Specification 47

Building energy management systems

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Foreword

1. This Specification is one of a series prepared by Defence Estates (DE) primarily for use in its contracts for mechanical and electrical engineering works. The Specification covers the installation of building energy management systems (BEMS). It is a revision of the former Standard Specification (M&E) No. 15, dated 1986.

2. When this Specification is used in connection with a Defence contract then it is to be read in conjunction with such further documents setting out contractual requirements particular to the contract.

3. Whilst this Specification was commissioned by DE for use on Ministry of Defence (MOD) contracts, it is acknowledged that it could be usefully applied to other contracts. DE commend its use to other Government departments. It may, therefore, be used outside the MOD estate. However, no warranty is given as to the accuracy of this Specification or its fitness for any purpose.

4. This Specification has been devised for the use of the Crown and its contractors in the execution of contracts for the Crown. The Crown hereby excludes all liability (other than liability for death or personal injury) whatsoever and howsoever arising (including, but without limitation, negligence on the part of the Crown, its servants or agents) for any loss or damage however caused where the specification is used for any other purpose.

Acknowledgements

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Abbreviations

ADC	-	Analogue to Digital Conversion
BEMS	-	Building Energy Management System
BS	-	British Standards
CDM	-	Construction (Design and Management) Regulations
CPU	-	Central Processing Unit
DAC	-	Digital to Analogue Conversion
DDC	-	Direct Digital Control
EDI	-	Electronic Data Interchange
EMS	-	Energy Management Systems
FCU	-	Fan Coil Unit
HVAC	-	Heating, Ventilation and Air Conditioning
HVCA	-	Heating and Ventilating Contractors Association
I/O	-	Input/Output
ISDN	-	Integrated Services Digital Network
IT	-	Information Technology
LAN	-	Local Area Network
M&T	-	Monitoring and Targeting
MCC	-	Motor Control Centre
OEM	-	Original Equipment Manufacturer
PABX	-	Private Automatic Branch Exchange
PIR	-	Passive Infra Red
PM	-	Project Manager
PPM	-	Planned Preventive Maintenance
PROM	-	Programmable Read Only Memory
PSTN	-	Public Switched Telephone Network
RAM	-	Random Access Memory
RCD	-	Residual Current Device
ROM	-	Read Only Memory
SCS	-	Structured Cabling System
UC	-	Unitary Controller
UPS	-	Uninterruptible Power Supply
VAV	-	Variable Air Volume
VDU	-	Visual Display Unit
VFC	-	Volt Free Contact
VGA	-	Video Graphics Array (A colour graphics display specification)

WAN   -   Wide Area Network

Contents

1   Section One - General Requirements

1.1   SCOPE

1.1.1   This Specification details the design and other requirements for building energy management systems (BEMS).

1.1.2   The BEMS shall comprise personal computer-based operator's station(s), printer(s) and other peripherals, controllers and intelligent unitary controllers, software, sensors and instrumentation necessary to meet the intent of the Particular Specification.

1.1.3   The BEMS shall provide control and monitoring for the plant and system functions as described in the Particular Specification.

1.1.4   The system shall be capable of being addressed by all installed operator stations simultaneously and one portable additional operator station.

1.1.5   Unless otherwise indicated, the work shall include design, manufacture, works testing, supply, delivery to site, installation, site testing, commissioning, making good any defects that occur during the defect liability period, provision of As Installed drawings and Operation and Maintenance documents, the whole of the labour and all materials necessary to form a complete installation (whether or not all the necessary components are indicated). The work will also include any Scope of Work forming part of a Particular Specification attached to the Contract.

1.1.6   Where indicated, the work shall include comprehensive planned preventive maintenance for a period of 12 months following acceptance of the completed installation.

1.1.7   Unless otherwise indicated, all equipment and materials to be installed shall be new.

1.1.8   The Contractor shall ensure that all equipment can be installed in the allotted space and shall maintain adequate access for maintenance and repair, in accordance with DMG08 Space Requirements for Plant Access, Operation and Maintenance.

1.1.9   All equipment shall be installed in accordance with the manufacturer's written instructions.

1.2   TERMINOLOGY

1.2.1   Building Energy Management System (BEMS) is a generic term used to describe computer based control systems for engineering services. Other titles used for such equipment are Building Management Systems (BMS) and Energy Management Systems (EMS). The term Building Energy Management System (BEMS) has been identified as the normal acronym for such systems and adopted throughout this Specification. Other terms are synonymous with this.

1.3   DEFINITIONS

1.3.1   Project Manager (PM) shall mean an official of the MOD or commercial representative responsible for the purpose of management and administration of the works covered within this Specification.

1.3.2   Where the work is to be undertaken as a sub-contract, 'Contractor' shall mean 'Sub-contractor'.

1.3.3   'Indicated' as used in 'as indicated,' 'where indicated,' 'unless otherwise indicated' and like phrases shall mean indicated in Schedule No. 1 of this Specification or in the other documents listed in the invitation to tender.

1.3.4   'Approval' (and words derived therefrom) means approval in writing by the PM, unless stated otherwise.

1.3.5   'Commissioning' is the advancement of an installation from the stage of static completion to full working order to specified requirements.   Commissioning includes the setting to work and regulation of an installation.

a)   Setting to work. The process of setting a static system into motion.

b)   Regulation. The process of adjusting the system operating criteria to the specified requirements.

1.3.6   'Site Performance Testing' is the evaluation of the performance of a commissioned installation**.**

1.4   RELATED DOCUMENTS

1.4.1   This Specification shall be read in conjunction with, and its requirements are in addition to, the general conditions of contract and any drawings and other documents issued with it and listed in the invitation to tender.

1.4.2   The Specifier shall list in the Particular Specification the exclusion of Standard Specification clauses which are not required for the implementation of the BEMS.

1.4.3   Any discrepancy between this Specification, the Conditions of Contract, other documents listed on the tender form or the Contract Drawings shall be referred to the relevant persons designated in the tender documents as soon as practicable during pre-acceptance stage, or to the PM thereafter.

1.5   PROVEN PERFORMANCE

1.5.1   Systems and equipment selected by the Contractor shall have performed successfully for a period not less than 2 years under the same conditions as those required by the tender documents.

1.5.2   Systems and equipment that do not comply with the foregoing proven performance requirement may be considered, provided full technical details and evidence of suitability are given at the time of tendering.

1.6   STANDARDS

1.6.1   Commodities specified to conform to British Standards shall be clearly and indelibly marked with the reference specified. Where this is impracticable, the relevant advice and delivery notes shall include the BS reference to which they are to comply.

1.6.2   Where commodities are specified as manufactured by a BSI Kitemark Licensee or where commodities/services are specified to be by Registered Firms (under BSI Assessment Schemes), the manufacturer/firm must be a current participant in the relevant scheme.

1.6.3   Where commodities/services are specified to be by registered/approved firms (under Approved Quality Assurance Schemes), the manufacturer/firm must be a current participant in the relevant scheme.

1.6.4   The equipment and/or installation(s) shall conform to the relevant British Standards and Codes of Practice current 3 months prior to the date for return of tenders, unless otherwise indicated. Certificates of compliance with British Standards, BSI Certification Schemes, and/or Quality Assurance Schemes, shall be provided to the PM at his request.

1.6.5   Unless otherwise stated, the installation shall comply with all relevant MOD Standards and Guidance and in particular the requirements of:

a)   Defence Estates Specification 034 Electrical Installations (to be issued late 2002, early 2003),

b)   MOD Specification 036 Heating, Hot and Cold Water, Steam and Gas Installations in Buildings,

c)   MOD Specification 037 Air Conditioning, Air Cooling and Mechanical Ventilation for Buildings,

d)   MOD Design and Maintenance Guide 08 Space Requirements for Plant Access, Operation and Maintenance.

1.7   REGULATIONS

1.7.1   All work shall be carried out in accordance with the MOD relevant Safety Rules and Procedures which may be seen on request to the PM.

1.7.2   The installations(s) shall comply with and be subject to all relevant Statutory Instruments, Regulations, special Guidance and Memoranda including but not limited to the

following:

a) The Health and Safety at Work etc. Act 1974.

b) Regulations under the Electricity Acts.

c) Electricity Supply Regulations 1991 (as amended).

d) The Electricity at Work Regulations 1989.

e) Factories Act and Regulations.

f) The Clean Air Act.

g) Control of Pollution Act.

h) Energy Conservation Act.

i) Regulations under the Factories Act.

j) The Building Acts and Regulations.

k) The Gas Safety (Installation and Use) Regulations.

l) The Control of Substances Hazardous to Health Regulations (COSHH).

m) The Pressure Systems and Transportable Gas Container Regulations.

n) The Construction (Design and Management) Regulations (CDM).

o) The Management of Health and Safety at Work Regulations (MHSW).

p) The Personal Protective Equipment at Work Regulations (PPE).

q) BS 7671: 1992 Requirements for electrical installations. (The IEE Wiring Regulations).

r) British Gas Corporation Codes of Practice.

s) The Institution of Gas Engineers Utilisation Procedures (IGE/UP).

t) Any special requirements of the Local Electricity, Gas or Water Companies and Fire Fighting Authority.

u) Regulations and requirements of British Telecom.

v) The Asbestos Regulations.

w) The Boiler (Efficiency) Regulations.

x) HSE Guidance Notes HS (G)70 – The control of legionellosis (including Legionnaires' disease).

y) CIBSE Technical Memoranda TM13:1991 Minimising the risk of Legionnaires' Disease.

z) BS 4737 Intruder alarm systems.

aa) BS 5445 Components of automatic fire detection systems.

bb) BS 6238:1982 (1993) Code of practice for performance monitoring of computer based systems.

cc) BS 7807: 1995 Code of practice for design, installation and servicing of integrated systems incorporating detection and alarm systems and/or security systems for buildings other than dwellings.

dd) BS EN 50065 Specification for signalling on low-voltage electrical installations in the frequency range 3kHz to 148.5 kHz.

ee) BS EN 55011: 1991 Specification for limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment.

ff) BS EN 55015:1996 Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment.

1.7.3   The tender shall be based on the Regulations current 3 months prior to the date of return of tenders.

1.8   ELECTROMAGNETIC COMPATIBILITY

1.8.1   The BEMS shall be protected from the effects of conducted and radiated electrical interference.

1.8.2   All components of the complete BEMS shall comply with the requirements of BS EN 50081 Generic Emission Standards and BS EN 50082 Generic Immunity Standard. They shall also comply with BS EN 60801 Electromagnetic Compatibility.

1.8.3   The BEMS shall be protected from interference by the operation of hand held radio

transmitters, radio pagers etc., within one metre of the equipment.

1.8.4   To avoid corruption of equipment by electrical interference, all wiring shall be installed to minimise coupling of electromagnetic and electrostatic interference on low voltage signals and data wiring. The preferred method of achieving this shall be by ensuring a physical separation of greater than 50mm between the power supply cables and the signal and data cables. Where mixed wiring is unavoidable, braided screen cable, dressed close to metalwork, is preferred. The Tenderer shall specify the methods by which he intends to eliminate any such interference with his signal and data transmission.

1.9   DRAWINGS

1.9.1   Working Drawings

1.9.1.1   Unless otherwise indicated in the Particular Specification, the Contractor shall provide working drawings for comment before manufacture or installation. The drawings shall show:

a)   General arrangement of the location of all BEMS equipment including but not limited to controllers, operator station(s), sensors and actuators.

b)   General arrangement of data transmission cable routes including method of installation (conduit, cable tray, duct etc).

c)   Detailed layout of BEMS equipment including cable routes and methods of cable installation in switch rooms, plant rooms, meter rooms, service ducts and other special areas.

d)   Power wiring to equipment.

e)   Field wiring to sensors, actuators etc.

f)   Schematic diagrams of all systems detailing the locations of each item of plant in the system and the control actuators and sensors, including cross-reference points and item numbers, to include the complete BEMS network.

g)   Plant operating logic and safety interlocks.

h)   Routing of alarms and messages.

1.9.1.2   An initial set of drawings described in Clauses 1.9.1 shall be sent to the PM for comment within five weeks of the acceptance of the tender.

1.9.1.3   Comment on such drawings by the PM shall not relieve the Contractor of responsibilities under the Contract for any discrepancies, errors or omissions therein.

1.9.2   Builders Work Drawings

1.9.2.1   Builders work drawings shall show fully dimensioned details of all builders work required.

1.9.2.2   With the agreement of the PM, holes and fixings, other than in plant rooms, may be marked out on site instead of being shown on drawings.

1.9.3   'As Installed' Drawings

1.9.3.1   Unless otherwise indicated in the Particular Specification, the Contractor shall provide four sets of approved drawings which, in addition to the requirements of 1.9.1.1, shall show where applicable:

a)   The location and identification number of each circuit control valve.

b)   The names of the manufacturers, model and type numbers and rating of all items of automatic controls equipment.

1.9.3.2   Unless otherwise indicated, draft copies of these drawings shall be submitted to the PM for approval, prior to completion of the Works. Draft drawings shall be clearly marked up as such. Final approved drawings shall be supplied to the PM not later than one calendar month before the date for completion of the Works (or such other time as may be agreed with the PM). Failure to do so could cause delay in any release which it is considered may be made from the Reserve on the completion of the Works or during the maintenance period, and in the settlement of the final account.

1.9.3.3   Each drawing shall be in accordance with BS 308: part 1 (to ensure suitability for micro-filming) and shall be a process negative on translucent material, not paper, of a standard size A1 to A4.   Where agreed by the PM, microfiche copies or CAD disks in agreed format may be supplied.

1.9.3.4   Electrical 'as installed' drawings shall be provided in accordance with DEO Specification

034.

1.9.3.5   The words 'AS INSTALLED' shall be inserted in 19mm block letters adjacent to the title block of each drawing, together with the name of the site, the building, the title of the installation, the contract number and the name of the Contractor. Each drawing shall be dated.

1.9.3.6   During the course of the Works, the Contractor shall maintain a fully detailed record of all changes from the initial Contract Drawings to facilitate easy and accurate preparation of the 'As Installed' drawings and to ensure that these drawings are in all respects a true record of the installation.

1.10   OPERATING AND MAINTENANCE DOCUMENTS

1.10.1   Unless otherwise indicated, the Contractor shall provide two separate copies of the approved Health and Safety File, including operating and maintenance documents and a completed set of the planned maintenance data sheets for the whole of the installation covered by the Contract.   These documents shall contain all relevant information for the safe operation and maintenance of the system.

1.10.2   Unless otherwise indicated, a draft copy of the document shall be submitted to the PM, for approval, prior to completion of the Works. Final approved documents shall be supplied to the PM not later than one calendar month before the date for completion of the Works (or such other time as may be agreed with the PM). Failure to do so could cause delay in any release which it is considered may be made from the reserve on completion of the Works, or during the maintenance period, and in the settlement of the final account.

1.10.3   Documents are to be bound in strong flexible and durable covers with four hole binding to accept standard punched A4 sheets to BS 5097: Part 1. Documents shall be clearly indexed for ease of reference.

1.10.4   Operating and maintenance instructions may be designed to be read in conjunction with 'As Installed' drawings and shall include the following:

a)   BEMS design philosophy.

b)   A general description of the scope, purpose and manner of control of each system and plant connected to the BEMS.

c)   Control strategy including diagrams.

d)   Instructions for switching on, operating, switching off and isolation.

e)   Instructions for dealing with fault diagnosis and remedial action.

f)   Precautionary measures necessary for ensuring health and safety and avoidance of misuse.

g)   Points list (all analogue and digital inputs and outputs).

h)   Details of set points, alarm levels, time schedules, overload settings.

i)   Central station software manual.

j)   Specifications for sensors and activators.

k)   Software back-up copies.

l)   Emergency procedures.

m)   Names and addresses of suppliers of all major components, including details of type and model reference, serial number, duty rating, order number and date of purchase.

n)   Spare parts lists for consumable items.

o)   Software revision number for each program.

p)   Maintenance schedules and other information to maintain equipment in accordance with the manufacturers recommendations.

q)   Commissioning data.

r)   Handover/acceptance documentation.

s)   Logbook – to record incidents, operational information and changes made to the system.

1.11   ELECTRICITY SUPPLY

1.11.1   The equipment supplied shall be suitable for operation on the site power supply and the supply voltage and frequency tolerances permitted by the Electricity Supply Regulations 1991 (as amended).

1.12   ELECTRICAL EQUIPMENT AND WIRING

1.12.1   Bonding of all extraneous conductive parts of the installation (including metallic pipework, insulation cladding etc.) shall be carried out in accordance with BS 7671 Requirements for electrical installations and BS 7430 Code of Practice for earthing.

1.13   STORAGE AND PROTECTION

1.13.1   All materials and equipment items shall be properly stored, as required by manufacturers' instructions where applicable. Particular care shall be taken to ensure that electrical equipment and components are kept dry and free from dust.

1.14   RATIONALISATION OF SUPPLIES

1.14.1   Items, fittings and accessories to be used in quantity shall, where practicable, be the product of one manufacturer and shall be used only for the purpose recommended by that manufacturer.

1.14.2   Where practicable, all equipment, components, and associated spares shall be generally available.

1.15   SAMPLES

1.15.1   The Contractor shall, as requested and prior to placing orders, provide samples for inspection by the PM.   The samples shall be as indicated by the PM.

1.16   SCHEDULES

1.16.1   Schedule No. 1 to this Specification gives information to tenderers relating to the clauses where options or specific numbers etc require stating.

1.16.2   Schedule No. 2 to this Specification is for tenderers to complete and return as part of their tenders.

2   Section Two - System

2.1   SCOPE

2.1.1   This part of the Specification covers the features of a BEMS that can be evaluated and tested prior to installation and which are independent of any installation characteristics. It describes the intrinsic requirements for operator stations, controllers, network communications, sensors and detectors. Requirements for documentation and warranties are detailed in Section Three – Installation.

2.1.2   Installation

2.1.2.1   The Standard Specification must be read with and may be modified by, other documents contributing to the full Project Specification.

2.1.2.2   The Specifier shall list in the Particular Specification the exclusion of Standard Specification clauses which are not required for the implementation of the BEMS.

2.1.2.3   The Tenderer shall seek clarification from the Specifier where Standard Specification clauses are retained but do not correspond to the requirements and functions of the BEMS expressed in the Particular Specification.

2.2   GENERAL

2.2.1   Response Times

2.2.1.1   The response times detailed below are the maximum acceptable response times for hard wired systems (These response times are not applicable to installations including modems or locations which are not hard wired. Response times for such locations shall be reasonable).

i)   **Alarms**

The time for activation of an alarm (at the source) to annunciation on an operator's station shall not exceed 5 seconds.

ii)   **Graphic Displays**

A graphic display shall be displayed complete with updated information from the field for all points, within 15 seconds of the operator request.

Once displayed, all point information will be updated from the field and displayed at intervals not exceeding 30 seconds.

iii)   **Logical Groups**

A logical group shall be displayed complete with updated information from the field for all points within 10 seconds of the operator's request. Once displayed the value shall be refreshed every 10 seconds.

iv)   **Selected Points**

The field value of a single input, output or virtual point shall be displayed on the operator's station screen within 3 seconds of a request.

v)   **Global Programme**

The time from occurrence of an event from one controller or unitary controller to the activation of the output of another controller or unitary controller shall not exceed 10 seconds.

2.2.2   Power Failure Restoration or Normal Mode Following a Fire or Fire Test

2.2.2.1   Full recovery from any of these conditions shall be automatic and a return to normal indication reported on the operator's station unless otherwise indicated. All plant shall be sequentially started on a controller-by-controller basis, with suitable time delays between the starting of each item of plant over 5kW.

