NA

From: NA
Sent: Tuesday, February 19, 2008 1:47 PM
To: members_of_the_staff
Subject: Revision to ACMV Master Specifications

Our Ref: OM-SC/008

Please note the following Air Conditioning & Mechanical Ventilation Installation master specifications have been revised as attached.

Section 8 - Controls (DSC & NSC)

Clause 8.12 - Computer Based Control System



A8.12 computer based control s...

Regards
NA

Alpha
Consulting Engineers Pte Ltd

FEEDBACK REPORT FORM

Ref No: 101-180208(S)

To: LCT From: CHOONG C G

Job No./Project: MASTER SPECS - ACMV - CONTROLS *(where applicable)*

Source of feedback: (Clause 8.12 Computer Based Control System)

Scope of Feedback: * ~~Quality / Environmental / Administrative / Contractual / Technical /~~ Specification / ~~Others~~

Section A : Problem & Cause

The section for the CCS software is not well developed.

Section B : Mitigating Action Taken, if any

N.A.

Section C : Suggested Corrective Action

Amend section 8.12 of ACMV Mech Spec as attached.

Section D : Approved Corrective Action

Document Affected : ☐ Yes ☐ No Affected Document : _____

Approved By : _____ Date : 18/2

Section E : Action

Action By : NA

Targeted Completion : End Feb '08

Actual Completion : 19 Feb '08 Verified By : _____

* *Delete as appropriate*

Distribution: | | | | | | |

energised both on the local control panel and at the Computer-based Control Centre.

8.11.7.3 FCU Controls - VAV

Each FCU shall be provided with an automatic fan speed controller to maintain a preset room dry bulb temperature. A temperature sensor located at the return air path shall send signal to the controller to modulate the FCU air quantity. The minimum air quantity supply to the room shall not be less than 40% of its maximum air capacity. FCU shall be connected to an ON/OFF switch. Location of this switch shall be to Architect's approval. The switch shall energise and de-energise the FCU's fan motor, speed controller and the 2-way motorised valve. Fan speed controller shall be of the proportional control type.

15/02/08

8.12 Computer Based Control System

8.12.1 General

A Computer-based Control System (CCS) shall be supplied and installed as specified in the Specification and Drawings and in accordance with the Schedule of Technical Requirements. The System offered shall be able to monitor all electrical and mechanical signals from the following services:

(a) Air Conditioning & Ventilation Installation

(b) Fire Fighting & Alarm Installation

(c) Plumbing & Sanitary Installation

(d) Electrical Installation

The CCS installed shall also be compatible with the general controls equipment used in the Air Conditioning and Ventilation Installation. The CCS installation shall be complete with all necessary components, equipment, accessories, wirings, etc. for a completely operable and satisfactory system. The Sub-Contractor shall provide all necessary details and information relating to the installation for the Architect's comments before commencement of works.

The CCS shall be completely modular in design, configuration and construction in both software and hardware to ensure future expansion capability within the Building without the need of replacing the equipment offered. However, additional equipment or increasing of central console function capability may be considered. The system shall include all proven computer software and hardware, operator input/output devices, automatic sensors, controls and all other necessary field and communication devices.

The CCS shall be suitable for continuous and satisfactory operation under an ambient condition from 21 degree Celsius to 40 degree Celsius and a relative humidity of up to 100% (non-condensing). The Sub-Contractors unable to comply with this requirement shall state so under the Schedule of Deviations to be submitted with their tenders.

The CCS shall be tolerant of PowerGrid's electricity power supply as specified elsewhere in these Specifications and the use of essential power supply from the standby generator set. All incidental cost for the use of any isolation transformer, voltage surge suppressor etc., if required, shall be deemed to have been included in the Sub-Contract Price. The CCS shall also be tolerant of power failures. When operating on essential power supply derived from the standby generator set or on restoration of the power supply, the system shall automatically come on line without operator intervention or execution of manual re-start procedures. During the temporary 'shut-down' time, there shall be no loss of programme or computer data. A battery-backed

(72 hours minimum) real time clock shall be included so that operator does not need to reset or re-enter the real time on restoration.

The CCS shall have a capacity to handle the function points specified in the Schedule of Technical Requirements plus 30% additional functional points for future use with no increase of central data equipment and Intelligent Field Stations. Full technical information and function points capacity shall be provided for the CCS offered. The functional points provided in the Schedule of Technical Requirements shall include, but not limited to, the following features:

(i) Start/Stop/Status/Alarm

All start/stop/status/alarm points shall be provided with true and positive indication. Suitable flow switches, or other status indication devices shall be provided as necessary. Alarm indication in flashing text shall be shown when a change of status occur after a pre-determined time delay. The time delay shall be soft-ware programmable through keyboard by operator to prevent irrelevant and unwanted alarm outputs during mechanical plants start-up.

