hereto or any person under them, arising out of or in respect of this Letter of Intent or the subject matter hereof, the same shall be referred to and finally resolved by arbitration under the Arbitration Act, 1940, as amended from time to time. The arbitration shall be administered in accordance with the rules and procedures of the Alternative Dispute Resolution International Center (ADRIC) at the Institute of Business Administration (IBA), Karachi.

4.2 The arbitration shall be conducted by a sole independent arbitrator mutually agreed upon by the parties. If the parties fail to agree on an arbitrator within fifteen (15) days of a written request by either party, the arbitrator shall be appointed in accordance with the rules of the ADRIC. The seat and venue of arbitration shall be Karachi, Pakistan, and the proceedings shall be conducted in the English language. The substantive and procedural laws of Pakistan shall apply. Subject to the foregoing, the parties agree that the courts at Karachi shall have exclusive jurisdiction.

Article V
TERMINATION

5.1 "IBA" may terminate this agreement if the job is not executed according to the requirement at any time after issuing a 30 day's notice.

Article VI
INDEMNITY

6.1 "THE SUPPLIER" in its individual capacity shall indemnify and keep IBA and any person claiming through IBA fully indemnified and harmless from and against all damages, cost and expenses caused to or incurred by "THE SUPPLIER", as a result of any defect in the title of IBA or any fault, neglect or omission by the "THE SUPPLIER" which disturbs or damage the reputation, quality or the standard of services provided by "IBA" and any person claiming through the IBA.

Article VII
WARRANTY

7.1 M/s _____ should provide three years comprehensive onsite warranty.

Article VIII
NOTICE

8.1 Any notice given under this AGREEMENT shall be sufficient if it is in writing and if sent by courier or registered mail.

Article IX
INTEGRITY PACT

9.1 The intention not to obtain the procurement / work of any Contract, right, interest, privilege, or other obligation or benefit from the IBA or any administrative or financial offices thereof or any other department under the control of the IBA through any corrupt practice(s).

9.2 Without limiting the generality of the forgoing the M/s _____, represents and warrants that it has fully declared the charges, fees, commission, taxes, levies

etc, paid or payable to anyone and not given or agreed to give and shall not give or agree to give to anyone within the IBA directly or indirectly through any means any commission, gratification, bribe, gifts, kickback whether described as consultation fee or otherwise, with the object of obtaining or including the procurement or service contract or order or other obligations whatsoever from the IBA, except that which has been expressly declared pursuant hereto.

9.3 M/s _____, accepts full responsibility and strict liability for making any false declaration/statement, not making full disclosure, misrepresenting facts or taking any action likely to degrade the purpose of declaration, representation and warranty. It agrees that any contract/order obtained aforesaid shall without prejudice to any other right & remedies available to the IBA under any law, contact, or other instrument, be stand void at the discretion of the IBA.

9.4 Notwithstanding any right and remedies exercised by the IBA in this regard, M/s _____, agrees to indemnify the IBA for any loss or damage incurred by it on account of its corrupt business practice & further pay compensation to the IBA in any amount equivalent to the loss of any commission, gratification, bribe, gifts, kickback given by the M/s_____as aforesaid for the purpose of obtaining or inducing procurement/work/service or other obligation or benefit in whatsoever from the IBA.

Article X
SEVERABILITY

10.1 If any terms covenant or condition of this agreement shall be deemed invalid or unenforceable in a court of law or equity, the remainder of this agreement shall be valid & enforced to the fullest extent permitted by prevailing law.

Article XI
MISCELLANEOUS

11.1 Any addition & alteration(s) made for item(s) or services as required by IBA on the basis of sample or in course of the work in progress which entail extra time & labor and material on part of the supply or services, shall not be charged separately/extra on 'Quantum Merit' basis before & on final material handed over with satisfactory completion of work to the "IBA". After FINALIZATION OF SAMPLE if any alteration(s), arise charges will be paid on mutually agreed upon.

11.2 The terms and conditions of the AGREEMENT have been read over to the parties which they admit to be correct and abide by the same.

11.3 All terms and conditions of tender vide # ME/05/26-27 will be the integral part of this agreement and can't be revoked.

IN WITNESS WHEREOF both the parties hereto have set & subscribed their respective hands to this agreement at Karachi on the date as mentioned above.

_____ _____

IBA, Karachi	M/s.
Name: _____	Name: _____
CNIC # _____	CNIC # _____
Address:	Address:
Registrar,	_____,
Institute of Business Administration	_____
Main Campus, University Road, Karachi	_____

WITNESS:

1. _____	**2.** _____
IBA, Karachi	M/s. _____
Name: _____	Name: _____
CNIC # _____	CNIC # _____
Address:	Address:
Associate Registrar,	_____
Institute of Business Administration	_____
Main Campus, University Road, Karachi	_____

Focal Person IBA _____