2.2.2.2   The main incoming switch disconnector or fuse-switch combination unit shall be monitored for its open status via an auxiliary contact. The purpose of this is to cancel mismatch alarms when the main switch disconnector or fuse-switch combination unit is switched off.   If there are two or more controllers in a motor control centre, the auxiliary contact shall be wired to each controller or, alternatively, the auxiliary contact shall be wired to one controller and the status conveyed to other controllers via the communication network.

2.2.3   Transient/Spike Protection

2.2.3.1   All microprocessor based controllers and other electronic equipment such as unitary controllers, personal computers, peripheral equipment and communications equipment, must be capable of withstanding transient disturbances from the input power supply. Protective devices shall comply with BS EN 60099 Surge arrestors.

2.2.3.2   Suppressors shall be fitted to all controller input and output points for protection against voltage transients, spikes etc.

2.2.3.3   The controllers communication network(s) shall be isolated against transient disturbances via optical couplers or other approved means. Where running between buildings, lightning protection devices shall be installed on the communications network at the point of entry to each building in accordance with BS 6651 Code of practice for protection of structures against lightning.

2.3   OPERATOR STATION

2.3.1   Description

2.3.1.1   The BEMS shall include the number of operator stations specified. Each of these facilities will include a computer processor, data storage, keyboard and display, possibly in the form of a personal computer, and other peripherals as specified.

2.3.1.2   The function of each Operator Station shall be as detailed in the Particular Specification.

2.3.2   Operation

2.3.2.1   The operator's station basic purpose is to display and format data and enable manual control functions (e.g. set point and program changes) to be performed in a user friendly manner. Operator's stations shall take no part in any plant or global control functions. Operator's stations shall not be used to transfer data between controllers on the communications network.

2.3.2.2   The software for carrying out the various detailed requirements of the Particular Specification shall be backed up at the operator's station irrespective of whether the routines are normally held and operated from a controller or unitary controller. The operator's station shall have the ability to upload and download controller configuration data via the communications network.

2.3.2.3   Where detailed within the Particular Specification the operator's station shall be configured to automatically attain full functional status following switch-on or restoration of power supply.

2.3.2.4   When a controller suffers a loss of memory, which is then detected by the operator's station, the operator's station shall automatically download all relevant stored configuration data to the controller. This feature shall be selectable on a controller by controller basis.

2.3.2.5   When a controller's software is modified locally, so that the controller software differs to that stored in the operator's station, an alarm shall be raised at the operator's station to indicate the discrepancy. Uploading the new configuration data from the controller shall be a manual, not an automatic operation.

2.3.2.6   Each operator's station shall have a real time clock which shall not be affected by power failure and which shall be synchronised with all other real time clocks on other operator's stations, controllers and unitary controllers, whenever a controller is brought back on line. All real time clocks shall also be synchronised on a daily basis with a nominated operator station as detailed in the Particular Specification. Real time clocks shall contain the necessary firmware to operate unaided until January 2050.

2.3.2.7   The operator's station shall be provided with a removable media back-up facility of suitable size, with a minimum of seven storage media units to allow daily back-up to be repeated on a weekly basis. Failure during back-up will therefore not lose all data. The backup facility shall be fully automatic, on a specified time basis, with the ability to manually backup the system. It shall be possible to load selected files from this storage facility on to the operator's station.

2.3.2.8   Each operator's station shall contain sufficient hard disk capacity for all database and software requirements described within the Particular Specification plus sufficient hard disk capacity for all graphic displays, historical records and trends as described below:

Graphic Displays   300 screens (no matter what complexity)

Historical Records 500,000 events

Trends   10,000,000 samples

2.3.2.9   All programming such as alarm inhibition, sequence interlocking, addition and deletion of points, etc., shall be through the operator's station (or a laptop computer if detailed in the Particular Specification).

2.3.3   Operator Actions

2.3.3.1   The functions available to suitably authorised operators shall be as specified but to include as a minimum the following:

a)   Acknowledge alarms, including muting of audible or flashing annunciators.

b)   Add to or delete points from the system.

c)   Inhibit alarms for reasons of time and/or priority as selected by the operator.

d)   Alter the limits at which the measured values cause alarms to be signalled.

e)   Alter plant "run" status on command from the keyboard.

f)   Re-schedule plant operation times from the keyboard. It shall be possible to apply such re-scheduling globally to a number of items of plant at one or more sites as selected by the operator.

g)   Adjust and synchronise all real time clocks on BEMS.

h)   Prepare a calendar for plant operation.

i)   Alter plant control parameters on command from the keyboard (e.g. increase temperature set point).

j)   Obtain and display data from the BEMS, including controllers, on command or at time intervals selected by the operator.

k)   Set up central facility and controller logging procedures.

l)   Archive and/or delete logged data.

m)   Reset counters from pulsed input signals.

n)   Reset limits or zero the count of run-time totalisation.

2.3.4   Operational Safety

2.3.4.1   Where an item of plant or equipment has been manually isolated locally, for safety reasons, it shall not be possible to change the plant or equipment to a fully operating state by use of the BEMS.

2.3.5   Data Handling

2.3.5.1   The operator station shall be equipped for continuous access to the operating parameters and logged data of the BEMS.

2.3.5.2   Operator stations shall incorporate a data storage management system which warns against impending on-line storage overflow and allows for data archiving to, and retrieval from the removable media back-up facility. The data management system should prompt the operator at pre-defined intervals to carry out the data archiving procedure.

2.3.5.3   Where detailed in the Particular Specification there shall be a facility to extract data in a fully defined manner so that it can be accessed by software supplied by others and

exported to other computer systems.

2.3.6   Colour Graphic Displays

2.3.6.1   In the graphics mode, the operator's station shall provide a minimum sixteen colour graphic capability. The colour graphics shall incorporate automatic updating of real time field data. Full alphanumerics shall spell out in plain English any current condition, value, or action.

2.3.6.2   Each graphic shall incorporate up to 40 freely assigned, connected or calculated points and shall be stored on the operator's station's hard disk ready to be displayed.

2.3.6.3   Graphics and all related dynamic data display points shall be mouse and/or keyboard programmable without interfering with the on-line operation of the system. They shall be easily developed, using a drawing package and library of standard symbols representing devices such as coils, smoke sensors, temperature sensors, thermal sensors, door contacts, pumps, fans, dampers, motors and similar items. The standard symbols library shall be augmented by user defined symbols at any time. Once defined, these symbols shall be able to be added to the standard symbols library. Editing features for adding, deleting and modifying data, as well as format controls, shall be provided. Access to the colour graphics features shall be controlled so that only designated operators can display or modify files.

2.3.6.4   Each and every input, output and calculated BEMS point shall be placed on an associated graphic display. Each and every system shall be provided with a separate graphic display comprising an overview screen and an engineering screen. These displays shall be linked as described below.

2.3.6.5   It shall be possible to interrogate each item of plant or system by graphic penetration. That is, all graphics shall be constructed in levels as follows:

Level 1 -   Graphic detailing site overview
Level 2 -   Graphic detailing building/block
             overview
Level 3 -   Graphic detailing system on each
             floor/within each plantroom
Level 4 -   Graphic for a general system
overview
Level 5 -   Graphic detailing system
             engineering parameters
Level 6 -   Graphic displaying system
             strategy diagram or flow chart
Level 7 -   Empty user definable graphic
screen.

2.3.6.6   The system software shall accept up to 10 levels of graphics. Changing from one graphic to another graphic shall be by the use of 'click' boxes on the graphics.

2.3.6.7   Graphical representation of plant i.e. schematics shall be two-dimensional in representation.

2.3.6.8   Level 4 graphic screen shall comprise as a minimum the following:

a)   Plant status (e.g. fan, pump, boiler, etc.).

b)   Measured values (e.g. temperature, humidity, static pressure, etc.).

c)   Output values (e.g. valve and damper position etc.).

d)   Alarms and resets.

e)   Plant command (on/off/auto).

f)   Plant command status (e.g. optimum start, fixed time start, boost, night low temperature cycle, manual, etc.).

g)   Critical overrides (e.g. fire shutdown, first stage frost, second stage frost shutdown, etc.).

h)   Associated graphics 'click' boxes.

2.3.6.9   Outside air temperature and humidity shall appear on all level 4 system graphics.

2.3.6.10   Level 5 graphic screen shall comprise as a minimum the following:

a)   Setpoints/schedules.

b)   Optimum start/fixed time programme settings.

c)   Control loop parameters.

d)   Plant run time status.

e)   Normal overrides (e.g. primary heating loop temperature, enthalpy, standby power shutdown).

f)   Associated graphics 'click' boxes.

2.3.6.11   Should a graphic be too large to place on a single display, it shall be segmented and each portion placed on separate graphics joined by 'click' boxes.

2.3.6.12   All set points defined in the Particular Specification shall be able to be modified via the graphics display.

2.3.6.13   It shall be possible to manually override (force) on/off each system via the applicable graphic screen. Indication shall be provided on a graphic when a system has been manually overridden. (See also 2.3.4 Operational Safety).

2.3.6.14   Point and controller status information shall only appear on the screen when the controller has confirmed back to the operator's station that the command has been executed. Where identified in the Particular Specification, this shall be by positive feedback that the desired effect has been achieved.

2.3.6.15   The colour of each point/symbol on a graphic display shall represent a different condition associated with the point/symbol. The exact colour will vary with different BEMS systems, however the colours detailed below are preferable. The conditions of each point below are minimum requirements.

a)   Healthy on (running)   Green
b)   Healthy off (stopped)   White
c)   Failed/alarm (unacknowledged) Red
                                    (flashing)

d)   Failed/alarm (acknowledged)   Red

                                    (steady)
e)   Override on (forced on)   Blue
f)   Override off (forced off)   Magenta
g)   Loss of communication   Yellow

2.3.6.16   The background colour chosen shall enhance the graphic display and not obscure any on screen data.

2.3.6.17   Colours chosen for periphery requirements e.g. pipework, ductwork, labelling etc, shall be agreed.

2.3.6.18   Plant and field equipment references (tags) used in the Particular Specification shall be included on all level 4 and 5 graphic screens.

2.3.6.19   In addition to those graphics mentioned previously, the following shall also be provided on separate graphics.

a)   All MCCs and BEMS control panels detailing their number and location.

b)   The BEMS network and items of intelligent BEMS equipment complete with addresses and locations.

2.3.6.20   All colour graphic displays shall be submitted to the PM for comment. Adequate time (8 weeks minimum) shall be allowed for this process, prior to commissioning on site.

2.3.7   Alarm Processing

2.3.7.1   Alarms shall be classified by their alarm type. The facility shall be provided for enabling and disabling each individual alarm on the system.

2.3.7.2   Once generated, the alarm shall be processed by its associated alarm type as defined.
The alarm types shall be as follows:

Type 1   -   General Mismatch
Type 2   -   Critical Mismatch
Type 3   -   General Digital
Type 4   -   General Analogue
Type 5   -   Critical Digital
Type 6   -   Critical Analogue.

Mismatch: The alarm is associated with an output command point and an input giving status feedback of the output command. The alarm is generated when the status feedback does not correspond with the output command status for longer than a defined time delay period.

Digital: The alarm is associated directly with an external volt free contact (i.e. a digital input). The alarm may be generated by transitions from either open to closed status, closed to open status, or any change of state. A time delay shall be associated with the alarm such that the alarm does not occur until the required alarm state has existed for longer than the delay period.

Analogue: The alarm is associated directly with an analogue input. The alarm is generated by the BEMS due to a measured variable exceeding specified limits. It shall be possible to define the limits in two ways:

a)   Fixed limits:

     The point has fixed upper and lower alarm limits. If the measured variable rises above the upper limit, or falls below the lower limit, then an alarm is generated e.g. high alarm limit = 30ºC, low alarm limit = 8ºC

b)   Floating limits:

     The point has an associated setpoint, and

an alarm is generated when the measured variable deviates either above or below the setpoint by more than a given alarm limit value. If the setpoint is changed, the alarm limits are automatically moved to suit, e.g. setpoint = 21ºC, alarm limits = Setpoint ± 2°C.

2.3.7.3   The above alarm limits shall have associated hysteresis bands to avoid nuisance alarming. A time delay shall be associated with the alarm such that the alarm does not occur until the required alarm state has existed for longer than the delay period.

2.3.7.4   The operator's station display shall have a dedicated area at the top or bottom of the screen for use as an alarm banner. The alarm banner shall display, as a minimum, the two latest unacknowledged alarms at the top of the current alarm list. Alarms shall be entered into the list according to their type and event order, with the most recent alarm being at the top of the list.   As new alarm events occur, the list shall be sorted to keep the list in the desired order.

2.3.7.5   On occurrence, all alarms shall be put in the alarm list and the relevant alarm message printed out on the operator's station(s) alarm printer(s). In addition, the following actions shall be taken dependant upon the alarm type.

Critical Alarms:

a)   The alarm printout shall be in bold text to clearly differentiate it from general or maintenance alarms.

b)   The banner alarm message display shall be differentiated by means of text size or colour from general alarms.

c)   Shall generate an audible alarm at the operator's station.

d)   Shall have the ability to bring up an associated alarm graphic or text screen at the operator's station.

General Alarms:

a)   Shall generate a banner alarm message.

b)   Shall generate an audible alarm at the operator's station.

c)   Shall have the ability to bring up an associated alarm graphic or text screen at

the operator's station.

2.3.7.6   It shall be possible, at the highest operator password level, to enable and disable the audible alarm feature of the operator's station. Where such an alarm has been disabled, a visible reminder message to this effect shall be displayed on the screen at the frequency stated in the Particular Specification. In addition a keyboard facility to mute the audible alarm shall be provided. An alarm that has been muted if not acknowledged within a user specified time shall be re-annunciated.

2.3.7.7   Alarms shall remain active until acknowledged by an operator logged on with the appropriate password level, even if the alarm has physically cleared. Upon acknowledgement, the alarm shall be moved to the appropriate place in the alarm list, the alarm banner shall be updated as necessary and an alarm acknowledgement message sent to the printer(s) which shall include the time, date and operator's identity. An acknowledgement message at a given printer shall be in the language/characters selected for that printer.

2.3.7.8   When an alarm is acknowledged, the audible alarm, if enabled, shall be muted unless another unacknowledged critical or general alarm exists on the system.

2.3.7.9   It shall be possible to acknowledge alarms on both an individual and group basis.

2.3.7.10   Upon clearance of an alarm, a clearance message shall be sent to the printer, which shall include the time and date. If the alarm has been previously acknowledged, it shall be removed from the alarm list.

2.3.7.11   All alarm events shall be included in the historical data program.

2.3.7.12   It shall be possible to view or print the contents of the alarm list in historical order, using the following selection criteria:

(i)   All alarms in the alarm list.
(ii)   Critical alarms only.
(iii) General alarms only.
(iv)   Acknowledged alarms only.
(v)   Selection of alarms associated with an individual drive or plant only.

2.3.7.13   The alarm processing system shall provide for:

a)   Alarm processing and if necessary allow annunciation of alarms to take precedence over other activities.

b) Distinction between active alarms whose
    condition is not yet cleared and
    unacknowledged alarms.

c) An alarm review facility.

d) Storage of alarm data together with other
    logged data as indicated above in order that
    alarms can be analysed together with other
    data either by the BEMS integral software
    or by other software.

e) Alarm data should include:

    condition identity
    condition value
    alarm source
    alarm time and date
    acknowledgement status

2.3.8   Alarm Inhibition

2.3.8.1   Consequential alarm suppression
algorithms shall be provided to limit the alarms
annunciated on the BEMS to those associated
with the source of the initial alarm condition
e.g. boiler lockout shall not initiate flow and
return water temperature alarms, fire alarms
shall not initiate mismatch alarms, restoration
of power following a power failure shall not
initiate mismatch alarms etc.

2.3.8.2   Analogue alarms associated with plant
shall be inhibited when the plant is commanded
off by the BEMS unless otherwise stated in the
Particular Specification.

2.3.9   Information Redirection and Alarm Transfer

2.3.9.1   It shall be possible to transfer alarms
from the normal operator station to an
alternative operator station (e.g. from the
central station to the Security Guardroom).
When this transfer takes place, only the alarms
identified in the Particular Specification shall be
raised.

2.3.9.2   Where indicated in the Particular
Specification each alarm raised at the
alternative operator station shall have a text
message describing the action to be taken.

2.3.9.3   It shall be possible for the system to
redirect information to other (e.g. future)
operator stations and/or printers on a time
schedule basis (including holiday programming)
or manual command basis. For example, all

alarms may be re-directed from the BEMS
alarm printer to the security room alarm
printer, after normal work hours.

2.3.10   Programming

2.3.10.1 The system shall have the facility for
the user to write his own programs.
Programming shall be performed via an
operator's station or portable computer.

2.3.10.2 It is essential that programming is
user friendly and does not require the services
of a specialist software programmer.

2.3.10.3 Full allowance shall be made for
complete programming of the system to achieve
all functions described in the Particular
Specification.

2.3.10.4 The Contractor shall be responsible for
setting up the software parameters for each
process loop, including the setting of the
proportional bands, integral times and
derivative rates, which shall all be site
adjustable and recorded in appropriate
engineering units.   All settings shall be such
that each process loop performs within the
required tolerances and that there is no hunting
(cycling) of final control elements.

2.3.10.5 Unless the Contractor specifically
states to the contrary in the Tender, it shall be
deemed that the Contractor has given the
following undertakings:

a) Ownership of application software shall be
    retained by the Client who requires
    unrestricted access to carry out
    modifications and adjustment to
    programmes as necessary.

b) The Tender price is deemed to include all
    royalties and other ownership fees payable
    for software.

c) There shall be no agreements of any kind
    preventing the Client's staff from modifying
    programs themselves, after Practical
    Completion.

2.3.11   Monitoring and Targeting

2.3.11.1 The system shall be capable of utility
monitoring and targeting, waste minimisation
and utility accounting in a single program.

2.3.11.2 The monitoring and targeting
application shall be capable of operating on the
BEMS central operator station, or other
nominated operator station, with no detriment

to the normal operation of the BEMS, and
allowing nominated alarms to be displayed when
the monitoring and targeting application is in
use.

2.3.11.3 Access to the monitoring and targeting
application shall be by use of a password, as set
out in 2.6.5 Password Access.

2.3.11.4 The application shall support the
following levels of data entry or data acquisition:

a)   Manually typed-in values.
b)   Hand-held data acquisition device.
c)   Manual data entry of invoice data.
d)   File importation.
e)   Dynamic data exchange.

2.3.11.5 Data entry prior to being committed to
permanent storage shall have a facility for the
following error checking:

a)   reading too high.
b)   reading too low.
c)   reading less than previous reading
      (incremental meters).
d)   too many digits in reading.
e)   date of data entry invalid (data already
      exists).

2.3.11.6 The system operator shall be able to
over-ride calculated data, for example, where a
meter was out of service.

2.3.11.7 The application shall support the
archiving of historical data to remove it from
the active databases, and its replacement.

2.3.11.8 The application shall support a
hierarchy of information levels, for example
comprising site; building; department; energy
accountable centre; cost centre; meters. The
levels shall be capable of being summated from
one level to the next.

2.3.11.9 The application shall allow energy
targets to be established using recognised
procedures.

2.3.11.10 The application shall provide an
exception reporting model.

2.3.11.11 The application shall provide report
and graph design capabilities including the
linking of external databases.

2.3.11.12   The application shall provide full
integration with the BEMS allowing data-import
routines to acquire data from the BEMS.

2.3.11.13 The Contractor shall initially
configure the monitoring and targeting system
including the report format and graphical data
presentation, in conjunction with the client, and
demonstrate the fundamentals of the package to
the system operator.