(ii) Analogue

All analogue shall be complete with high and/or low limits. The analogue readings shall be compared with the pre-determined high and low limits and annunciate each time a value enters or returns from an alarm limit condition. Each alarm shall be distinguished as either a high or low limit conditions with programmable alarm message and instructions.

Printouts/Displays shall express analogue values in the same units as in these Specifications and/or shown in the Specification Drawings, and shall include negative signs where applicable.

Accuracy between sensor and readout shall be within $\pm$ 0.2 degree Celsius. Every analogue sensor shall have individual zero and space adjustment.

(iii) Status

True and positive indication shall be provided for all status points required under this Sub-Contract. Flow switches or other accepted status indication devices shall be provided as and when necessary.

(iv) Status/Alarm

This shall be similar to the status indication, except that when there is a change of state, an alarm condition shall be displayed with flashing text and provided at the printout. When the point returns to normal after an alarm, a normal change of state message shall be output by the system. The status/alarm printouts and displays shall include and show the following information:

- time and date
- address text to show where the function point is located and its function at the plant
- reaction text to give instructions concerning corrective action, intervention to be initiated or maintenance activities etc.

8.12.2 Hardware

The digital control system shall be provided complete with the following hardware:

8.12.2.1 Communications Network

The communications network connecting the operator workstations to the Intelligent Field Stations shall be an industry standard LAN. One of the following industry standard LAN shall be considered: Ethernet, ARCNET, Token Bus, Token Ring. The communications network shall be able to support peer-to-peer communications of all points in the system concurrently. The communications network shall communicate at a minimum speed of 100 Mbits per second. Data transmission shall be in digital form through the high speed communications network for alarm reporting, quick report generation from multiple network controllers, and upload/download efficiency between network devices.

The communications network shall support communications between Intelligent Field Stations, between Intelligent Field Stations and operator workstations and between operator workstations. The communications network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions in the event of single or multiple failure.

The communications network shall support the point reporting resolution specified and/or communication traffic of minimum 300 Change of State messages per minute.

The communications network design shall also include the following provisions:

- Message and alarm buffering to prevent information from being lost.

- Error detection, correction, and retransmission to guarantee data integrity.

- Default device definition to prevent loss of alarms or data, and ensure alarms reported as quickly as possible in the event an operator devices does not respond.

- Commonly available, multiple sourced, networking components and protocols shall be used to allow the CCS to coexist with other networking applications such as office automation.

- Use of an industry standard IEEE 802.x protocol Communications to assure calculable performance under worst-case network loading.

- Synchronization of the real-time clocks in all network control shall be provided.

(a) <u>Workgroup Hub/Switch</u>

12-port cascaded 10/100/1000 Base-T/TX Gigabit Ethernet Hubs/Switches, which supports data rates up to 1,000 Mbps shall be provided.

With strict adherence to the IEEE 802.3u specification for 10/100/1000 Base-T/TX Gigabit Ethernet, the hub/switch shall support 12 nos. of RJ45 connections using Cat 5e UTP cable.

It shall be possible to simply cascade a second hub/switch to form a built-in port for connection of more than 12 Gigabit Ethernet devices.

The hub/switch shall have an optional fiber-optic up-link module for future backbone connection.

The hub/switch shall have LED status indicators for power, collision, network utilization, error and valid port link status.

The hub/switch shall allow "hot swapping" (installation or removal of modules with the power on) of modules in the operating network without interruption to other users in the network.

The hub/switch shall be remotely manageable and hub/switch management software must be provided.

The hub/switch management software shall provide capability to monitor and manage all equipment attached to the hub/switch up to individual port level.

The hub/switch shall be able to identify malfunctioning ports and automatically partition or restore them to avoid network disruption.

The multipart repeater modules in the hub/switch shall be able to function as a standalone unit.

The hub/switch management software must present the hub/switch operating status as well as the status information of each module attached to the hub/switch in a graphical user interface. Documentation for the software must be provided.

(b) Communication Cabling

The cabling shall employ EIA/TIA 568 Cat 5e twisted-pair cabling and a looped configuration topology.

All the patch cable supplied must be factory build with no field termination.

All cables shall conform to the IEEE 802.3u standard and 10/100/1000 Base-T/TX cable shall be provided to each node.

Installation and plastic market tag cable labeling shall be included.

Upon completion of installation, end to end testing of all cables shall be conducted and documented.