2.3.12   Equipment – Operator Station

General

2.3.12.1 The Operator Station shall comprise a
personal computer, complete with monitor,
keyboard and mouse. The Operator Station
shall include a printer.

2.3.12.2 The Operating system shall support
integral memory management and self test
diagnostic routines.

2.3.12.3 The Tenderer shall state in Schedule 2
the specification of components to be provided
for each Operator Station.

Monitor

2.3.12.4 Each Operator Station shall be
supplied with a high resolution colour graphic
monitor with a minimum resolution of 1024 x
768 pixels. The monitor shall comply with the
latest international standards for
electromagnetic emissions. The monitor and
graphic card combination shall be capable of a
screen refresh rate greater than 72Hz (non-
interlaced) for all screen resolutions used by the
system.

2.3.12.5 The dimensions of the visible viewing
area shall be as stated in the Particular
Specification. A text only display shall consist of
80 characters per line with 25 lines.

Keyboard

2.3.12.6 The keyboard shall be a 101/102
Enhanced QWERTY keyboard with full
upper/lower case ASCII key-set, a numeric key
pad, and dedicated cursor control key pad.

Printers

Dot Matrix:

2.3.12.7 Each operator's station on the BEMS
shall be capable of supporting a dot matrix
printer.

The printer shall:

a)   Not hinder the operation of the BEMS.
      Where this occurs, sufficient buffer

memory shall be provided to overcome this.

b)   Have push-button selection of printing quality. The printer shall be able to produce draft quality and letter or near letter quality text.

c)   Have a 132 column format capability.

d)   Be capable of using both continuous and single sheet stationery.

e)   Be capable of supporting all such functions as enlarged, double width, double height and reduced size text available on all software installed on the BEMS operator's station.

2.3.12.8 Any printer specified for fire and security alarms only, shall be of the two colour type – fire alarms red, security alarms black.

Laser:

2.3.12.9 Each operator's station on the BEMS shall be capable of supporting a laser printer.

The printer shall:

a)   Have a resolution of 600 dots per inch (dpi).

b)   Have a paper tray capable of holding at least 100 pages.

c)   Have a manual paper feed capability and be capable of accepting smaller than A4 items of stationery e.g. envelopes.

d)   Have a minimum printing speed of 12 full pages of text per minute.

e)   Have a cartridge toner system which shall be simple to remove and replace.

f)   Be compatible with printer drivers supplied with the BEMS operator's station.

Ink Jet:

2.3.12.10 Each operator's station on the BEMS shall be capable of supporting a colour ink jet printer. Where specified, ink jet printers shall be used to copy any required graphic screens together with all dynamic data, graphical trend log displays and support "Print Only" functions as required.

The printer shall:

a)   Have a minimum of 16 colours.

b)   Have a minimum printing speed of 4 full black and white graphic pages per minute.

c)   Have a minimum printing speed of 1 full colour graphic page per minute.

d)   Have a cassette ink system, so that ink renewal is a simple operation.

e)   Produce a true copy of the graphic display i.e. have a true to life aspect ratio.

Environment

2.3.12.11 All equipment associated with the BEMS operator station shall be capable of operation in the following conditions without detriment:

a)   Temperature   0 - 45ºC

b)   Relative humidity 0 – 95% RH (non-condensing).

2.4   CONTROLLERS

2.4.1   Description

2.4.1.1   Controllers are real time, programmable/ configurable devices which control and/or monitor plant and/or environmental conditions via actuators and sensors. This definition may include both general purpose controllers and unitary or dedicated controllers.

2.4.1.2   The BEMS shall comprise the number of controllers necessary to meet the Particular Specification.

2.4.1.3   Controllers shall be complete with power supplies, a real time clock, input and output modules, memory, processors and all other items necessary for proper and correct interfacing and operation of the control functions described in the Particular Specification.

2.4.2   Communication

2.4.2.1   All controllers shall have peer to peer communications.

2.4.3   Stand Alone Operation

2.4.3.1   All controllers shall have a stand alone capability such that a failure of the operator's station shall still permit the plant and controls associated with the controllers to continue to operate normally, with the controllers

continuing to communicate with one another.

2.4.3.2   In the event of transmission failure in the controllers network, the controllers shall continue to operate with all sequence interlocks and control strategies operating normally excepting those which require global information. Either user adjustable default values or the last sensed value (user selectable) shall then be assumed for these global parameters.

2.4.4   Configuration

2.4.4.1   Configuration data shall be stored in the controllers or the unitary controllers. Configuration data shall include but not be limited to the following:

a)   The engineering unit applicable (ºC, kPa, m³/s etc.)

b)   The point identifier (minimum of 12 characters).

c)   The point alarm message if applicable (minimum of 80 characters).

d)   The point descriptor (minimum of 32 characters).

e)   Other miscellaneous information necessary for the correct operation of the entire BEMS (e.g. trending run hours, accumulation, access levels etc.)

2.4.4.2   All configuration data shall be displayed in alphanumeric characters. Configuration shall include, but not be limited to, the following:

a)   All system peripherals and remote controllers.

b)   System inputs and outputs (binary and analogue).

c)   System alarms.

d)   System calculation results (e.g. efficiency values).

e)   System parameters and timers.

f)   System program (e.g. event initiated program).

g)   System points received via a data interface.

2.4.4.3   All configuration data shall be capable of modification as required by the Client after

the system has been deemed Practically Complete.

2.4.4.4   Once configured, points shall then be assigned to colour graphic displays and/or logical groups.

2.4.5   Status Information

2.4.5.1   Controllers shall be able to provide the operator's station with status information concerning their internal operations. This information shall include, but not be limited to:

a)   Data transmission and verification.

b)   Input/output point status (i.e. sensor fault, point forced, etc.)

c)   Program status (i.e. program error, program running, etc.)

d)   Internal battery condition.

2.4.5.2   All necessary interfacing equipment shall be provided so that the controllers are fully compatible with all items of plant and equipment.

2.4.5.3   The controller shall be capable of accepting digital, analogue, pulsed inputs and providing digital and analogue outputs.

Digital input

Shall monitor the change of state of a volt free contact.

Pulsed input

Pulses (voltage-free contact closures, i.e. digital type input) originating typically from flow meters, electrical kWh or kVA meters, etc. and shall be accumulated into registers. A register shall be resettable to zero either by software or operator command. The input must be able to accept pulses up to a frequency of 10Hz with a minimum duration of 50ms. All counts must be stored in a non-volatile register so the count value is not affected by a power failure.

Digital output

The output signal, a voltage free contact which shall close upon energisation of the output. Should digital outputs be used to drive modulating actuators, other than for terminal unit applications, a potentiometer shall be fitted to the actuator and connected to the BEMS to provide actuator position feedback. The controller shall use this feedback to ensure the

accuracy of positioning of the actuator.

Analogue inputs

Analogue to digital conversion (ADC) with a minimum resolution of 1024 counts (10 Bit) over the input range (i.e. 0-10V, 2-10V, 0-20mA, 4-20mA etc.) of the sensor. The sensor range shall match the process control range.   Any equipment necessary for the conversion of an input signal to the required input level shall be provided.

Analogue outputs

Digital to analogue conversion (DAC) shall be performed by the controllers with a minimum resolution of 256 counts (8 Bit) over the output range which shall also match the control range of the device and/or system being controlled. Any equipment necessary for the conversion of the output signal to the required process level (i.e. 0-10V, 2-10V, 0-20mA, 4-20mA etc.) shall be provided.

Where analogue outputs are specified for driving damper and valve actuators, they shall not be used to drive, raise or lower actuators through interface devices.

Universal inputs

Shall be configurable to either digital or analogue input and shall have the features defined above.

2.4.5.4   Each analogue input shall be calibrated (to compensate for non-linear characteristics of input devices, line resistance and similar items) to achieve an accuracy of the displayed value on the operator's station, as detailed in the Particular Specification for each sensing device. Calibration and scaling data shall be retained in the controller memory. Open or closed circuits on sensor inputs shall be recognised by the controller and annunciated as alarms on the system operator's station(s).

2.4.5.5   It shall be possible to characterise each analogue output to an actuator in order to obtain a near-linear response from the device the actuator is controlling.   This may take the form of a look up table with a minimum of six co-ordinates, such as the linear output from a control loop is converted into a non-linear control signal to the actuator.

2.4.6   Power Supply

2.4.6.1   Controllers shall be suitable for operation on the site power supply and the supply voltages and frequency tolerances permitted by the Electricity Supply Regulations.

2.4.7   Interruption of Electrical Power Supply

2.4.7.1   Each controller shall be provided with its own internal back up supply, capable of maintaining all memory including the real time clock for not less than 72 hours continuous generation. If the back up supply is by use of a battery, then the battery shall be easily replaceable, i.e. not soldered to the PCB.

2.4.7.2   On restoration of the electrical power supply, the controller shall automatically return to normal action as specified in the Particular Specification. Failure to return to normal action shall cause an alarm to be reported at the central operator station.

2.4.8   Self Testing

2.4.8.1   The system shall monitor the operational status of controllers.   On failure of a controller an alarm will be signalled to the central operator station.

2.4.8.2   On detecting a fault, the plant or devices under the control of the controller shall be set to pre-determined condition established by the Contractor or as specified in the Particular Specification and the execution halted of any programme or event dependent on the condition.   Execution shall recommence according to criteria established by the Contractor or the Particular Specification when the fault is cleared.

2.4.9   Data Gathering and Storage

2.4.9.1   Controller interfaces shall be appropriate for gathering data from sensors and devices provided by the Contractor or listed in the Particular Specification. All interface units required to comply with the Particular Specification are to be included. Unless otherwise stated the following interface characteristics will apply to existing plant and equipment:

a)   Analogue Input.   As variable currents (4-20mA), variable voltages (0-10V) or variable resistances.

b)   Binary Inputs.   As derived from "Volt Free" contacts in field equipment switching a voltage applied to the circuit from the controller (max 24 volts/20mA). The

interface shall be selected to monitor a normally open or normally closed circuit.

c) Pulsed Input. As derived from "Volt Free" contacts in field equipment switching a voltage applied to the circuit from the controller (max 24 volts/20mA) at a pulse frequency of up to 10Hz.

2.4.9.2   All inputs shall be scanned periodically at not more than 2 second intervals.

2.4.9.3   All inputs should be protected against spurious out of range signals including those caused by contact noise or "bounce".

2.4.9.4   Errors introduced by the analogue to digital conversion of field signals shall not exceed 0.5% of the operating range of the field device.

2.4.9.5   The central station operator shall be able to select the points to be logged by the system.

2.4.9.6   The total number of logging channels available for each controller shall not be less than 20% of the total physical points on that controller.

2.4.9.7   The controller memory shall be sufficient to log the equivalent of 5 days data at 15 minute intervals for 20% of the total number of physical points on the controller.

2.4.9.8   Logging memory shall be flexibly allocated to the points selected for logging by the operator, including "soft" or "virtual" points.

2.4.9.9   When a log is set up, the following shall be allowed for:

a) An error indication if the maximum logging channels are exceeded.

b) The ability to specify the frequency and duration for which each data value is to be stored.

2.4.9.10   Each logged value shall be associated with its point reference, unit of measurement, the date and time measured and, if specified, the initiating status value.

2.4.10   Controls Signals to Field Devices

2.4.10.1 Controller interfaces shall be appropriate for providing control of signals to actuators and devices provided by the Contractor or listed in the Particular Specification.

2.4.10.2 Unless otherwise stated the following interface characteristics shall apply to existing plant and equipment:

a) Analogue Output. As variable currents (4-20mA) or as variable voltages (0-10V).

b) Binary Output. Shall be selectable as "normally closed" or "normally open" at the controller. The Tenderer shall state the maximum voltage and current rating of the binary outputs.

c) Pulse Output. Continuously variable control for actuators should be available in the form of pulsed signals.

2.4.10.3 Conversion of digital data to analogue form shall be within an error tolerance of 0.5% of the digital value.

2.4.11   Environment

2.4.11.1 Controllers shall be suitable for operating normally within the following environmental ranges:

Temperature   0 - 45ºC
Relative humidity   0 - 95% (non condensing)

Protective devices shall be installed when conditions are expected to fall below dew point.

2.4.11.2 The equipment shall operate normally in the electrical environment associated with building services plant room areas.

2.4.11.3 The equipment shall be suitably protected against the effects of moisture, dust and dirt in the environment when and where it will be installed.

2.4.12   Construction

2.4.12.1 When not installed inside MCCs, controllers shall be enclosed in lightweight wall mounted enclosures. These enclosures shall be constructed to IP51 Degree of Protection in accordance with DIN 40 050. The enclosures shall be provided with a key-lock, and all locks shall use the same key numbers.

2.4.12.2 The controllers shall be constructed so that the cabinets and internal terminal strips can be mounted, and electrical terminations made, with all electronics being added at a later date during the testing and commissioning phases.

2.4.13   Terminations

2.4.13.1 Where practicable it should be possible to replace circuit boards in controllers without disconnecting field wiring from terminals.

2.4.13.2 Terminals of the screw down clamp type fixed to purpose made mountings shall be used.

2.4.13.3 Groups of terminals carrying different voltages shall be segregated in accordance with BS 7671 Requirements for Electrical Installations.

2.4.14   Controllers – Spare Capacity

2.4.14.1 Each controller or controller location shall be provided with spare hardware capacity for future additions of at least 20% of each type of point. Universal inputs may be counted as either a spare digital or analogue point, but not both.   Note that this spare capacity may be accomplished by the addition of input/output modules. Memory shall also be sufficient to allow all programmes associated with these points to be run in the controller.   The Tenderer shall state in his tender how many spare points are actually available on each controller or at each controller location and the expansion capability.

2.4.15   Remote Portable Terminals

Remote Panel Facia Mounted Touch Pad/Display Panel

2.4.15.1 Touch pad/display panels (liquid crystal) shall be password protected and shall provide setpoint adjustment, plant command, system monitoring and alarm interrogation and acknowledgement facilities.

Hand Held Terminal

2.4.15.2 A hand held terminal shall incorporate a keypad and liquid crystal display, shall be password protected and shall provide setpoint adjustment, plant command, system monitoring, alarm interrogation and acknowledgement facilities. The hand held terminal shall be plugged into any controller or unitary controller throughout the system and once connected shall be able to access all control devices on the associated network.

2.4.16   Laptop Computer

2.4.16.1 A laptop computer shall be used to interrogate and program controllers where stated in the Particular Specification.

2.4.16.2 The computer shall be supplied with all necessary software to allow for local interrogation and programming, whether it be a copy of the head-end software, a dedicated programming/ interrogation program or else a terminal emulation program. This software shall be password protected.

2.4.16.3 The computer shall be plugged into any controller or unitary controller throughout the system and once connected shall be able to access all control devices on the associated network.

2.4.17   Uninterruptable Power Supply

2.4.17.1 Operator Stations and controllers as listed in the Particular Specification shall be provided with uninterruptable power supplies (UPS).

2.4.17.2 Operation of UPS shall be such that in the event of mains failure the equipment supported shall not power down and reboot.

2.4.17.3 A UPS shall be capable of maintaining, in a fully functional mode, its associated devices for a period of 20 minutes at all times throughout the design life of the installation.

2.4.17.4 The UPS shall have sealed batteries and include volt free contacts for connection to the BEMS for monitoring of the following conditions:

a)   Battery low level.

b)   Charger fault.

2.5   CONTROLLER PROGRAMMING

2.5.1   General

2.5.1.1   This sub-section describes the minimum requirements for standard monitoring and control routines and algorithms which may need to be present in one or more BEMS controllers in order to meet the requirements of the Particular Specification and Schedules.

2.5.1.2   These routines and algorithms should be resident at the controller either as firmware or software downloaded from the central operator station during commissioning.

2.5.1.3   Specific routines or algorithms may be omitted where the Particular Specification does

not require them.

2.5.1.4   In this document "software" should be
taken to refer to any computer code which
implements monitoring and control routines or
algorithms, whether stored in volatile memory
(RAM) or as firmware in read only memory
(ROM).

2.5.1.5   Software warranty requirements are
detailed in Section 3 – Installation.

2.5.1.6   The software supplied shall include the
facility to create "soft" or "virtual" points.
These shall have a unique reference and accept
an assigned binary or analogue value in the
same manner as real points.

2.5.1.7   It shall be possible to override all
input and output points by use of the BEMS
manufacturers standard software engineering
pages or graphics.

2.5.2   Manual Start/Stop

2.5.2.1   Manual start/stop shall be provided for
each system and individual item of plant e.g.
pump, fan, etc.

2.5.2.2   When the manual command can be
overridden by other signals e.g. fire, frost, etc.
the system or item of plant selected for manual
start/stop control shall be manually controlled
without 'forcing' the output point(s) directly.

2.5.3   Monitoring Routines

Binary Inputs

2.5.3.1   The software routines necessary to
process binary inputs shall be resident at the
controller.

2.5.3.2   The routines shall be configurable
such that one or more events may be enabled in
direct response to any defined logical
relationship between the status of a number of
physical or soft points.

Analogue Inputs

2.5.3.3   The software routines necessary to
process analogue inputs shall be resident at the
controller.

2.5.3.4   It shall be possible to assign limiting
values to each analogue point. Each limit shall
be associated with a configured response.

2.5.3.5   It shall be possible to set both
maximum control deviations and absolute limits

for each analogue point.

2.5.3.6   It shall be possible to configure the
system such that modifications made to any
limit at the controller are automatically
reported to the central operator station.

2.5.3.7   It shall be possible to define a
relationship between an analogue point
threshold value and a digital point status.

Pulsed Inputs

2.5.3.8   The software routines necessary to
process pulsed inputs shall be resident at the
controller.

2.5.3.9   The pulsed input signals shall be
stored as a cumulative total. It shall be possible
for the operator to reset the counter.

2.5.3.10   It shall be possible to add or subtract
pulse counts from different meters to record net
consumptions.

2.5.3.11   The software routines shall compare
the number of pulses with preset limits on the
basis of either:

a)   Total number of pulses per unit time.

b)   Time required for a total number of pulses.

2.5.3.12   The inputs which are used to monitor
fluctuating pulse rate (e.g. maximum demand
meter for electricity) shall have operator
adjustable limits similar to those described for
analogue inputs.

2.5.3.13   When data for pulsed inputs is
recorded or achieved, the record shall include
both the pulse count and logging interval for
cumulative counts.

Calculation (Metering Programme)

2.5.3.14   Where defined in the Particular
Specification, a totalisation programme shall be
provided for each electric meter (pulsed) output.
The system shall initiate an identifiable alarm
output whenever the preset limit has been
exceeded for the particular item. The
Contractor shall propose a schedule of preset
limits to be entered and used during testing and
commissioning.

2.5.3.15   The total shall be accessible by
command from the operator, who shall also be
able to reset the limits or zero the count for
each meter.

2.5.3.16   Where specified that meter reading information will be used for validation or for re-charge purposes, the pulsed outputs shall be recorded in a data logger at the controller supported by the controller internal battery such that a continuous record is available of each meter reading.

Positive Feedback

2.5.3.17   The software shall include routines necessary to confirm that specific items of plant (pumps, fans etc.) are functioning correctly. This shall be done by monitoring physically separate but functionally related sensors, transducers or soft points. For example, a pump is only to be signalled as "running" when a "closed" signal is received from the starter and/or an appropriate sensor indicates that the flow in related pipework has been established.

2.5.3.18   Following plant switch-on, if the expected response has not been established by a pre-set time, an alarm signal shall be raised and it shall be possible to operate the standby plant.   The operator shall be provided with a facility to adjust the pre-set time delay.

2.5.3.19   The controller shall be capable of utilising measured feedback of an actuator position to give a percentage open reading.