(c) Network Equipment Cabinet

The network equipment cabinet must comply with the industrial standard 19" equipment cabinet.

It shall be able to house all the proposed connectivity equipment, including hubs and cable management system.

There must be power supply sockets to provide power to the network equipment installed inside the cabinet.

The cabinet must provide built-in fans for the ventilation of network equipment inside the cabinet.

The base of the cabinet must have rollers for the ease of moving the cabinet from one place to another.

Both doors at the front and rear must be detachable.

The cabinet must provide locks both in front and at the back.

The height of the cabinet should be preferably 1 .8m.

8.12.2.2 Basic Central Equipment

The CCS shall communicate in full English language. Point addresses shall be in alphanumeric of not less than 14 characters. Basic central equipment shall comprise one high performance real time, digital personal computers, rated with such applications, complete with keyboard and mouse, one colour graphic monitor, system printers. The work station shall provide for total keyboard-less operation as the primary operator interface. The mouse shall not require the use of more than one button for operation.

(a) System Server

The System Server shall comprise a high performance real time, digital multi-media personal computer, rated for such application; complete with keyboard and mouse, colour graphic LCD monitor and integrated speakers.

The System Server shall meet the following minimum specification:

- 32 bit processor 3.0 GHz CPU
- Minimum 8 GB RAM on board
- Minimum 2 nos. 500 GB Hard Disk in RAID1 configuration
- Two (2) DVD-RW Drive
- XGA graphic card with 512 MB Video RAM
- Integrated 16-bit Sound Card
- 15-in-1 Memory Card Reader
- Mouse and keyboard
- Minimum of 5 expansion slots (PCI or ISA)
- 10/100/1000 Gigabit Ethernet network interface card

The colour graphic monitor shall be 24" LCD flat wide screen type with non-glare display screen, resolution of 1680 by 1050 and 16.7 Million colours.

The technical specifications shall serve as the minimum requirement. The sub-contractor shall undertake to supply the computer complying with the most up to date technical standard at the time of installation of the system.

The Operating System for the System Server shall be Windows NT Server or later.

The System Server shall be complete with adequate memory capacity to cater for all the function points (including 30% future additional points), software programmes and system for

future expansion without any changes to the central processor or operator communication devices except for the additional memory modules and appropriate Software. Full information on computer memory capacity sizing shall be provided for the CCS proposed and such information shall be supplied at the time of tendering.

Programmes/data shall be loaded through DVD drives.

(b) Operator Workstation

The proposed system shall support network connected Operator WorkStation (OWS) in the 10/100/1000 Base-T/TX Gigabit Ethernet LAN environment. The Operator WorkStation shall comprise of a high performance real time, digital multimedia personal computer, rated with such application, complete with keyboard and mouse, colour graphic LCD monitor and integrated speakers.

The Operator WorkStation shall meet the following minimum specification:

- 32 bit processor 3.0 GHz CPU
- Minimum 8 GB RAM on board
- Minimum 2 nos. 500 GB Hard Disk in RAID1 configuration
- Two (2) DVD-RW Drive
- XGA graphic card with 512 MB Video RAM
- Integrated 16-bit Sound Card
- 15-in-1 Memory Card Reader
- Mouse and keyboard
- Minimum of 5 expansion slots (PCI or ISA)
- 10/100/1000 Gigabit Ethernet network interface card

The colour graphic monitor shall be 24" LCD flat wide screen type with non-glare display screen, resolution of 1680 by 1050 and 16.7 Million colours.

The technical specifications shall serve as the minimum requirement. The Sub-Contractor shall undertake to supply the computer complying with the latest technical standard at the time of installation of the system.

The Operating System on the Workstation shall be Windows NT/XP/Vista or later.

(c) Portable Operator WorkStation

The Contractor shall provide one colour notebook computer, suitable for remote dialing-in, as the Portable Operator WorkStation (POW). The POW shall come with the same graphical software as in Operator WorkStation. The POW shall meet the following minimum specifications:-

- 32 bit processor 2.0 GHz CPU
- Minimum 4 GB RAM on board
- Minimum 160 GB Hard Disk
- Integrated DVD-RW Drive
- XGA graphic card with 256 MB Video RAM

- Integrated 16-bit Sound Card
- Integrated Memory Card Reader
- Integrated keyboard with touchpad and one (1) mouse
- Integrated 10/100/1000 Gigabit Ethernet network interface card
- Integrated wireless interface card for IEEE802.11a/b/g/n and Bluetooth

The colour graphic display shall be 12" LCD flat wide screen type with non-glare display screen, resolution of 1280 by 800 and 16.7 Million colours. The overall weight for the POW shall not be more than 2 kg.