Run Time Totalisation

2.5.3.20   A run time totalisation programme shall be provided for each drive or plant enable output. The system shall initiate an identifiable alarm output whenever the preset limit has been exceeded for the particular item.   The Contractor shall propose a schedule of preset limits to be entered and used during testing and commissioning.

2.5.3.21   The run time total shall be accessible by command from the operator, who shall also be able to reset the limits or zero the count for each item.

Trend Logs

2.5.3.22   The software shall include logging routines to enable the operator to prepare logs at each controller for any real or soft point on the system including measured values, status reports etc.

2.5.3.23   The operator shall be provided with the option to specify desired logging duration, start and/or stop time of the trend period and logging frequency.

2.5.4   Control Routines

General

2.5.4.1   For control purposes, the data obtained from field devices shall be allocated to appropriate control software routines and algorithms as defined by the operator.

2.5.4.2   Provide a facility to allow the pulsing of the BEMS output signal to the actuators as means of controlling rate of movement of the actuator.

2.5.4.3   Provide a facility to drive actuators to their open or closed positions at the end of plant operating periods.

Control Modes

2.5.4.4   The following control loops shall be provided as standard from which control loops in the Particular Specification can be configured.

a)   On/off control and floating control.

b)   Time proportional control.

c)   Proportional, proportional plus integral and proportional plus integral plus derivative control.

Time Control

2.5.4.5   The time programme shall enable and disable the item(s) of plant specified at specific times for each day of the week.   It shall be possible to specify a minimum of four switching times per day.

2.5.4.6   Pre-defined start/stop programmes for plant connected to a controller shall be available at that controller at all times. These programmes are to include variations to suit weekends, holidays etc., which can be pre-programmed by the operator.

2.5.4.7   It shall be possible to superimpose onto a standard time schedule the following functions:

a)   Optimum start/stop control day omit.

b)   Fixed extensions and contractions.

2.5.4.8   Control shall automatically revert to the standard time programme on subsequent days.

2.5.4.9   The system shall be capable of being switched from British Summer Time to

Greenwich Mean Time and back. The operator shall be able to preset the changeover date and time.

2.5.4.10   It shall be possible to program for up to twelve months in advance including holidays and to make temporary time adjustments which automatically reset once operated.

2.5.4.11   At the request of the operator, a system summary of all or selected time schedules may be displayed at the operator's station and/or printed out.

2.5.4.12   The programming calendar shall take into account leap years where appropriate.

Start/Stop Control

2.5.4.13   The software routines shall be capable of starting and stopping plant according to the sequences detailed in the Particular Specification including any specific requirements for "off" position or status of plant items, valves and dampers etc.

2.5.4.14   Where specified, standby plant shall operate automatically on failure of duty plant. Controllers are to report plant failure alarms to the central operator station.

2.5.4.15   Controllers shall be capable of alternating the lead plant where duty and standby equipment is installed. This shall be achieved both by an operator command and on a time-scheduled basis.

2.5.4.16   The operator shall be provided with the option to override any start/stop action programmed within the controllers. When reverting to normal automatic control, the original programme shall be automatically reinstated and updated to the correct time.

2.5.4.17   Delayed plant starting facilities shall be provided at controllers to reduce power surges. It shall be possible to start plant sequentially by adjusting the delay period for each item.

2.5.4.18   It shall be possible for the operator to specify minimum on/off cycle times and/or the maximum number of starts per hour for specified items of plant.

Plant Protection During Shutdown

2.5.4.19   The software shall include a plant protection routine which enables the operator to select and automatically run items of plant (such as pumps etc.) for short periods during out

of season shut-down. These run periods shall be adjustable by the operator.

Sequence Control

2.5.4.20   The software shall include sequence control routines to automatically sequence the operation of plant by monitoring load parameters and efficiently match the plant to the load.

2.5.4.21   It shall be possible to program different automatic sequences of control.

2.5.4.22   The operator shall be provided with the facility to override the automatic sequence and program an alternative sequence.

2.5.4.23   The set point values for each control action shall be variable and adjustable by the operator.

2.5.4.24   The routines shall include an operator adjustment for switching control differentials to prevent short cycling.

2.5.4.25   The routines shall ensure that when the maximum number of start/stop cycles for a particular plant is reached, then its schedule is automatically modified, e.g. by rotating standby equipment or changing the lead machine.

2.5.4.26   The routines shall also include the facility to operate all plant ancillaries associated with sequence control unless these have been specifically excluded in the Particular Specification.

2.5.4.27   The routines shall include the facility to proceed with the defined sequence when one of the items of plant in the sequence is isolated or fails to operate unless the safety requirements dictate otherwise.

Rotational Point

2.5.4.28   This programme shall initiate the altering of the control point designation (such as duty/standby and lead/lag) under any one of the following circumstances:

a)   On a calendar basis (e.g. weekly, monthly).

b)   Once a predefined hours run total has been reached.

c)   Once a predefined time is reached.

2.5.4.29   Major plant items (boilers, chillers etc.) affected by the automatic changeover of other items of plant (pumps, fans etc.) which are

running when the rotational point is required to operate shall be shut down in a controlled manner before point rotation occurs.   Following point rotation, the main plant shall be restarted as required.

2.5.4.30   The parameter which defines which item of plant is which (i.e. lead or lag; duty or standby) shall be configured to allow its display. Upon failure of the lead or duty machine the lag or standby machine will run in its place and become the duty/lead machine.

2.5.4.31   Once the rotational point has operated to place the failed lead/duty machine in the lag/standby position, or the lag machine has failed, the rotational point shall be inhibited until the failed machine is reset from the operator's station.

Boiler Management

2.5.4.32   Safety and firing of boilers will normally be supervised by separate controls supplied by the boiler manufacturer.   The BEMS software routines shall however include the following boiler management functions:

a)   Enable/disable command signal to the boiler controller.

b)   The selection of the fuel in multi-fuel installations.

c)   Signalling of faults and alarms.

d)   Monitoring of the following minimum performance parameters:

burner status
fuel consumption (on each boiler)
heating flow/return temperatures
hours run

Chiller Management

2.5.4.33   Operation of packaged chiller plant will normally be supervised by separate controls supplied by the chiller manufacturer. The BEMS software routines shall however include the following chiller management functions:

a)   Enable/disable command signal to the chiller controller.

b)   Signalling of faults and alarms.

c)   Monitoring of the performance parameters of electrical load (on each chiller); chilled water flow/return temperatures; hours run.

Optimum Start/Stop

2.5.4.34   Optimum start and stop programmes shall be provided for energy conservation where specified and shall calculate the optimal start and stop times for the HVAC plant, based on occupancy time, measured internal space and outside conditions. The programmes shall be suitable for both heating and cooling operation as specified and shall be self-adaptive, i.e. they shall make corrections to the optimisation character-istics in accordance with the accuracy of their predictions. The programme shall take account of the day of the week, occupancy patterns and holidays.

2.5.4.35   Unless otherwise detailed in the Particular Specification, any optimum start 'boost' condition shall be terminated by either occupancy time being reached or by occupancy temperature being achieved whichever occurs first.

2.5.4.36   For both optimum start and stop operation, after the initial learning period, setpoint should be achieved within 15 minutes of the start or end of occupancy.

2.5.4.37   The programme shall incorporate facilities for maintaining the internal space temperature of the building or system above a predetermined minimum level, outside occupancy hours.

2.5.4.38   For each optimum start programme, the following points shall be logged:

a)   Plant start time.

b)   Outside air temperature at plant start time.

c)   Inside air temperature at plant start time.

d)   Time optimum start terminated.

e)   Lowest inside air temperature at optimum start termination time.

f)   Time inside setpoint achieved.

2.5.4.39   For each optimum stop programme the following points shall be logged:

a)   Plant stop time.

b)   Outside air temperature plant stop time.

c)   Inside air temperature at plant stop time.

d)   Time inside setpoint achieved.

Weather Compensation Control

2.5.4.40   Weather compensation shall be provided to allow system control in relation to external weather conditions. This shall include the option to adjust temperature and flow and re-define the weather compensation.

2.5.4.41   Abrupt changes in the heating system performance or space temperature shall not adversely affect the automatic adaptive compensation process.

2.5.4.42   A single weather compensation curve should be used for each zone irrespective of the number of temperature sensors provided in that zone.

2.5.4.43   The routines shall respond to the reset signals arranged to achieve boost, night set back and boiler safety.

Frost Protection

2.5.4.44   The software shall include frost protection routines to operate plant and pumps in order to protect building services systems and their components from frost damage.

2.5.4.45   The protection shall be provided in two stages:

a)   When the outside air temperature falls to the operator set minimum frost protection temperature, the selected pumps shall be started and circulation established through pipework systems and their components. The operator shall be able to pre-select which plant is to be started. The automatic standby plant is to operate on failure of the duty plant.

b)   When the system temperature falls below the operator preset minimum, the full frost protection facility shall be initiated. In the case of heating systems, the heat source shall be turned on and operated to maintain the return flow temperature above the pre-set minimum. For other liquid systems, they shall have their specified protective devices activated (e.g. frost protection heaters).

2.5.4.46   Where specified, frost protection of a plant shall operate whether the plant is selected to run in 'test' or 'auto'.   If necessary, a separate BEMS binary output shall be provided

for this purpose.

Building/Plant Protection

2.5.4.47   The software shall include protection routines to operate the plant in order to protect the building fabric and its contents against effects of low internal temperatures and of condensation.

2.5.4.48   If the air temperature falls below the pre-set protection temperature, the heating system and related plant is to be turned on and heat supplied to maintain the air temperature at or above the protection set point temperature.

2.5.4.49   The building/plant protection routine shall override other operating programmes unless otherwise specified. Building protection shall operate whenever the normal heating is switched off.

Load Cycling Control

2.5.4.50   The software shall include routines to intermittently disconnect selected plants to make electrical energy savings.

2.5.4.51   The periods of disconnection and the environmental or other control limits shall be adjustable by the operator.

Load Shedding

2.5.4.52   When specified, this programme shall monitor the site's energy usage and power factor and be capable of predicting the maximum demand, in kVA and kW, and automatically shedding load to limit the demand to predetermined limits.   Loads which may be shed will be nominated on a schedule. This shall be arranged on a priority basis. Each load shall also be given an associated kW or kVA value together with minimum on and maximum off times.

2.5.4.53   The unloading shall be cyclic so that items of similar priority level having been switched off, shall be stacked at the bottom of that priority queue unless determined otherwise by the operator. The system shall provide the facility for the operator to select the demand limit and the loads available for shedding. The maximum demand period shall parallel that of the Electricity Supply Authority half-hour cycle for maximum demand.

Fresh Air Control

2.5.4.54 The software shall include routines to optimise the proportions of fresh and recirculated air based upon conditions of these two airstreams and the requirements of the controlled space. The proportions shall be based upon either the enthalpy or the dry bulb temperature measured by sensors in each airstream as specified.

2.5.4.55 The fresh air proportion shall modulate between an operator set minimum value to full fresh air, as specified.

Enthalpy Control

2.5.4.56 An enthalpy switchover programme shall operate for the plant detailed in the Particular Specification. The programme shall monitor the outside air enthalpy and the return air enthalpy for the nominated plant.

2.5.4.57 When the specific enthalpy of the outside air exceeds that of the return air during a cooling cycle, a command signal shall be provided to position and hold the HVAC plant dampers in the minimum fresh air position. The dampers shall remain in this position for a minimum specified time.

2.5.4.58 When the specific enthalpy of the outside air is less than that of the return air, the normal damper control sequence shall be resumed provided the minimum time period has elapsed.

2.5.4.59 Whenever enthalpy changeover occurs the enthalpy condition shall be logged.

Air Quality Control

2.5.4.60 The software shall include routines to enable the operation of the ventilating plant to be controlled in response to measured air quality.

2.5.4.61 Where air quality control is used in conjunction with fresh air control then the greater demand for fresh air is to have priority.

Lighting Control

2.5.4.62 The software shall include routines to control lighting in the following ways:

a)   On/off switching of external and internal lights at fixed times in accordance with the weekly schedules defined by the operator.

b)   The dimming and switching of internal lights based on the signals from external and internal photo sensors. This is to incorporate a user adjustable delay.

c)   Switching internal lights off according to occupancy detectors.

d)   The on/off switching of external lighting based on the signals from an external photo sensor.

2.5.4.63 The automatic control of lighting by the BEMS is to be capable of being overridden by local switches and by the operator at the central operator station.

2.5.4.64 The lighting system is to be manually controlled in the event of failure of the BEMS.

Emergency Lighting

2.5.4.65 The emergency lighting shall be monitored but not controlled.

Occupancy Control

2.5.4.66 The software shall include a routine to enable the operation of the plant to be controlled in response to the level of occupation, as described in the Schedules.

2.5.4.67 For each occupancy zone, one or more control signals shall be available to switch lights, ventilation and heating systems.

Fire and Security Control

2.5.4.68 The BEMS shall be compatible and interface with the fire and security systems as described in the Schedules.

2.6   COMMUNICATIONS

2.6.1   General

2.6.1.1   This sub-section describes the requirements for two way data communications between the various functions (controllers or operator stations) within the BEMS. Each station must include facilities which allow the automatic establishment of data communications with the other functions within the BEMS and the ability to exchange data. The communication network itself is covered in Section 3 of this standard specification.

2.6.2   Software

2.6.2.1   The communication software shall allow for the transmission of alarm messages and data reporting, as well as remote access to controllers and operator station(s) for updating control and monitoring data, and if appropriate,

software.

2.6.2.2   The communication protocol used shall achieve error free data transfer. The protocol shall:

a)   Include an error detection check.

b)   Include an error correction and/or re-try technique.

c)   Limit re-transmission.

d)   Raise an alarm condition on failure.

2.6.2.3   At the end of communication, whether this is a normal termination or due to failure, each station shall automatically reset itself and any associated equipment to the normal disconnected state and be ready to receive or initiate another communication.

2.6.2.4   The communication system shall be capable of operating at a speed of at least 1,000 logged values and associated data per minute.

2.6.2.5   The communication system shall operate so that at least 99% of complete communication conversations shall be successful unless the communication network fails.

2.6.2.6   Complete conversations shall be error free.

2.6.2.7   Controllers shall automatically synchronise their real time clocks with that of the system when communicating with the system.

2.6.2.8   All software relating to plant monitoring and control detailed in the Particular Specification shall reside at the controller or unitary controller level.   Only management software shall reside at the operator station.

2.6.2.9   All programmes shall be scanned as a minimum every two seconds.

2.6.2.10   Software shall include diagnostic routines which check hardware for correct operation. All hardware faults shall be annunciated at the operator station.

2.6.3   ESCROW Agreement

2.6.3.1   The Contractor shall complete and sign the ESCROW Agreement (Sample Agreement Document set out in Annex A)

2.6.4   Data Distribution Equipment

General

2.6.4.1   Power supplies for data distribution equipment connected to a public switched telephone network (PSTN) shall comply with BS EN 41003 1997 – Particular safety requirements for equipment to be connected to telecommunications networks.

Modems

2.6.4.2   Modems shall be approved by the relevant authority and conform to BS6320 Specification for modems for connection to public switched telephone networks etc. 1992.

2.6.4.3   The connection between modem and telephone lines must be wired direct.

2.6.4.4   To meet BEMS operational requirements, modems and associated BEMS communication equipment shall provide the following functions:

a)   Auto answer.

b)   Auto dial.

c)   Auto re-dial.

2.6.4.5   The modem shall block any communication until a password has been entered. After a pre-determined number of attempts (as defined in the Particular Specification) by unauthorised persons to access the site via the modem, it shall contact the central operator station and issue an alarm message that unauthorised access has been attempted.

2.6.4.6   The transmission rates shall be selected for compatibility with both the BEMS and PSTN or ISDN, but shall operate at a minimum of 9600 baud.

2.6.4.7   The system shall have the capability of storing 6 different telephone numbers and dialling them in sequence.

2.6.4.8   The BEMS System Contractor shall install the telephone point and be responsible for all authority fixed charges up to and including the end of the defects liability period. However, call charges after Practical Completion shall not be included.

2.6.5   Password Access

2.6.5.1   Any controller keyboard, operator station or display facility shall be protected by a 'security code' system.

2.6.5.2   Operators shall gain access to the system by logging on which shall be achieved by entry of a unique operator name and password combination.

2.6.5.3   Each operator shall be assigned a system access level which shall enable that operator, once logged on, to access only those command, monitoring and programme functions which have an equal or lower access level.   A minimum of eight access levels shall be provided.

2.6.5.4   Only the highest access level shall enable assignment or reading of operator passwords. The system shall support a minimum of twenty separate operators.

2.6.5.5   The system shall record (to the operator's station's hard disk and optionally on a selected printer) logging on/off activity. Terminals shall automatically log off after a pre-set time if no keyboard activity has occurred. In addition, operators shall be able to manually log off when leaving the terminal.

2.6.5.6   It shall be possible for the central operator station to request that changes made at controllers are reported automatically to the central station.

2.6.5.7   The configuration of system access levels shall be submitted for approval before commissioning commences.

2.6.6   Systems Logs and Reports

2.6.6.1   An operator shall be able to display system logs on any operator's station to print logs on any BEMS printer. Logs as a minimum shall include:

a)   Critical alarm summary log.

b)   Critical and general alarm summary log.

c)   Summary of all current alarms.

d)   Status logs which include a review of selected system points (e.g. graphic display or logical group).

e)   Time schedule logs, which print all or selected time schedules.

f)   Trend logs, which display real time values of selected points in a graphical format. Up to four points shall be able to be displayed on each trend log. These logs shall be capable of updating at one second intervals.

g)   Historical trend logs, which log the value of selected points as recorded at predetermined intervals. Sample times for each point to be logged shall vary from 5 seconds to 24 hours.

h)   Hours run values for selected or all equipment.

i)   Accumulated register values for selected or all equipment.

j)   Change of state conditions for selected or all equipment.

2.6.6.2   In addition, an operator must be able to record, format, display and/or print out information, as detailed above, on a building, controller or ID basis.

2.6.6.3   The point ID basis shall allow an operator to enter all or any part of a point identifier complete with wild cards. The system will then perform the required function (i.e. search, record, print etc.) on all points which have common identifier characters to that entered.

2.6.6.4   A print screen function shall also be available.

2.6.6.5   The BEMS shall be able to arrange all data in a format compatible with Microsoft Excel software or an approved equivalent, which shall also be supplied with the system.

2.6.6.6   When an operator's station is being used for spreadsheet purposes and other similar programming functions, which may not be directly related to the monitoring and control aspects of the system, it shall continue to monitor, display and enunciate alarms upon their occurrence.

2.6.6.7   Once the hard disk unit of an operator's station is 90% full, it shall raise an alarm to indicate this.

2.7   CONTROLS

2.7.1   General

Ambient Conditions

2.7.1.1   All controls shall be capable of operating in ambient conditions varying

between 0-45ºC and 0-95% RH (non-condensing).

Conduit Entry

2.7.1.2   All control devices shall, unless provided with a flying lead, have a 20mm conduit knockout. Alternatively they shall be supplied with adaptors for 20mm conduit.

Ancillary Items

2.7.1.3   The following ancillary items shall be included when items of equipment are installed in the situation listed:

a)   External Mounting

All devices mounted externally, or which due to their location are exposed to the elements, are to be suitably weatherproofed to IP65.

b)   Pipework Immersion

Corrosion resisting pockets of a length suitable for the complete active length of the device, screwed ½" or ¾" BSPT suitable for the temperature, pressure and medium.

c)   Duct Mounting

Mounting flanges, clamping bushes, couplings, lock-nuts, gaskets, brackets, sealing glands and any special fittings necessitated by the device.