The technical specifications shall serve as the minimum requirement. The Sub-Contractor shall undertake to supply the POW complying with the latest technical standard at the time of installation of the system. The Sub-Contractor shall purchase the POW only two months before the testing and commissioning of the CCS. He shall notify the Architect before the purchase.

(d) Alarm Printer

The alarm printer shall be connected to the System Server for logging of all alarm messages and acknowledgment of alarms.

The printers shall comply with the following minimum specifications:

- 136 column/250 character per second minimum print speed.

- 24 pins dot matrix character structure switchable to 29 x 23 dot matrix for letter quality output with 96 ASCII upper/lower case character set.

- Software selectable under, emphasized, double strike and expanded (double width) characters capability.

- Adjustable line spacing of six or eight lines per inch with compressed mode option for 220 characters/line and bi-directional printer and logic seeking.

- Adjustable tractor feed for 92mm to 364mm paper widths.

- Single bin 50 sheet cut sheet feeder

The alarm printer shall be directly connected to the system communications network and shall operate when the workstation is off-line.

(e) Network Colour Printer

A hard-copy multi-color graphics printer shall be provided for recording graphic displays and associated dynamic data. Printer shall meet minimum requirements as follows:

- 720 x 720 dpi resolution with minimum 21 basic colors with different shades.

- Minimum 4ppm for Near Photo Quality Printing.

- 10 Kilobytes Input data buffer size

(f) Portable Service Terminal

To assist owner's personnel in troubleshooting the mechanical systems, connections for portable service terminals shall be provided at each network controller.

Connection of the portable service terminal shall not affect the normal operation of any other parts of the system.

The password used to gain access into the system using the terminal shall be the same as the password used to log on to the Operator Workstation. The method of addressing points used at the portable service terminal shall be the same as the method of addressing points at the Operator Workstation.

The operator shall be able to access all points in the system from the portable service terminal.

The method of accessing data stored in any one Intelligent Field Station shall be identical to the format for information stored in other network controller.

The Portable Service Terminal shall provide the following functions for all points in the network:

- Displaying point status
- Adjusting analog values
- Commanding binary values
- Viewing last 48 samples for all analog values
- Viewing last 10 change of states for all binary values
- View and adjust alarm/warning limits
- View and adjust time schedules

One portable service terminal shall be provided.

The portable service terminal shall be provided with a connector allowing connection to each IFS.

The terminal shall incorporate a keyboard, a visual display and rechargeable battery power supply.

(g) Uninterruptable Power Supply (UPS)

A solid-state UPS system shall be furnished to provide regulated no-break alternating current (AC) power to all central hardware, in the CCS room, communication controllers/modems, necessary for the operation of the system and to all DDC controllers which control and monitor emergency equipment such as smoke purging/extract/pressurisation fans and staircase exit MV fans etc., per CCS Point Schedule.

The UPS shall be designed for unattended operation under any combination of the following environmental conditions without degradation of operating characteristics and mechanical and electrical damage.

Operating ambient temperature : 0°C to 40°C
Relative Humidity : 0% to 95% without condensation

Built-in protection against lightning surges shall be provided on the primary source.

Noise generated by the UPS under any condition of normal operation shall not exceed the allowable sound pressure level of 45 dB measured at 2 meters from the nearest surface of the cabinet.

The UPS shall be sized to provide a minimum output of 1.5 times the total connected load drawn by all the equipment. Power factor at full load shall be better than 0.80 lagging.

The battery shall have a capacity to support the full rating of the UPS module for a minimum period of 120 minute at a temperature of 25 deg C.

8.12.2.3 Intelligent Field Stations (IFS)

IFS shall be provided to perform monitor and control function for all M&E equipment such as chillers, pumps, fans, AHUs, FCUs, VAV boxes, etc. as specified in the Point Schedules.

The IFS shall be capable of standalone operation to provide stable and continuous control function without dependant of other CPU or Workstations.

The IFS shall be able to continue executing reaction program, storage of Data, time programme, energy optimisation program and programmable logic control with full STANDALONE capability during power failure or transmission failure with the workstation or other IFS,

IFS shall be Full 16 bits microprocessor-based with EPROM for operating system and minimum 25mHz operating speed. There shall be adequate memory capacity to cater for all function points (including 30% future additional points), software programmes and system for future expansion without any changes to the microprocessor unit except for the additional memory modules and appropriate software. EPROM shall be socketed for easy replacement. The operating program consist of the basis program, reaction program, etc shall be stored in its individual EPROM of minimum 320k bytes. All other variable data such as limit values, time command and control parameter shall be stored in the static RAM or EPROM of minimum 320k which may be expandable to no less than 768k bytes. The IFS shall have at least 1MB RAM for system function and shall be backed up by battery or capacitor for no less than 8 hours. Provision shall be made for instant loop recovery upon power restoration after an outage beyond that which is power backed. RAM and clock for EPROM/RAM systems shall be provided with power back of 4 hours instant recharge capacitor or 12 hours trickle charged batteries. RAM images, including all user additions and changes shall be up/down line loadable to central disk for back up. All IFS shall be automatically re-

initialized upon power restoration after an outage beyond that which is power backed.