2.7.1.4   **Additional Features**

a)   Concealed Adjustment

All two position switching devices shall have concealed adjustment unless detailed otherwise in the Particular Specification.

b)   Hand Reset Feature

All two position switching devices requiring a hand reset feature are detailed in the Particular Specification.

c)   Operating Voltage

All two position switching devices shall be capable of switching voltages up to 240V AC and all accessible live parts shall be shrouded to IP 2X as a minimum. Devices with metallic cases or exposed metal parts shall be supplied complete with an earth terminal.

2.7.2   Sensors, Detectors and Switching Devices

General

2.7.2.1   Sensors, detectors and associated meters shall comply with the requirements of any relevant British Standard, and also have a proven record of long term precision and reliability when used with BEMS and with building services systems.

2.7.2.2   All sensor output signals shall be compatible with interfaces fitted to associated controllers.

2.7.2.3   Connections to sensors and detectors shall be by use of screw down clamp type terminals or self locking connectors.

2.7.2.4   Sensors, detectors and meters shall be installed in accordance with the manufacturer's instructions and recommendations.

2.7.2.5   Calibration conditions for meters shall be fully documented in the BEMS manuals and clearly marked on or adjacent to the meters.

Accuracy

2.7.2.6   Control and measuring devices shall have the following limits of accuracy:

Temperature : ± 0.5°C
Pressure   : ± 0.5% of full scale reading
Humidity   : ± 2% RH
Air flow   : ± 2% of full scale reading
Water flow   : Operating range of 5:1 and
                        accuracy of better than
                  ± 2%of the measured value.

2.7.2.7   To ensure accuracy, all temperature measuring devices in wells or pockets shall be installed using a suitable heat transfer medium.

Averaging Elements

2.7.2.8   Shall be used in frost protection and mixing applications and where listed in the Particular Specification.

2.7.2.9   Shall have a minimum capillary length of 5m.

2.7.2.10   The capillary element shall be serpentined across the whole duct.

2.7.2.11   Where the span of the element is less than 1m, it shall be fixed with purpose-made clips and may be unsupported across the duct.

2.7.2.12   Where the span of the element is
above 1m then it shall be adequately and rigidly
supported.

Room Thermostats

2.7.2.13   When of the bimetal detector type
they shall be fitted with a shunt accelerator
heater.

2.7.2.14   Shall be suitable for mounting on
British Standard conduit boxes.

2.7.2.15   Scale ranges shall cover a band of at
least 5°C and no more than 15°C on either side
of the set point detailed in the Particular
Specification. The operating differential shall
not exceed 1°C, under all load conditions, for
rates of temperature rise and fall within the
controlled space of 3°C per hour, and 2°C for
rates of 14°C per hour.

2.7.2.16   Where room adjustment is required,
as detailed in the Particular Specification, this
facility shall include mechanical stops to limit
the amount of adjustment.

2.7.2.17   Manual override shall only be provided
when detailed in the Particular Specification.

Duct Mounted and Immersion Thermostats

2.7.2.18   Shall be either of the rigid stem type
or else of the capillary terminated in sensing
bulb type. Stem lengths shall be selected upon
the duct or pipe size so that the stem extends
half way into the duct or pipe. If this is not
possible then the stem shall have a minimum
length of 300mm. Capillary and bulb assemblies
shall have a minimum length of 1.5m.

2.7.2.19   Scale ranges shall cover a band of at
least 5°C and no more than 30°C on either side
of the set point detailed in the Particular
Specification.

2.7.2.20   The operating differential shall not
exceed 3K for all load conditions. Thermostats
do not need to be provided with an adjustable
differential unless detailed in the Particular
Specification.

Duct Mounted Frost Protection Thermostats

2.7.2.21   May be of either the rigid stem or
capillary type according to the duct cross-
sectional area unless a clamp-on type is
specified in the Particular Specification.

Rigid Stem

2.7.2.22   Shall be used on ducts having a cross-
sectional area of up to and including 0.6m².
They shall be as specified for duct mounted
thermostats.

Capillary

2.7.2.23   Shall be used on ducts having a cross-
sectional area exceeding 0.6m². Shall have a
minimum capillary length of 5m and shall
operate when any 300mm length of sensing
element falls below the set point. The capillary
element shall be serpentined across the whole
duct. Where the span of the element is less than
1m then it shall be fixed with purpose-made
clips and may be unsupported across the duct.
Where the span of the element is above 1m,
then it shall be supported adequately and
rigidly.

Electronic Clamp-on Type

2.7.2.24   Shall be used as an alternative to rigid
stem and capillary types were detailed in the
Particular Specification. The thermistor
element shall be clipped to the heat exchanger
return tube within the ductwork by means of a
phosphor bronze clip(s). The unit shall be
arranged for automatic reset after power
failure.

2.7.2.25   If the thermostat is located in an area
where the ambient temperature outside the
ductwork may fall below the switching point of
the thermostat, then the thermostat housing
shall either be located within the ductwork or
else insulated against the effects of cold upon its
switching action.

Humidistats

2.7.2.26   Shall not require regular
maintenance, re-calibration or regeneration.

2.7.2.27   Room versions shall be suitable for
mounting on British Standard conduit boxes.

2.7.2.28   Scale ranges shall cover a band of at
least 10% RH on either side of the set point
detailed in the Particular Specification.
Operating differentials, under all load
conditions, shall not exceed 5% RH.

Pressure Switches for Pipework

2.7.2.29   Shall be bellows operated, the bellows
being suitable for the medium and the working
temperatures and pressures.   The pressure
switch shall be capable of withstanding a

hydraulic test pressure of twice the working pressure.

2.7.2.30   Connections shall be suitable for 8mm (¼") o.d. copper tube.

2.7.2.31   Shall be supplied suitable for pipe or wall mounting.

2.7.2.32   The set point shall fall within 30%-80% of the scale range.

2.7.2.33   Static pressure switches shall have differentials adjustable over 10%-30% of the scale range.

2.7.2.34   Differential pressure switches shall have a differential of no more than 0.2 bar (20kPa).

Pressure Switches for Air Systems

2.7.2.35   Shall be diaphragm operated. Switches shall be supplied with air connections permitting their use as either static or differential pressure switches.

2.7.2.36   Shall be supplied complete with brackets suitable for wall mounting or mounting on ducts in any plane.

2.7.2.37   The setpoint shall fall within 30% - 80% of the scale range.

2.7.2.38   Shall have a switching differential of not more than 10% of the scale range.

Air Flow Switches

2.7.2.39   Shall be selected for the correct air velocity, duct size and mounting attitude.

2.7.2.40   Where special atmospheric conditions are detailed in the Particular Specification the exposed parts of the switches shall be suitably coated or made to withstand such conditions.

Water Flow Switches

2.7.2.41   Shall be selected for the correct water velocity, pipe size and mounting attitude.

2.7.2.42   Shall be installed in short branch connections only.

2.7.2.43   Shall be installed in accordance with appropriate water bylaws.

Level Switches

2.7.2.44   Shall be selected for the fluid type, system pressure and have adjustable differentials. They may be:

a)   Conventional float type

b)   Capacitance type

c)   Conductivity type.

2.7.2.45   Where conductivity types are offered they shall include all probes (including earth).

Room Temperature Sensors

2.7.2.46   Shall have an accuracy of ± 0. 5°C

2.7.2.47   Shall operate on extra low voltage and be suitable for mounting on British Standard conduit boxes.

Room Humidity Sensors

2.7.2.48   Shall have an accuracy of ±0.2%RH.

2.7.2.49   Shall operate on extra low voltage and be suitable for mounting on British Standard conduit boxes.

2.7.2.50   Shall not require regular maintenance, re-calibration or regeneration.

Immersion and Duct Mounted Temperature Sensors

2.7.2.51   Shall have an accuracy of ± 0. 5°C unless otherwise specified in the Particular Specification.

2.7.2.52   Duct mounted averaging element sensors shall have a minimum sensing length of 5m.

2.7.2.53   Average elements composed of multiple thermistor beads are not acceptable.

Duct Mounted Humidity Sensors

2.7.2.54   Shall have an accuracy of ±2% RH.

2.7.2.55   Shall operate on extra low voltage.

2.7.2.56   Shall not require regular maintenance, re-calibration or regeneration.

Pressure Sensors

2.7.2.57   Shall be suitable for the medium and the working temperatures and pressures.   The pressure sensor shall be capable of withstanding a hydraulic test pressure of 1.5 times the working pressure.

2.7.2.58   Connections shall be suitable for 8mm (¼") o.d. copper tube.

2.7.2.59   Ductwork versions shall be supplied with air connections permitting their use as static or differential pressure sensors.

2.7.2.60   The set point shall fall within 40%-70% of the sensing range of the sensor.

2.7.2.61   The sensor shall have a sensitivity such that a change of 2% from the stabilised condition shall cause modulation of the corrective element.

2.7.3   Actuators

General

2.7.3.1   Shall be installed in accordance with the manufacturer's recommendations.

2.7.3.2   Shall have a sufficient torque to open and close valves and dampers against the maximum out of balance pressure across them.

2.7.3.3   Shall have position indicators unless fitted to terminal units.

2.7.3.4   Shall have a manual override facility unless fitted to terminal units.

2.7.3.5   Shall have a linear stroke/control signal characteristic.

Control Damper Actuators

2.7.3.6   Shall be of the type where the damper spindle passes through the actuator and is secured by a U clamp.

Actuator Additional Features

2.7.3.7   Required when detailed in the Particular Specification. Auxiliary switches shall have contacts suitable for 240V AC 2amp rating. Modulating motors shall have auxiliary switch packs containing at least two electrically independent switches, one for each end of the motor travel, adjustable for operation over at least half the motor travel. Two position motors shall have one electrically independent switch. Feedback potentiometers shall have resistance varying proportionally with the actuator travel. An auxiliary spring shall be provided for fail safe conditions, which shall be rated for a minimum of 1000 operations. The spring shall have sufficient torque to open or close valves and dampers against the maximum out of balance pressure across them.

2.7.4   Unitary Controllers

General

2.7.4.1   Where a controller is used to monitor and control VAV boxes, FCUs, heat pumps etc., they shall be classed as unitary controllers (UCs).

2.7.4.2   UCs shall be either small freely programmable controllers of firmware or application specific controllers which shall be selected to meet the performance requirements of the Particular Specification.

2.7.4.3   UCs shall be of the types detailed in the Particular Specification. Any necessary transformers shall be supplied with controllers.

2.7.4.4   Real time clock functions are not essential where these commands are generated by other controllers, which shall also control the transfer of information to, from and between UCs on the same communications network.

2.7.4.5   Each UC shall be capable of being interrogated and adjusted by an operator's station or portable terminal which may plug into the network at any point.

2.7.4.6   Only inputs and outputs points necessary to meet the functional requirements of this Specification are required to be supplied. The spare capacity as detailed under 2.4.14 Controllers - Spare Capacity is not required.

Electronic/Microprocessor single or multi-stage

2.7.4.7   Proportional plus integral controllers for single stage control shall have the two control adjustments of single stage proportional controllers, calibrated in the same manner, plus one further control adjustment for integral time. This adjustment shall permit the selection of integral times covering the minimum span of 15-40 minutes and the scale shall be calibrated in minutes.

2.7.4.8   Multi-stage controllers shall be supplied with additional proportional band adjustments for stages after the first.

2.7.4.9   The middle stage of a three-stage controller shall have an adjustable 'minimum'

limit output. This shall be calibrated.

2.7.4.10 Microprocessor based multi-loop
controllers shall provide proportional plus
integral plus derivative control action. All
adjustments shall be made through an integral
keypad complete with a display. Where
standard units do not include an integral
keypad/display a portable unit shall be supplied.
  The display/keypad shall enable the operator
to interrogate/adjust all settings and display the
measured values via password access. The
memory shall be backed up for 48 hours by an
integral battery which shall be trickle charged,
require no maintenance and have a life of at
least five years.   An integral capacitor shall
prevent the loss of memory when the battery is
being replaced. Hardware shall be provided to
enable all software to be uploaded and
downloaded to/from a permanent storage
medium.

Optimum start/stop

2.7.4.11 Shall be microprocessor based and of
the 'self-learning' type for both the on and off
functions. The optimum off function shall be
enabled or disabled at the controller.

2.7.4.12 The optimum decisions shall be based
on inside and outside air temperatures.

Additional Features

2.7.4.13

a) Facility to utilise the room sensor to run
    the plant in the boost mode outside
    occupancy hours to maintain a temperature
    of 10ºC. This temperature shall be site
    adjustable.

b) Capability for up to three room sensors.

c) Termination of the boost mode shall be by
    either occupancy temperature being
    achieved or occupancy time being reached,
    whichever is sooner. The boost period
    shall only be terminated once per day.

d) Circulating pumps operate on low outside
    air temperature.

e) Separate programming for each day of the
    week.

f) A separate fixed time start/stop facility.

g) Day/week omission facility.

h) Battery reserve to retain the programme
    for a period in excess of three months.

i) Password access for parameter adjustment.

j) Integral display/keypad.

Step Controllers

2.7.4.14 Step controllers of the electro-
mechanical type shall incorporate a recycling
switch in addition to the step switches required
for the operating functions. All step switches
shall have changeover contacts rated for 2A
minimum at 220-250V, 50Hz.   If 415V, 50Hz is
applied to two adjacent step switches, adequate
insulation shall be provided between the
switches.

2.7.4.15 All switches, apart from that for
recycling shall be easily adjustable for position
of operation over the full span of rotation. The
step controller shall be supplied with a
removable cover which completely shrouds the
terminals on the step and recycling switches.

2.7.4.16 Step controllers of the electronic type
shall recycle to zero on interruption of the
power supply. The outputs shall be voltage free
changeover contacts rated for 2A minimum at
220-250V, 50Hz.

2.7.4.17 The switching intervals and switching
differentials of the step controller output stages
should be fully adjustable. Each stage shall
have adjustable switch on and off time delay
facilities. Non-adjustable switching intervals
and switching differentials are acceptable on
applications involving electric heater batteries
only. Signal lamps shall be incorporated on the
front of the step controller to indicate the
number of stages in operation.

2.7.4.18 Both types of step controller shall be
suitable for wall or panel mounting.

Thyristor Controllers

2.7.4.19 Thyristor controllers for stepless
control of electric heater batteries shall be of
the type utilising burst firing, integral cycle
with cut off at zero voltage. Wave chopping
types are not acceptable. Single-phase versions
shall be capable of handling up to 20A at 240V,
50Hz.   Units shall be supplied complete with
quick acting fuses for the specified loadings and
live parts shall be shrouded to comply with
classification IP2X BS EN 60529. The thyristor

controller shall accept a 0-10V DC or 4-20mA
input signal.

2.7.5   Flow Measurement

Differential Pressure Transmitter/Orifice Plates

2.7.5.1   Shall include a differential pressure
transducer and orifice plate complete with
carrier ring which shall have pressure tappings
and means for local isolation.

2.7.5.2   The flow measurement device shall be
positioned in accordance with the
manufacturer's installation instructions.
Manufacturer's calibration test certificate and,
application data, including pressure drop versus
flow rate through the complete scale range,
accuracy and maximum permissible static
pressure shall be provided.

Turbine

2.7.5.3   The flow measurement device shall be
positioned in accordance with the
manufacturer's installation instructions.
Manufacturer's calibration test certificate and
application data, including pressure drop versus
flow rate through the complete scale range,
accuracy and maximum permissible static
pressure shall be provided.

Electromagnetic Flow Meters

2.7.5.4   The flow measurement device shall be
positioned in accordance with the
manufacturer's installation instructions.
Manufacturer's calibration test certificate and
application data including setpoint scale range,
accuracy and maximum permissible static
pressure shall be provided.

Ultrasonic Flow Meters

2.7.5.5   The flow measurement device shall be
positioned in accordance with the
manufacturer's installation instructions.
Manufacturer's application data including
setpoint scale range, accuracy and maximum
permissible static pressure shall be provided.

Air Velocity Sensors

Probe Type

2.7.5.6   Shall include a sensor complete with a
square rooted output and duct mounting probes
selected to suit the application. Sensing lines
may be run in PVC or similar tubing.

2.7.5.7   The probes shall have multiple sensing
points, shall be of stainless steel construction,
shall be of suitable length to suit the duct size
and be individually adjustable for calibration
purposes.

2.7.5.8   The sensor shall provide an output
signal of 0 to 10V DC or 4 to 20mA.

2.7.5.9   The accuracy of the measured velocity
shall be ± 3% of the working range and shall be
inclusive of all inaccuracies including the
sensor.

Solid State Type

2.7.5.10   Shall include a duct mounting
multipoint, solid state, air flow sensor array
complete with signal processing unit.

2.7.5.11   The sensor array shall be selected to
suit the application and duct size.

2.7.5.12   The signal processing unit shall
provide an output signal of 0 to 10 DC or 4 to
20mA.

2.7.5.13   The accuracy of the measured velocity
shall be ±2% for velocities less than 5 m/s and
±4% for velocities of between 5 and 10 m/s.

Gas Detection

2.7.5.14   Gas detection shall be provided as
defined in the Particular Specification for such
gases as Carbon Dioxide, Carbon Monoxide and
Nitrogen Dioxide.

2.7.5.15   The manufacturer of the required
equipment shall provide a test kit for the
commissioning/calibration of the detection
system for use by the specialist Contractor.
Documentary evidence of such testing shall be
provided.

Natural Gas

2.7.5.16   Gas sensors shall be arranged for
automatic reset after a power failure.

2.7.5.17   Gas sensors shall have two volt free
contacts which shall operate to provide the
following:

a)   Gas detected.

b)   Gas sensor fault.

2.7.5.18   Volt free contacts shall be suitable for
switching 240V AC.

2.7.5.19   The Manufacturer of the gas sensor
shall provide calibration data for demonstrating
the operation of the gas sensor when using a
suitable test kit.

Refrigerant (CFC or HCFC)

2.7.5.20   A Manufacturer's calibration test
certificate shall be provided for the detection
system.

Weather Station

2.7.5.21   This shall provide information on
temperature, humidity, wind, rain, pressure,
solar and fog. A manufacturer's calibration test
certificate shall be provided for the weather
station.

2.7.6   Light Sensors

2.7.6.1   Light sensors shall use
photoconductive or photovoltaic cells.

2.7.6.2   The operating range of light sensors,
unless otherwise specified, shall be as follows:

Internal sensors	0 - 1,000 lux
External daylight sensors	1,000 – 30,000 lux
External security sensors	0 – 100 lux

2.7.6.3   External enclosures shall be
waterproof to IP55.

2.7.6.4   Any power supply required by the
sensor should be provided by the controller.

3 Section Three - Installation

3.1 SCOPE

3.1.1 This part of the specification covers the installation and commissioning of the BEMS and the features that can subsequently be evaluated and tested prior to handover.

3.1.2 It describes the functional requirements for the installation of a new or modified BEMS, including detailed design, supplying, assembling, fixing in position, connecting, inspecting, testing and leaving in working order. The BEMS equipment must also conform to Section 2 – System.

3.1.3 The words "complete installation" shall mean not only items of mechanical and electrical equipment covered by this specification, but all incidental sundry components, computer programs, data and documentation necessary for the complete execution of the Works and for the proper operation of the installation, whether or not these sundry components are mentioned in detail in the tender documents issued in connection with the contract.

3.2 GENERAL

3.2.1 Requirements

3.2.1.1 The Contractor shall provide a schedule of site conditions including security, cleanliness, weather protection etc. which must be met and maintained before equipment is delivered.

3.2.1.2 The BEMS shall be configured and commissioned according to the requirements of the Specification and Schedules.

3.2.1.3 The procedures defined as being set up by the operator will be set initially by the Contractor. The operator shall have the facility to make future adjustments to suit the needs arising from use of the BEMS.

3.2.1.4 The Contractor shall ensure adequate protection of the equipment on site and will advise the PM of any damage that occurs to equipment including finishes, and carry out repairs as directed by the PM.

3.2.1.5 The combined system comprising buildings, plant and BEMS shall be capable of being tuned.

3.2.2 Levels of software

3.2.2.1 The system shall be defined with 5 levels of software:

Operating system -	As supplied with the computer equipment
BEMS Programme -	Supplied by the BEMS manufacturer
Configuration -	Created by the Contractor
Graphic pages -	Created by the Contractor
Parameters -	Commissioned by the Contractor and modified by the user.

In the following clauses, software shall be taken to include operating systems and programmes which are present in volatile and/or non-volatile memory i.e. "firmware".

3.2.3 Software

Warranties

3.2.3.1 The operating system shall be warranted error free within the system warranty. It shall not be possible to invalidate this warranty. The BEMS programme shall be warranted error free within the system warranty. It shall not be possible to invalidate this warranty.

3.2.3.2 The vendor shall undertake to inform the user of any defects which may become

apparent through the use of this software in other systems.

3.2.3.3   The configuration shall be warranted error free as commissioned. It shall not be possible to invalidate this warranty through modification of parameters.

3.2.3.4   The graphic pages shall be warranted error free as commissioned. It shall not be possible to invalidate this warranty through addition of further pages or modifications of parameters.

Software Development

3.2.3.5   The revision and issue number of operating systems and package software included in the Tender shall be submitted in writing with the Tender. The availability and cost of any further packaged software not specifically called for in this specification shall also be indicated.

3.2.3.6   The functional description and details of any software that will need to be written especially for these Works shall be submitted in writing with the Tender. The procedure for preparing this software and the development period allowed for in the Tender for this purpose shall also be indicated. Tenderers shall provide a summary of their previous experience in having similar software written.

3.2.3.7   The Tenderer shall demonstrate that the operation of all software conforms to the specification.

3.2.3.8   The BEMS documentation shall include the procedures which enable the operating systems and BEMS programme to be updated.

3.2.3.9   The procedures for modifying the configuration, graphics pages and parameters shall allow alterations and additions to be made systematically without necessitating total shut down of the BEMS or the building services.

3.2.3.10 All the software included in the Tender shall support, without modification, the future addition or removal of controllers or points up to the practical limit of the installed system hardware.

Software Support

3.2.3.11 The Contractor shall ensure that two backup copies of all software items, as commissioned, are provided at handover such

that in the event of a subsequent software failure it shall be possible to reload the software in the "as commissioned" form.

3.2.3.12 The Contractor shall ensure that a backup copy of all software items is obtained prior to any software changes made by him during the warranty period such that in the event of a subsequent software failure it shall be possible to reload the software in the previous form. This backup copy shall be lodged with the PM.

3.2.3.13 Provisions for backup copies of firmware will be as detailed in the Particular Specification.

3.2.3.14 The Tender shall contain details of the software support service offered, where the software will be written and how it will be charged for.

3.2.3.15 When existing software is replaced, a copy of the superseded software shall be retained for one year or as detailed in the Particular Specification.

3.2.4   Proven Performance

3.2.4.1   Systems and equipment selected by the Contractor shall have a successful proven performance for not less than 2 years under equivalent conditions to those required by the tender documents. Systems and equipment that do not comply with the forgoing proven performance period may be considered provided full technical details and evidence of suitability are given at the time of tendering.

3.3   FIXING AND CONNECTION

3.3.1   Stand Alone Operation

3.3.1.1   Sensors and actuators associated with primary control loops for any one item of plant should be connected to a single controller such that a communication failure between controllers does not adversely affect the operation of the plant.

3.3.1.2   On failure of the controller, or loss of its power supply, plant or devices under the control of that controller shall be set to a safe/pre-determined condition as specified in the Schedule of Actions on BEMS Failure.

3.3.1.3   Plant shall be started and stopped in normal operation according to the sequences

detailed in the Schedules including any specific requirements for "off" position of status of plant items, valves and dampers etc.

3.3.1.4   Where no sequences are specifically detailed plant shall be started and stopped in a safe manner with due regard to electrical and mechanical constraints.

3.3.2   Data Communication

3.3.2.1   BEMS installation shall allow data communication between controllers and operator facilities of at least:

a)   a speed of 1,000 logged values and associated data per minute.

b)   transparent error checking and correction such that complete conversations are error free.

3.3.3   Cabling Installed as part of the BEMS Contract

General

3.3.3.1   The specification covers electrical cabling below 110V i.e. signal and data communications wiring and optical fibres.

3.3.3.2   Power cabling, including power supplies to BEMS equipment, will be installed according to the project Electrical Specification.

3.3.3.3   All cabling must be adequately protected from the environment through which it passes to avoid the possibility of mechanical damage or electromagnetic interference.

3.3.3.4   Cabling and conduits associated with sensors shall be installed in a manner that prevents spurious transfer of moisture and heat etc. from external sources to sensing devices.

3.3.3.5   Avoid running trays, trunking, conduits and cables horizontally at floor or pedestal level.

Cable Types and Application

3.3.3.6   The types of cable installed must in no way prejudice satisfactory operation of the BEMS.

3.3.3.7   The cables, installation and jointing shall comply with the BEMS manufacturers recommendations and the project Electrical Specification.

3.3.3.8   Unless otherwise recommended by the BEMS manufacturer or specified, data transmission and analogue sensor cables must be screened.

3.3.3.9   The cross sectional area of cables shall be sufficient to ensure that sensor circuit resistance limits are not exceeded.

3.3.3.10   The method of installation and routing of cables shall not prejudice the satisfactory operation of the BEMS.

3.3.3.11   Data transmission cables shall not be installed within the same conduit or trunking as power cables.

Mechanical Protection

3.3.3.12   The mechanical protection of the BEMS wiring shall comply with the project Electrical Specification.

Identification

3.3.3.13   All cables shall have identification sleeves at their terminations which combine the requirements of BS 7671 Requirements for Electrical Installations with those for specific circuit identification. Ensure that the identification is consistent with the relevant wiring diagrams. Mark "cross over" or "null modem" cables for communication between processors and terminal devices with an "X" at both ends.

3.3.4   Cabling and Associated Data Distribution Equipment Installed by Others

General

3.3.4.1   This sub-section refers to the connections of the BEMS to cabling systems provided by others.

3.3.4.2   Confirm by testing or obtain appropriate certificates from original suppliers that any existing means of communication provided between controllers or between

controllers and operator facilities is of suitable standard for satisfactory operation of the BEMS.

3.3.4.3   Where the existing means of communication is found to be unsuitable for satisfactory operation of the BEMS, advise the PM at the time of tender.

Local Telephone Systems

3.3.4.4   Local telephone systems are defined as private telephone networks on one or more sites maintained by the user and independent from the public telephone system.

3.3.4.5   Where an existing telephone system is to be used, confirm prior to tendering that the BEMS can operate satisfactorily on this system. The primary system requirements are:

a)   The internal telephone line is suitable for the speed and mode of data transmission required by the BEMS.

b)   The extent of data loss or corruption on the internal telephone system is tolerable with respect to the data transmission techniques used by the BEMS.

3.3.4.6   If the existing local telephone system is considered to be unsuitable, state this in writing at the time of Tender and indicate the features which make it unacceptable.

3.3.4.7   Connections to the local telephone system are to be dedicated to the BEMS equipment.

Public Telephone Systems

3.3.4.8   Public telephone systems are Public Switched Telephone Networks (PSTN) and private circuits supplied and maintained by public telecommunication organisations.

3.3.4.9   Obtain certification from the network operator prior to tendering confirming that the BEMS is able to operate satisfactorily on the proposed public telephone system.

3.3.4.10   Any connection between the BEMS and British Telecom PSTN shall comply with BS EN 41003, BS 6305 and BS 6789, Part 1, where relevant.   Modems shall carry the green "Approved for Use" sticker issued by British Telecom. Connections between the BEMS and private circuits run by public telecommunication operators in the UK, shall where relevant, comply with BS 6328.

3.3.4.11   Any connection between the BEMS and foreign (outside the UK) public telephone systems, shall comply with their relevant standards.

Mains Borne Signalling

3.3.4.12   Where mains borne signalling is used, it shall comply with the recommendations of BS EN 50065 Part 1.

3.3.4.13   All necessary equipment to ensure that there is no mutual interference between the signalling system of the electricity utility and mains borne signalling of the BEMS shall be provided.

Use of Existing Cabling and Wire Ways

3.3.4.14   This refers to existing cabling systems other than telephones.

3.3.4.15   Where existing cabling is to be used, undertake the tests necessary to ensure that the cabling is satisfactory for the BEMS purposes.

3.3.4.16   Where multi-core cables are to be used, those available for use by the BEMS will be identified by the PM.

3.3.4.17   Ensure that the potential corruption of data cannot arise from the following:

a)   Other installations not connected to, but in close proximity to the route of existing cabling.

b)   Other electrical services using existing cabling.

c)   Other adjacent cabling.

3.3.4.18   State in writing at the time of tender whether existing cabling is suitable or not.

3.3.5   Connections to Plant and Controls Equipment

General

3.3.5.1   All devices and terminals necessary to connect the BEMS to items of plant and control equipment shall be provided.

3.3.5.2   Take account of any existing services that have to remain in continuous operation. Agree with the PM the method by which the

BEMS equipment can be installed without disrupting the operation of the connected building services.

3.3.5.3   Where plant and control equipment are supplied by others, provide the PM with adequate details of installation requirements. This information shall be provided in time and sufficient detail to enable any other Contractors and their suppliers to incorporate the BEMS connection facilities before delivering their equipment to site.

3.3.5.4   Where plant is subject to warranty by others, obtain clearances in writing from those concerned that the proposed modifications do not invalidate the warranties.

3.3.5.5   Ensure that modifications carried out as a result of this contract are fully documented and do not affect the satisfactory operation of safety devices connected to any plant or system affected directly or indirectly by the BEMS Works. Carry out proving tests on safety devices to the satisfaction of the PM.

3.3.5.6   Ensure that the use of existing relays, contactors, starters and switches as part of the BEMS installation is fully documented.

3.3.5.7   All wiring under this contract shall be carried out in a neat manner by skilled operatives. Clip wiring to form a loom and route to avoid interference with the correct operation or maintenance of other components.

Safety Interlocks

3.3.5.8   Scheduled interlocks to establish and maintain safe/pre-determined plant conditions under all modes of operation including loss, reduction and restoration of power shall be provided.

3.3.5.9   Physical interlocks shall be hard wired and tested to ensure safe and/or sequenced operation of the plant before the BEMS is set to work. Interlocks shall be arranged to prevent unsafe or out of sequence operation of the plant by the BEMS.

3.3.5.10   The plant must not be operated using the BEMS under any circumstances until all interlocks have been tested to the satisfaction of the PM.

Manual Control

3.3.5.11   Manual control facilities shall be provided as listed in the Particular Specification

to enable the user to operate essential plant in the event of a failure of the BEMS. These facilities shall include:

a)   Start/stop operation of the plant.

b)   Hand setting of motorised control devices such as valves, dampers etc.

c)   Override reset signals to discrete controllers.

3.3.5.12   Ensure that the manual control facilities do not override safety devices or interlocks.

Volt Free Contacts

3.3.5.13   The contact materials shall be suitable for use in the installation and at the expected voltages and currents. Use screw down or locking spade terminals for electrical connections to volt free contacts.

Relays

3.3.5.14   Use demountable relays of the totally enclosed type having at least one spare set of changeover contacts. Use terminals which are shrouded and of a screw down clamp or locking spade terminal type.

Actuators

3.3.5.15   Actuators for air volume control together with linkages shall operate smoothly from fully open to fully closed without binding, and with adequate torque to overcome the resistances of bearings and airflow.

3.3.5.16   Linkages shall be clearly marked with the clamping position such that after maintenance or replacement the mechanism is able to operate correctly.

3.3.5.17   Actuators should be fitted with visual position indication.

3.3.5.18   Where specified, actuators shall include a position feedback device suitable for connection to the BEMS.

3.3.5.19   Actuators should be electrically and mechanically protected from the effects of valve or damper seizure.

3.3.5.20   Actuators shall incorporate a disconnection device to allow manual operation of the valve or damper in the event of actuator

failure.

Signalling from Starters

3.3.5.21   Additional contacts for signalling and remote operation purposes shall be provided as specified in the points schedule.

3.3.5.22   The operation of the starter in either AUTO or HAND mode shall be signalled to the BEMS using auxiliary volt free contacts built into the contactor.   A signal derived directly from the digital output at the outstation is not acceptable. Provide a separate "run" signal for each speed of a multi-speed starter/controller.

3.3.5.23   Alarms for a trip or fault condition shall be signalled to the BEMS using auxiliary volt free contacts built into the contactor.   The trip or fault alarms shall be signalled in both AUTO and HAND modes.

3.3.5.24   Indication of HAND, OFF and AUTO mode shall be signalled using auxiliary volt free contacts fitted to the selector switch.

Control Equipment

3.3.5.25   Obtain advice from the relevant supplier when additional facilities are to be fitted to control equipment supplied by others.

3.3.5.26   Use the control manufacturer's standard accessories to provide any additional contacts, limit switches, potentiometers etc.

3.3.5.27   Use the knockouts, cable routes and terminals etc. incorporated into the design of control devices.

Packaged Plant

3.3.5.28   Connections to packaged plant shall be made within the plant control panel. Where there is insufficient space for this, then a further enclosure to the plant to accommodate the connections shall be fitted.

3.3.6   Additional Provisions for Retrofit
           Installations

3.3.6.1   Arrange for any necessary control modifications to existing plant to be carried out by the original supplier. Give the supplier details of the requirements for connection of equipment to the BEMS. State the name of supplier in the Tender together with a priced

schedule for the necessary work.

3.3.6.2   Where details of existing plant are not available from the original supplier or from record documents, provide a specialist conversant with the particular type of plant to carry out any necessary modifications. Provide the specialist with the details of the BEMS connections required. State the name of the specialist in the Tender together with a priced schedule for this work. Advise the PM of any difficulties with connections.

3.3.6.3   Advise in writing at the time of tender any potential delay to the contract arising from the difficulty of providing the necessary BEMS connections to the plant.

3.3.6.4   Use existing relays and volt free contacts where feasible.

3.3.6.5   Fit auxiliary contacts to contactors etc. where adequate space is available. If the space is not adequate then install additional relays.

3.3.6.6   Obtain advice from the original supplier when additional facilities are to be fitted to existing control equipment.

3.3.6.7   Use the control manufacturer's standard accessories to provide any additional contacts, limit switches, potentiometers etc.

3.3.6.8   Use the knockouts, cable routes and terminals etc. incorporated into the design of control devices wherever possible.   Obtain approval from the PM for ad hoc fixings and modifications to control devices before action is taken on site.

3.3.7   Enclosures for BEMS Equipment

3.3.7.1   The degree of protection afforded by the BEMS equipment enclosure may be reduced to category IP41 in accordance with BS5490 Specification for classification of degrees of protection of enclosures, where the enclosure is fitted inside another panel e.g. a motor control centre. Otherwise enclosures shall be constructed to give the minimum degree of protection to IP54 in accordance with BS5490.

3.3.7.2   Doors shall be 700mm maximum width, mild steel with folded edges and welded corners suitable for eliminating distortion and whip, to a minimum thickness of 2mm.   They shall have hinges of a type which permit removal of the door stays and which prevent

them opening more than 90⁰ degrees.

3.3.7.3   Where the BEMS equipment is incorporated into another control panel, safe access to the BEMS equipment must be possible without isolating the control panel.

3.3.8   Control Panels

Control Panel Design

3.3.8.1   The layout of control panels should reflect the layout of the plant being served. Indicators and controls for associated plant should be grouped together.

3.3.8.2   All doors on any panel containing exposed dangerous voltages shall be provided with interlocked isolators such that the door cannot be opened except with the isolator in the "off" position. Isolation shall comply with BS7671 Requirements for Electrical Installations.

3.3.8.3   Equipment which requires on-line adjustment and testing by non-electrically qualified personnel must be accessible and usable without interrupting the supply or overriding safety interlocks. In general controllers should not be located within control panels where isolation is necessary to gain access.

3.3.8.4   The panel shall be designed to maintain all components within their environmental temperature tolerance limits, having regard to the likely conditions in the area of installation. Where this can only be achieved with mechanical ventilation, incoming air shall be filtered.   Filters should be of a replaceable, disposable type.

Control Panel Construction

3.3.8.5   The doors and casing shall be of rigid self supporting structure. Bracing and stiffening shall be used as necessary to take the weight of internal components and control assemblies. No sharp edges or corners shall be accepted.

3.3.8.6   Control panels weighing more than 50kg including installed components shall have lifting eyes fitted to facilitate delivery and installation.

3.3.8.7   All panels shall be provided with adequate undrilled and/or detachable gland plates of sufficient size and strength to accept glands for all types of cable conduits and cable

trunking intended for termination within the panel.

3.3.8.8   All wiring within the panel shall be arranged in looms and/or perforated trunking. All cables shall be run continuously from terminal to terminal without intervening joints.

3.3.8.9   All terminations shall be fully shrouded, recessed or otherwise protected against accidental contact to comply with classification IP2X of BS EN 60259.

3.3.8.10   Where live equipment cannot be isolated then it shall be covered with a Perspex shield carrying appropriate warning labels in addition to specified shrouding to comply with classification IP2X of BS EN 60529.

3.3.8.11   Wiring looms, cable ways and trunking should be sized to allow for 20% expansion or addition.

3.3.8.12   Flexible looms shall connect door mounted to interior mounted components such that wires shall not weaken or break with repeated door opening. The loom shall be arranged to avoid pinching or looping as the door is closed and be fully supported at each end.

3.3.8.13   All components shall be IP2X finger protected in accordance with BSEN 60529 Specification for degrees of protection provided by enclosures, such that live parts cannot be accidentally touched.

Control Panel Labelling

3.3.8.14   All panels and individual panel sections shall be provided with exterior labels to BS5378 Safety Signs and Colours Part 1 Specification for colour and design (ISO 3864), indicating voltage within the panel section, clear warnings of risk and instructions for isolation. Requirements for informing the BEMS supervisor and/or disabling alarms prior to isolation of control circuits should also be displayed.

3.3.8.15   All switches, controls and indicators on control panels and cubicles shall be clearly labelled as to function and associated plant.

3.3.8.16   If the panel does not totally control the supply or electricity to associated plant then a notice affixed to the front of the panel shall warn of the need for isolation elsewhere.

3.3.8.17   All cables shall be identified with permanently fixed number ferrules. The numbering shall correspond to the numbers affixed to the terminals. Identification and coding should be that used on the design drawings, schematics and schedules.

3.3.9   Power Supplies and Batteries

Power Supply

3.3.9.1   Any additional equipment necessary to ensure that the BEMS is adequately protected against disturbances on the incoming mains and on any standby power supply shall be provided. Carry out all necessary tests to ascertain the quality of all the power supply sources.

Internal Battery Power Supplies

3.3.9.2   This section refers to small rechargeable batteries up to 5Ah rating of the type normally fitted on or adjacent to electronic circuit boards.

3.3.9.3   The tender shall state in writing at the time of tender:

a)   which batteries require regular inspection and how the battery condition shall be monitored.

b)   the maximum service life of the batteries supplied with each item of equipment.

3.3.9.4   The interval between maintenance inspections for each battery power supply shall be not less than 12 months.

3.3.9.5   Lead acid cells are not acceptable for batteries mounted on or adjacent to electronic circuit boards.

3.3.10   Expansion

3.3.10.1   The installation features of the system shall be arranged to allow for at least 20% expansion without redundancy i.e. by addition rather than replacement of hardware.

Section Four - Training

4.1 PROVISION

4.1.1 Provide the training stated in the Particular Specification in the operation and use of the BEMS.

4.1.2 Where possible, provide training at the suppliers works including "hands on" experience of equipment and software similar to the BEMS installation. State the venue for training in writing at the time of tender. Do not include staff accommodation and travelling costs.

4.2 DEFECTS LIABILITY PERIOD

4.2.1 During the Defects Liability Period, the Contractor shall provide personnel skilled in all aspects of the operation of the BEMS for a period of six (6) weeks, to competently and thoroughly instruct the site personnel (as detailed in the Particular Specification) in all aspects of operation, maintenance and trouble shooting techniques associated with the installation.

4.3 TESTING AND INSPECTION OF SENSORS AND ACTUATORS

4.3.1 Training is to include instruction on the procedures for testing and routine inspection of sensors and actuators so that operators remote from the site can more readily assess the nature of a fault and the extent of remedial work required.

4.4 SOFTWARE PROGRAMMING

4.4.1 In addition to the above operator training syllabus, an intensive course in software programming and maintenance shall be conducted to enable the site personnel to undertake software development and maintenance. It is envisaged that this will be completed within the above 6 weeks time frame.

4.5 MANUALS

4.5.1 Appropriate reference and training manuals shall be provided for the staff as part of the training course.

Section Five – Testing and Commissioning

5.1 GENERAL

5.1.1 Commissioning shall involve carrying out all the tests necessary to ensure the correct operational state of the installation. All software shall be loaded and proved. All variable parameters and switches shall be set to appropriate values and settings to ensure compliance with the specification.

5.1.2 Control panels should be checked and rectified off-site at the manufacturer's factory.

5.1.3 The application software should be tested off-site on a software simulation test rig by the manufacturer.

5.1.4 The Contractor shall carry out the commissioning process which shall, as far as possible, be carried out off site.

5.1.5 On site commissioning should start only after pre-commissioning checks of associated building services plant as defined in the relevant CIBSE Commissioning Code and BSRIA Application Handbook 2/92 Commissioning of BEMS – a Code of Practice.

5.1.6 The Contractor shall provide all the necessary test equipment and instruments to carry out the commissioning process.

5.1.7 Prior to activating the BEMS control of the plant it shall be demonstrated to the PM that all the safety interlocks and fail safe conditions are implemented and operational.

5.1.8 A complete record shall be made of all the values of the variable parameters and switches which have been set as a result of the commissioning process. This record shall be included with the documents handed over on completion.

5.1.9 Indelibly mark all physical adjustments to the BEMS field devices so that any movement from the commissioned setting is immediately apparent.

5.1.10 The Contractor shall ensure that engineers conversant with the BEMS are in full time attendance on site to supervise all stages of commissioning and performance testing.

5.1.11 The Contractor shall inform the PM in advance and obtain agreement for the commissioning procedures and proposed timetable for commissioning.

5.1.12 Where tests are carried out on an operational BEMS, ensure that those personnel required to respond to alarms are aware of start and finish times of the testing.

5.2 OPERATION OF BUILDING SERVICES PLANT

5.2.1 Those responsible for the operation of the plant will be available to make any adjustments required for commissioning and testing purposes and to ensure safe operation of the plant.

5.2.2 Where the operation of unserviceable or seasonally disused plant could preclude complete commissioning of the BEMS, the PM shall be informed in sufficient time to allow alternative arrangements for commissioning the BEMS to be made.

5.3 WORKS STANDARDS

5.3.1 All wiring within control MCCs shall be checked at the manufacturer's works, prior to despatch, for loose connections, correct terminations and compliance with wiring diagrams. In addition, functional checks shall be carried out in the manufacturer's works to ensure that all interlocking and sequencing is in accordance with the performance requirements

of the Specification. The PM or his representative shall be given seven days written notice of such tests so that they may attend if they so desire.

5.3.2   This shall be followed by an insulation resistance test with a testing instrument which meets the requirements of BS 7671.

5.3.3   With all live control circuits and neutrals disconnected but with all switch disconnectors closed and power fuses fitted, the MCCs shall be subjected to a pressure test of 2.0kV for one minute, across the following points:

a)   Phase to phase
b)   Phase to neutral
c)   Phase to earth.

5.3.4   With all electronic components and time switches removed and with all switch disconnectors closed and power fuses fitted, an insulation resistance of not less than 20 Megohms shall be obtained between each of the following points.

a)   Phase to phase
b)   Phase to neutral
c)   Phase to earth
d)   Neutral to earth.

5.3.5   Certified schedules detailing all tests and their results in accordance with BS 7671 shall be submitted to the PM within fourteen days of the tests.

5.4   APPROVAL OF STANDARDS

5.4.1   The standard of workmanship shall comply with the requirements of the PM who shall carry out periodic inspections of completed work and work in progress.

5.4.2   Any work not to the satisfaction of the PM during such inspection shall be replaced to a standard satisfactory to the Project Manager at no cost to the Contract for the subsequent inspection.

5.5   TESTING AND WITNESSING OF SOFTWARE

5.5.1   When the Contractor has written and tested the software and prior to loading software onto controllers on site, the Contractor shall demonstrate to the PM or their Representative that the software functions in accordance with the Specification by in-house

simulation of plant operating conditions.

5.5.2   The Contractor shall give the PM seven working days notice of software test dates. The PM may decline to test software off-site. Testing and witnessing of software off-site is additional to the demonstrations detailed under Acceptance Testing and Handover of the Installed System in this Specification.

5.5.3   The Contractor shall produce a written report for all tests listing all noted defects, detailing which defects were rectified during the test and which items remained outstanding. Should a significant number of defects remain outstanding at the termination of a test then the entire associated system/controller software shall be re-tested.

5.6   COMMISSIONING

5.6.1   The installation shall be thoroughly tested by the Contractor to ensure every point and item of plant is being controlled and/or monitored correctly.

5.6.2   It is a requirement that the system is tested and commissioned by personnel who have gained an intimate understanding of the project throughout its design stages. These personnel must also have had at least three years experience in the controls field. Exceptionally should any commissioning personnel not meet these requirements the Contractor must apply to the PM for approval prior to allowing the said commissioning person(s) on site. The PM reserves the right to refuse such commissioning personnel from working on site.

5.6.3   All testing and commissioning shall be preplanned and scheduled in order that it is fully co-ordinated with other relevant trades and shall be carried out in a safe and efficient manner with a minimum of inconvenience to all concerned.

5.6.4   A method statement and programme shall be prepared and agreed with the PM.

5.6.5   The installation shall be tested progressively as construction progresses and then finally on completion to ensure that the installation complies with the Specification and operates correctly under normal, emergency and fault conditions.   Control, protection and operative devices shall be checked for correct

adjustment and rating. Records of testing shall be kept and submitted to the PM for their information.

5.6.6   All equipment or materials found to be faulty during testing shall either be replaced or repaired free of charge.

5.6.7   Where work is being carried out in an occupied building, the management of the building shall be kept fully informed regarding the nature of the testing and commissioning. Steps shall be taken to ensure that any possible hazards or inconvenience that may arise due to the testing and commissioning shall be minimised.

6 Section Six - Acceptance Testing and Handover of the Installed System

6.1 CONTRACTOR TESTS

6.1.1 The Contractor shall test the system and be confident that it meets the requirements of the intent of the Specification, is fully operational, commissioned and all deliverables have been handed over. Then the Contractor shall demonstrate the system to the satisfaction of the PM.

6.1.2 The PM may invite an independent witness to observe the completion tests.

6.1.3 All the tests shall be documented and signed by the testers and the witnesses.

6.1.4 Before the PM attends any demonstrations, the Contractor shall issue a signed document stating that the system has been fully tested and commissioned and complies fully with the Specification.

6.1.5 The tests and verifications shall at least include the following:

a) Audit on the cabling and hardware installation.

b) Demonstration of the physical and logical integrity of the system. This shall include demonstrating that sensors and actuators are correctly connected and addressed.

c) Demonstration of all control actions, including stroking of actuators.

d) Demonstration of sensor calibrations.

e) Demonstration of successful system software commissioning. This should include loading software and documented commissioning data from media and subsequent operation.

f) Demonstration that all safety interlocks and fail safe conditions are implemented and operational.

g) Verification of specified graphics.

h) Verification of specified training requirements.

i) Verification of handover of all specified operating manuals, documentation and drawings.

j) Verification of handover of backup copies of software.

k) Verification of handover of consumable spares.

6.2 RADIO TRANSMITTERS

6.2.1 The Contractor shall make available a minimum of three hand held radio transmitters (complete with chargers etc.) to be used by the PM during the period of acceptance demonstration. Any such devices must be approved for use on the site prior to the acceptance demonstration and should not interfere with the installation or operation of the site.

6.3 CALIBRATION OF INSTRUMENTS

6.3.1 Calibration of all devices shall be demonstrated using currently certified instruments. It will be the responsibility of the Contractor to ensure all instruments and their calibration certificates are available for inspection prior to the demonstration. The instruments and certificates shall remain the property of the Contractor.

6.4 FULLY OPERATIONAL SYSTEM

6.4.1 Acceptance of the system does not absolve the Contractor from his responsibility to provide a fully operational system, should any defects appear during the warranty period, notwithstanding that a fault is not apparent at the time of commissioning.

Section Seven - Performance Tests

7.1   GENERAL

7.1.1   Performance tests are carried out after practical completion to demonstrate that the system functions according to specification.

7.1.2   Any specified characteristic or function of the system can be subject to a performance test.

7.1.3   Performance tests may be carried out during the defects liability period at the instigation of either the PM or Contractor. Both parties shall witness the tests.

7.1.4   Where the performance test is instigated by the PM and carried out by the Contractor, the Contractor will bear the cost of the performance test if a defect in performance is found to exist.

7.2   DEFECTS AND WARRANTIES

7.2.1   Should any defects become apparent during the defects liability or warranty periods, then the Contractor shall rectify those defects "at no cost" according to the Conditions of Contract.

7.2.2   The warranty for any items replaced under warranty will begin at the time of replacement, extending to the period defined in the conditions of contract.

7.3   PROCEDURE

7.3.1   Performance tests shall be carried out in general accordance with BSRIA Application Guide 2/94 BEMS Performance Testing, using personnel with skill levels 2 and 3 as defined in Section 2 of the Application Guide.

Section Eight - Maintenance and Spares

8.1   SPARES

8.1.1   The Contractor shall submit an additional offer at the time of Tender comprising a comprehensive priced list of consumable items and recommended equipment spares.

8.1.2   The list shall be prepared having due regard to the use and extent of the BEMS supplied.

8.1.3   The Contractor shall keep a record of all items replaced during the defects liability period, including the date and reason for replacement.

8.1.4   An undertaking shall be provided from the equipment supplier that all necessary spares will be available for a minimum period of ten years from the date of completion of the defects liability period.

8.2   MAINTENANCE

8.2.1   Where indicated in the Particular Specification, the Contractor shall submit an additional offer at time of tender for three levels of maintenance contract for the system offered i.e. basic, intermediate and comprehensive, for periods of one, three or five years.

8.2.2   The quotation for each level of maintenance contract shall be based on a firm price contract, which is paid monthly and indexed (as per a formula supplied by the Contractor) annually.

8.2.3   Variations throughout the contract period will increase the maintenance contract price on a pro rata basis that is dependent upon the ratio of variations to the original contract price.

8.2.4   The maintenance prices quoted will be based on costs at the time of Tender. The Tender date maintenance price will then be indexed until the system is out of warranty, at which time the first year's maintenance costs will be calculated.

8.2.5   Normal working hours are defined as 9.00am to 5.00pm, Monday to Friday, excluding Bank Holidays unless otherwise indicated.

8.2.6   Unless otherwise agreed, emergency call out shall be charged extra to the base contract.

8.2.7   The minimum service for each of the three levels of maintenance contract shall be as detailed below.

8.2.8   Indicative minimum maintenance service

The number of visits and callout response times are indicative only. They should be selected to achieve the desired reliability and service level.

Basic

8.2.8.1

a)   Preventive maintenance on a 2 visits per year basis. Duties shall include items a) to g), i) to n) and p) to u), from the list in 8.2.8.4. Item u) shall be attended to outside of normal working hours at a time agreed with the Property Manager or appropriate Authorised Officer.

b)   Report and record faults and calibration of sensors/instrumentation.

c)   Rectify faults, excluding main plant faults and recalibrate sensors and instrumentation. Cost of labour and parts to be agreed with the Property Manager or appropriate Authorised Officer.

d)   Telephone support during normal working day.

e)   On site response to emergency call out within 8 working hours.

f)   Essential site specific spares held in stock, off site, by the Contractor for use in an emergency call out.   Essential site specific spares shall include but not be limited to BEMS controller hardware e.g. input/output modules, communications board (where separate), power supply etc. Spares used shall be chargeable to the client. Stock shall be replenished as used.

g)   Loan of BEMS operator's station hardware e.g. PC, monitor, keyboard, printer etc. if original equipment removed from site for repair.

Intermediate

8.2.8.2

a)   Preventive maintenance on a 12 visits per year basis. Duties shall include items a) to u) from the list in 8.2.8.4 below. Item u) shall be attended to outside of normal working hours at a time agreed with the Property Manager or appropriate Authorised Officer.

b)   Report and record faults.

c)   Rectify faults, excluding main plant faults. Cost of labour and parts to be agreed with the Property Manager or appropriate Authorised Officer.

d)   Report and record calibration of sensors and instrumentation.

e)   Recalibrate sensors and instrumentation where required, cost to be inclusive.

f)   Telephone support during normal working day.

g)   On site response to emergency call out within 4 working hours.

h)   Essential site specific spares held in stock, off site, by the Contractor for use in an emergency call out. Essential site specific spares shall be included but not be limited to BEMS controller hardware e.g. input/output modules, communications board (where separate), power supply etc. Spares used shall be chargeable to the client. Stock shall be replenished as used.

i)   Loan of BEMS operator's station hardware e.g. PC, monitor, keyboard, printer etc. if original equipment removed from site for

repair.

Comprehensive

8.2.8.3

a)   Preventive maintenance on an 8 hour, 6 days per week (Monday to Saturday) basis excluding Bank Holidays. Duties shall include items a) to x) from the list in 8.2.8.4 below.

b)   Report and record faults.

c)   Rectify faults, excluding main plant faults, the cost of labour to be inclusive, the cost of replacement parts, excluding frequency converters, to be inclusive when they have become faulty through normal wear and tear.

d)   Report and record calibration of sensors and instrumentation.

e)   Recalibrate sensors and instrumentation where required, cost to be inclusive.

f)   Telephone support 24 hours per day.

g)   On site response to emergency call out within 2 hours of call on a 24 hours, 365 days per year basis.

h)   Essential site specific spares held in stock, on site, by the Contractor for use in an emergency call out. Essential site specific spares shall include but not be limited to BEMS controller hardware e.g. input/output modules, communications board (where separate), power supply etc. Spares used shall only be chargeable to the client if they become faulty through reasons other than normal wear and tear.

i)   Loan of BEMS operator's station hardware e.g. PC, monitor, keyboard, printer etc. if original equipment removed from site for repair.

Preventive Maintenance Duties

8.2.8.4

BEMS

a) Clean operator's station(s) e.g. monitor screen, housings etc. Clean and check operation of printer(s).

b) Carry out manufacturer's maintenance procedures i.e. perform diagnostic tasks

where appropriate, clean filters, clean disc and tape drives etc.

c) Check all cables and connectors.

d) Check integrity of communications network between the operator's station(s), controllers and where applicable, unitary controllers.

e) Check standby battery reserves/operation of UPS system.

f) Check from the operator's station the operation of all plant e.g. boilers, chillers, pumps, fans, electric heaters, batteries, humidifiers, terminal units, valves and dampers in conjunction with associated safety devices by overriding the auto condition and forcing plant on/off, open/closed etc.

g) Software changes to be fully backed-up if any are made e.g. sensor calibration, off-sets etc.

h) Check from the operator's station all controller and PC based software programmes including control loops, rotational points, control strategies, global information etc.

Field Equipment/Plant

i) Check overall condition of all automatic control valves, i.e. check for correct stroke/travel, check that valve is not letting by excessively, check for gland leakage etc. Lubricate in accordance with the manufacturer's requirements.

j) Check overall condition of all damper actuators i.e. check for correct stroke/travel, check auxiliary switches and potentiometers, check spring return if applicable etc. Lubricate in accordance with the manufacturer's requirements.

k) Inspect, clean and check calibration of all sensors and instruments.

l) Check power and control wiring connections at plant and control devices.

m) Check condition and operation of all on/off control devices e.g. thermostats, humidistats, differential pressure switches, flow switches, level switches etc.

n) Check operation of all unitary controllers including speed controllers where field mounted. Carry out functional checks and diagnostic routines, as recommended by the

manufacturer.

o) Check generation of alarms associated with digital inputs by operating field equipment.

p) Visual inspection of condition of main plant i.e. typically pulley belt failure etc.

MCCs

q) Clean exterior/interior of all MCCs.

r) Check condition of wiring, check electrical terminations are tight.

s) Visual and functional inspection of all components e.g. switch disconnectors, switches, indicator lamps, fuses, contactors, overloads, frequency converters etc. Ensure overloads are set correctly for the connected load. Carry out functional checks and diagnostic routines as recommended by the manufacturer.

t) Check operation of local switch disconnectors/stop locks.

u) Check and re-torque busbar nuts and bolts (once per year).

Building Performance

v) Check space temperatures at start of occupancy and time setpoints achieved. Adjust parameters if necessary following consultation and agreement with the Property Manager or appropriate Authorised Officer.

w) Check space temperature/humidity during occupation. Adjust parameters if necessary following consultation and agreement with the Property Manager or appropriate Authorised Officer.

x) Submit monthly report of building performance to the Property Manager or appropriate Authorised Officer.

Note:

(1) When working on or testing MCCs it is essential that all local and national statutory regulations are observed at all times.

(2) Operation of plant under fire and fireman's override conditions is covered by the building statutory fire alarm/evacuation tests, it is not included under Preventive Maintenance.

Annex A – Escrow Agreement

ESCROW AGREEMENT IN CONSIDERATION OF

The Client agreeing under the terms of his Agreement with the Main Contractor to the engagement of The BEMS Contractor and his associated Controls Supplier.

THE BEMS CONTRACTOR UNDERTAKES THAT

1.   The BEMS Contractor will deposit a copy of the source code for all of his software related to the package with a third party to be nominated by the Client.

2.   If the BEMS Contractor or Controls Supplier shall at any time make any change to the source code, the BEMS Contractor shall immediately deposit a revised copy with the said third party.

3.   The BEMS Contractor will pay all costs and charges including those of the said third party incurred in connection with this Escrow Agreement.

4.   In the event that the BEMS Contractor or his appointed agent or the associated Controls Supplier cease to be in the business of maintaining the program product, the Client may invoke this Escrow Agreement to obtain access to the source code and supplementary documentation which is held in Escrow.

5.   In the event that the BEMS Contractor or his appointed agent default or fail to undertake maintenance or the program product the Client may invoke this Escrow Agreement to obtain access to the source code and supplementary documentation which is held in Escrow.

SIGNED on behalf of the said
BEMS Controls Contractor

Signature:

_____

in the presence of:

_____

the   day of   20...

Annex B – Glossary of Terms

Buffer	Semi-conductor memory (RAM) used for temporary storage of I/O communications data.
Communications Channel	Intelligent device which arbitrates one or more communications channel.
Controller	Standalone intelligent control device, fully programmable, with peer to peer communications capability, capable of DDC control of plant. Usually with a capacity of more than 16 input/output points. Also referred to as an outstation.
Controller Network	Second highest data communications level associated with a BEMS. Allows the transfer of information between controllers and/or communications controllers.
EEPROM	Electronically Erasable Programmable Read Only Memory.
EPROM	Erasable Programmable Read Only Memory.
Escrow Agreement	Software source code held by a third party nominated by the Client.
Event Record	Stored historical information detailing a particular alarm event, control parameter change, database change, or operator logging action.
Forced Point	The overriding of any input or output to a specific value. Forcing is applicable to both digital and analogue points.
Gateway	Device which allows communications between two separate communications channels.
Global Communication	The transfer of information between devices on a communications network.
I/O Module	Printed circuit board which plugs into a controller to provide the required BEMS inputs and outputs.
Input Power Supply	Source of electrical power to controllers, computers, peripheral equipment and communications equipment.
Intelligent Device	Processor based device including controllers, unitary controllers, communications controllers and operators' stations.

Logical Groups	Sensors and other sources of performance data that have been grouped together to provide operational information for a specific plant item, system or area.
On Line	State when a controller on a network is ready to receive and transmit data.
Operator's Station	Computer based colour graphics terminal. Connected to the BEMS network and capable of receiving and displaying real time plant information.
Outstation	See 'Controller'
Real Time	Relating to current information obtained from inputs, outputs and virtual points or programmes. It does not relate to stored or historical data.
ROM	Read Only Memory.
Scan Time –I/O	The time taken by a BEMS controller to read all its inputs, process them, send output signals and be ready to read input signals again.
Scan Time - Alarms	The time taken between the occurrence of the alarm and for it to be reported and displayed at the BEMS operator's station or nominated output device e.g. a remote printer.
Schematics	Graphical representation of plant layout, complete with real time point information displayed on the operator's station.
Software licence	Includes any form of document or agreement which may limit the Client's use of the software resident in the BEMS.
Supervisory Network	Highest data communications level associated with a BEMS. Allows transfer of information between outstations and operators' stations.
Token	Communications flag passed between intelligent devices on a common communications channel. An intelligent device is only allowed to initiate communications when it has the token.
Trend Log	A collection of stored data samples relating to either physical I/O or virtual points. Each sample is collected at a fixed time interval from the previous sample collected.
Unitary Controller	Applications specific controller usually with a capacity of less than 16 input/output points.
Unitary	Lowest data communications level associated with a Controller Network BEMS. Allows the transfer of information between unitary controllers and/or their associated communications controller.
Universal Point	A physical input/output point which may be used for either analogue or digital purposes.
UPS	Uninterruptable Power Supply.

Virtual Point

Software point, which may or may not be linked to a physical I/O point, used for the internal transfer of information by a controller.

Wild Card Character

Specific alphanumeric character in a point identifier which substitutes for any other alphanumeric character when a search of points is conducted.

Annex C - Mnemonic Tags for Plant Equipment and Identification

The following mnemonic equipment identification scheme shall be used throughout the Building Energy Management System specification.

1 / SFC / 001

Device Number

Device Type
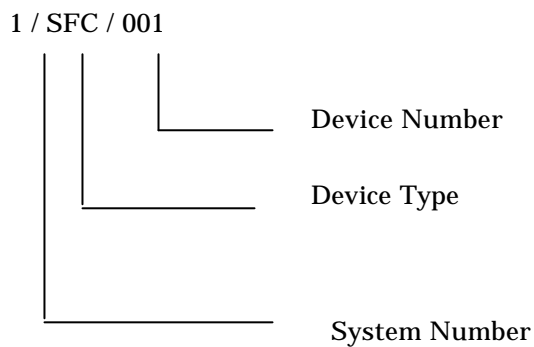
System Number

Each plant is to have a system number, each item of equipment of the plant a device type, each device type a device number.

The following is a list of device types and their associated mnemonics:

DRIVES

SFx	–	Supply Fan
EFx	–	Extract Fan
RFx	–	Return Fan
PPx	–	Primary Pump
SPx	–	Secondary Pump

The characters C, V, 2 or 3 will be substituted for the x notation to indicate constant, variable volume, or multi-speed fans or pumps.

PRESSURE DEVICES

AFS	–	Air Flow Switch
DPS	–	Differential Pressure Switch

DPX   –   Differential Pressure Sensor

SPX   –   Static Pressure Sensor

HPS   –   High Pressure Switch

LPS   –   Low Pressure Switch

OPX   –   Oil Pressure Switch.

TEMPERATURE DEVICES

TAS   –   Thermostat with Averaging Element

TDS   –   Thermostat Stem Type

TIS   –   Immersion Thermostat

TCS   –   Thermostat Clamp-on Type

TWS   –   Thermostat Wall Mounting Type

THL   –   Temperature High Limit

TAX   –   Temperature Sensor with Averaging Element

TSX   –   Temperature Sensor Stem Type

TIX   –   Immersion Temperature Sensor

TCX   –   Temperature Sensor Clamp-on Type

TWX   –   Temperature Sensor Wall Mounting Type

TGX   –   Glass Surface Temperature Sensor

TOX   –   Outside Temperature Sensor

HUMIDITY DEVICES

HDS   –   Humidistat Duct Mounted

HDX   –   Humidity Sensor Duct Mounted

HWX   –   Humidity Sensor Wall Mounted

HOX   –   Outside Humidity Sensor

ENTHALPY DEVICES

EOX   –   Outside Enthalpy Sensor

EWX   –   Wall Mounted Enthalpy Sensor

EDX   –   Duct Mounted Enthalpy Sensor

THX   –   Combined Temperature and Humidity Sensor

FLOW MEASURING DEVICES

QDX   –   Volume Flow Measuring Station Duct Mounted

QPX   –   Volume Flow Measuring Station Pipe Mounted

QDS   –   Volume Flow Switch (Air) Duct Mounted

QPS   –   Volume Flow Switch (Water) Pipe Mounted

VDX   –   Velocity Measuring Station Duct Mounted

MDX	–	Mass Flow Measuring Station Duct Mounted
MPX	–	Mass Flow Measuring Station Pipe Mounted
FDS	–	Flow Switch Paddle Type Duct Mounted
FPS	–	Flow Switch Paddle Type Pipe Mounted

DAMPERS

CDM	–	Modulating Control Damper
CDO	–	On/Off Control Damper
CDR	–	Raise/Lower Control Damper
SDO	–	On/Off Smoke Damper

VALVES

CVM	–	Modulating Control Valve
CVO	–	On/Off Control Valve
CVR	–	Raise/Lower Control Valve
GVS	–	Gas Solenoid Valve
OVS	–	Oil Solenoid Valve

LEVEL SWITCHES

HLS	–	High Level Switch
LLS	–	Low Level Switch

HUMIDIFIERS

HMS	–	Humidifier Step Control
HMM	–	Humidifier Modulating Control
HMO	–	Humidifier On/Off Control

RUN AROUND PUMPS

RAP	–	Run Around Pump

FAN COIL UNIT

FCU	–	Fan Coil Unit

HEATER BATTERIES

HBM	–	Heater Battery Modulating Control
HBS	–	Heater Battery Stepped Control
HBO	–	Heater Battery On/Off Control

BOILERS

BRM   –   Boiler Modulating Control

BRS   –   Boiler Stepped Control

BRO   –   Boiler On/Off Control

BHL   –   Boiler High/Low Control

CHILLERS

CHM   –   Chiller Modulating Control

CHS   –   Chiller Step Control

CHO   –   Chiller On/Off Control

CHQ   –   Chillers Sequence Controller

VOLT FREE INTERFACES

VFC   –   Volt Free Contact

FLT   –   Fault

SEC   –   Security Input

LIT   –   Lighting

FIR   –   Fire Detection System & Fireman's Override Switches

SWITCHES ETC

PBS   –   Push-button Switch

POT   –   Potentiometer

SSW   –   Selector Switch

MISCELLANEOUS

GSX   –   Gas Sensor

LCS   –   Local Control Switch

GBS   –   Gas Booster Set

PRU   –   Pressurisation Unit

FSC   –   Frost Safety Command

ESB   –   Emergency Stop Buttons

FCH   –   Fan Convector Heater

IMH   –   Immersion Heater

TRH   –   Trace Heating

CCH   –   Crank Case Heater

SDO   –   Safety Digital Output

HEP   –   Heat Pump Interfaces

SDX   –   Duct Mounted Smoke Sensor

WLX   –   Water Leakage Sensor

CIN   –   Contents Indicator

HAS   –   High Level Alarm Sounder

PRS   –   Proximity Switch

HCG   –   Hydrostatic Contents Gauge (with capillary tubing and transmitter)

ACU   –   Air Conditioning Unit

SOX   –   Outside Solar Sensor

LOX   –   Outside Light Sensor.

Schedule No. 1: Information for the Tenderer

This first page of Schedule No. 1 gives an overall indication of the scope of the proposed installation. The following pages give more detailed information of the requirements.

Project location

Primary site use

Buildings to be served by BEMS

Gross area of buildings to be served by BEMS   …………..m^2

Gross cube of buildings to be served by BEMS   …………..m^3

Clause	*Item	*Options/Requirements
	General Requirements	
1.1.3	Plant and system functions	see Particular Specification
1.1.5	Scope of work	see Particular Specification
1.1.6	Comprehensive planned preventive maintenance	*not required/see Particular Specification
1.1.7	All equipment and materials shall be new	*all new/see Particular Specification
1.4.2	Specifier to list excluded clauses	*all included/see Particular Specification
1.5.2	Systems not of proven performance	*will be considered/will NOT be considered
1.6.4	Confirm to relevant British Standards and Codes of Practice current 3 months before date of return of tender	*as Clause 1.6.4/see Particular Specification
1.6.5	Compliance with relevant MOD Standards and Guidance	*as Clause 1.6.5/see Particular Specification
1.8	Electromagnetic compatibility	*as Clause 1.8/see Particular Specification
1.9.1.1	Working drawings for comment	*as Clause 1.9.1.1/not required
1.9.3.1	Contractor shall provide four sets of 'as installed' drawings	*as Clause1.9.3.1/see Particular Specification
1.9.3.2	Draft copies of 'as installed' drawings shall be submitted to the PM	*not required/as Clause 1.9.3.2
1.10.1	Contractor shall provide two copies of the approved Health and Safety File	*as Clause 1.10.1/see Particular Specification
1.10.2	Draft copy of document	*as Clause 1.10.2/not required
1.15	Provide samples for inspection by PM	*not required/see Particular Specification
	System	
2.1.2.2	Standard Specification clauses not required	*not applicable/see Particular Specification
2.2.2	Power failure restoration or normal mode following a fire	*as Clause 2.2.2/see Particular Specification
2.3.1.1	No. of operator stations, peripherals etc.	*not required/… No. required
2.3.1.2	Functions of Operator Stations detailed as	*not specified/see Particular Specification/Tenderer to specify
2.3.2.3	Operator station configured to attain full functional status following switch-on or restoration of power supply	*not required/required
2.3.2.6	Nominated operator station for real time clock	*see Particular Specification

Clause	*Item	*Options/Requirements
	General Requirements	
	synchronisation	
2.3.2.8	Operator station hard disk capacity	*as Clause 2.3.2.8/see Particular Specification
2.3.2.9	Lap top computer	*not required/required/…….No required
2.3.3.1	Operator actions	*see Particular Specification
2.3.5.3	Facility to extract data and export to other systems	*as Clause 2.3.5.3/not required
2.3.6	Colour graphic displays	*as Clause 2.3.6/not required
2.3.6.14	Positive feedback of desired effect	*as Clause 2.3.6.14/not required/see Particular Specification
2.3.7.6	Frequency of visible reminder message of alarm disabled	*not required/see Particular Specification
2.3.8.2	Analogue alarms inhibited when plant commanded off	*as Clause 2.3.8.2/see Particular Specification
2.3.9	Information redirection and alarm transfer	*not required/as Clause 2.3.9/see Particular Specification
2.3.9.1	Alternative operator station designated as	……………………………………..
2.3.9.2	Alarms to be transferred to alternative operator station	*not required/see Particular Specification
2.3.11	Monitoring and Targeting	*not required/see Clause 2.3.11/see Particular Specification
2.3.12.5	Dimensions of monitor visible viewing area	*Diagonal dimension to be not less than 17" (430mm)/see Particular Specification
2.3.12.7	Dot matrix	*not required/… No. required/ location
2.3.12.9	Laser	*not required/… No. required/ location
2.3.12.10	Inkjet	*not required/… No. required/ location
2.4.1.2	Number of general purpose and unitary controllers	*see Particular Specification/ Tenderer to state in Schedule 2
2.4.5.4	Accuracy of displayed value at the operator's station	*see Particular Specification
2.4.7.1	Controller shall automatically return to normal action	*see Particular Specification
	*Delete or complete as necessary	

Clause	*Item	*Options/Requirements
	General Requirements	
2.4.8.2	On detecting a fault controller set to pre-determined condition	*established by the Contractor/see Particular Specification.
2.4.9.1	Controller interfaces	*as Clause 2.4.9.1/see Particular Specification
2.4.10.2	Interface characteristics	*as Clause 2.4.10.2/see Particular Specification
2.4.15	Remote portable terminals	*not required/as Clause 2.4.15/see Particular Specification
2.4.16.1	Laptop computer	*not required/see Particular Specification
2.4.17	Uninterruptable power supply	*not required/as Clause 2.4.17/see Particular specification.
2.5.3.14	Totalisation program for meters	*not required/ *shall be provided for electricity meters … no. & ref gas meters …no. & ref fuel oil meters … no. & ref water meters … no. & ref
2.5.3.16	Meter reading information used for validation or recharge	*not required/as Clause 2.5.3.16/see Particular Specification
2.5.4.35	Optimum start 'boost'	*as Clause 2.5.4.35/not required/ see Particular Specification
2.5.4.47-49	Building/plant protection routine shall override other operating programmes	*not required/see Particular Specification
2.5.4.52-53	Load shedding	*not required/see Particular Specification and associated Schedule
2.5.4.54-55	Fresh air control proportions	*not required/based upon enthalpy/based on dry bulb temperature
2.5.4.56-59	Enthalpy control	*not required/see Particular Specification Minimum time dampers in minimum fresh air position shall be ……… minutes
2.5.4.60-61	Air quality control	*not required/see Particular Specification
2.5.4.62-64	Lighting control	*not required/see Particular Specification
2.5.4.65	Emergency lighting	*not required/see Particular Specification
2.5.4.66-67	Occupancy Control	*not required/see Particular Specification
2.5.4.68	Fire and Security control	*not required/see Particular Specification
2.6.4.5	Pre-determined number of unauthorised attempts to access via the modem	*not required/three/see Particular Specification

Clause	*Item	*Options/Requirements
	General Requirements	
2.7.1.4 (a)	Two position switching devices shall have concealed adjustment	*not required/required
2.7.1.4 (b)	Two position switching devices hand reset feature	*not required/required
2.7.2.8	Averaging elements	*not required/see Particular Specification
2.7.2.15	Room thermostats set point	*see Particular Specification
2.7.2.16	Room Adjustment	*not required/see Particular Specification
2.7.2.17	Manual override	*not required/see Particular Specification
2.7.2.19	Duct mounted & immersion thermostat set point	*see Particular Specification
2.7.2.20	Duct mounted & immersion thermostats, adjustable differential	*not required/see Particular Specification
2.7.2.21	Duct mounted frost protection thermostat clamp-on type	*not required/see Particular Specification
	Duct mounted frost protection thermostat electronic clamp-on style	*not required/see Particular Specification
2.7.2.28	Humidistat set point	*see Particular Specification
2.7.2.40	Airflow switches special atmospheric conditions	*not applicable/see Particular Specification
2.7.2.51	Immersion & duct mounted temperature sensor accuracy	*as clause 2.7.2.51/see Particular Specification
2.7.3.7	Actuator additional features	*not required/see Particular Specification
2.7.4.3	Unitary controller	*not required/see Particular Specification
2.7.5.14	Gas detection	*not required/see Particular Specification
	Installation	
3.2.3.13	Provisions for back up copies of firmware	*not required/…..No. required To be submitted to
3.2.3.15	Superseded software	*as Clause 3.2.3.15/see Particular Specification
3.3.1.2	Schedule of Actions on BEMS failure	*not required/see Particular Specification
3.3.1.3	Plant start/stop sequence	*not required/see Particular Specification
3.3.3.8	Data transmission and analogue sensor cables must be screened	*not required/see Particular Specification
3.3.5.11	Manual control facilities	*as Clause 3.3.5.11/see Particular

Clause	*Item	*Options/Requirements
	General Requirements	
		Specification
3.3.5.18	Actuators shall include a position feedback device	*not required/see Particular Specification
3.3.5.21	Additional contacts for signalling and remote operation	*not required/see Particular Specification
3.3.6	Additional provision for retrofit installations	*not required/see Particular Specification
	Training	*not required/see Particular Specification.
4.1.1	Site personnel to be trained	*see Particular Specification
	Maintenance	
8.1.1	Spares – comprehensive priced list of consumable items	*as Clause 8.1.1/not required
8.2.1	Maintenance – additional offer for three levels of maintenance	*as Clause 8.2.1/not required

*Delete or complete as necessary

Schedule No. 2: Information to be Supplied by Tenderer

Clause	*Item System	Requirements
1.8.4	Methods intended for the elimination of interference with signal and data transmission.	
2.3.1.2	Functions of Operator Stations detailed as	Tenderer to specify (where required under Schedule 1)
2.3.10.5	Ownership of application software retained by Client; Tender price includes all royalties and ownership fees; client can modify programmes	confirmed/not confirmed
2.3.12.3	Specification of components for each Operator Station	Tenderer to provide
2.4.1.2	Number of general purpose and unitary controllers (where required under Schedule 1)	Tenderer to provide
2.4.14.1	Controller spare capacity	Tenderer to provide
3	Installation	
3.2.3.5	Availability and cost of further packaged software	Tenderer to provide
3.2.3.6	Functional description and details of software to be written	Tenderer to provide
	Procedure for providing software	Tenderer to provide
	Previous experience of having similar software written	Tenderer to provide
3.2.3.14	Software support service	Tenderer to provide

Clause	*Item System	Requirements
3.3.4.2	Any existing means of communication between controllers and operator facilities is of suitable standard	*Confirmed/*not confirmed *by test *by certificate
3.3.4.5	Existing local telephone system	*suitable/*not suitable If not suitable, Tenderer to state reasons
3.3.4.9	Certification from network operator that BEMS is able to operate satisfactorily	*provided/*not provided
3.3.4.18	Existing cable is suitable	*confirmed/*not confirmed
3.3.5.3	Plant and control equipment supplied by others	Tenderer to provide details of installation requirements
3.3.5.4	Plant subject to warranty by others	Tenderer to obtain clearance in writing that proposed modifications do not invalidate warranties
3.3.6.1	Additional provision for retrofit installations - use of original supplier	Tenderer to state name of supplier and provide priced schedule
3.3.6.2	Additional provision for retrofit installations - use of a specialist	Tenderer to state name of specialist and provide priced schedule
3.3.6.3	Potential delay in contract due to providing BEMS connections to plant	Tenderer to advise
3.3.9.3	Internal battery power supplies	Tenderer to state which batteries require regular inspection, how batteries shall be monitored, maximum service life of batteries
4	Training	
4.1.2	Venue for training	Tenderer to state