Each IFS shall be able to share data and transfer required information to and from among each other without transmitting through the workstation. The data transfer and information sharing shall be unlimited, i.e. any information from any IFS can be imported to another IFS for logic control function, or any programming function. The number of points able to share around between various IFS shall be unlimited.

The IFS functioning as Direct Digital Controller shall be capable of processing data in a digital format using a microprocessor and handling a number of control loops with on-line definition of interlaced control functions and their characteristics. The IFS shall constantly scans it's set points and actual values using it's own processor and determines the control action to be taken.

Control loop shall be provided for control and monitor with the combination of any control mode such as Proportional, Proportional plus Integral, Proportional, Integral and Differential as well as cascades. All the control loop shall be software selectable at anytime. Each control loop shall also have minimum of 2 set points adjustment and 2 output control function. The analogue output of the control loops shall be continuously updated and output by the programme.

Digital control algorithms shall be built-in to enable proportional, integral, derivative and two-position control modes in any combination.

All parameters, slope, control action, limit values etc., can be modified easily in digital form.

Each IFS shall consist of multiple input/output hardware points with termination for sensors and contact interface for direct wiring.

The following input and output function capabilities shall be supported:

- Digital inputs (voltage free contacts on monitored equipment, voltage applied by IFS shall not exceed 24Vdc) for normally open/closed contacts

- Pulsed inputs

- Analogue inputs (continuous 4-20mA, 0-10VDC)

- Digital outputs (momentary, continuous and pulse-width modulated), each indicated by a LED

- Analogue outputs (continuous 4-20mA, 0-10VDC)

Each IFS shall incorporate a 12-bit analogue to digital converter and a 8-bit digital to analogue convertor.

LED indicating lights shall be provided for status indication of the IFS in the following functions:

* ON/OFF status of the IFS power supply
* CPU status
* Communication status with other IFS

* Scanning of internal I/O points
* Communication status with Workstation

I/O ports shall be Universal type for input and Universal type for outputs allowing the required digital and analogue inputs/outputs to be software programmed to suit the particular application and future modification.

Cabinet housing the IFS shall be wall mounted and constructed as specified under Section '7' - Switchboards. Additional cooling fan may be provided to remove excessive heat generated by the electronic components. A plastic coated, fade free points list shall be mounted on the inside to the cabinet door identifying all output and input points together with terminal numbers and addresses.

IFS should have capacity to be accessed directly by a laptop computer and directly linked to a printer to printout substantial information which include alarm printing, reporting, trending, system display and graphical printout. All IFS to be provided with one output port to a printer for direct printing. Printer may not be provided for each IFS.

High level and commonly used programmable computing software similar to the 'C language' or 'Visual BASIC' must be provided to meet the control requirements called for in the 'Control Sequence of Operation' section of the Specifications. Each IFS shall have resident in its memory and available to the programs a full library of digital control algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences. The Controllers shall measure response time and adjust control parameters accordingly to provide optimum control. The software shall allow self-tuning of the variable control loops (P, P+I, P+I+D) of the AHUS and chiller system so as to provide the most efficient and optimised controls at different load conditions. The energy management programs update their parameters based on past experience and current operating conditions.

Each intelligent field station must be able to perform the following energy management functions and be equipped with software capability to operate on a stand alone basis without a master controller or a IBMS computer. Minimum requirements of software packages are:

- Passwords
- Point Parameter Involvement
- Time Display
- Time & Command Programme
- Event Initiated Command Programme
- Run Time Totalisation Programme
- Power Failure Restart Programme
- Summaries Logging Programme
- Trend Recording Programme
- Optimum start/stop

- P.I.D control
- Timers
- Interlocking
- Diagnostics

IFS communication link shall be of flexible configuration such that system expansion shall easily be done by T-tap off from the system transmission line at any location to add a IFS or a workstation without any other forms of additional hardware.

IFS's shall include protection against generated back e.m.f. voltage surge power transformers with over voltage protection, communication controllers, time clock, input and output modules for analogue and digital functions and self charging battery backup capable of supporting all function and self for 72 hours. Printed circuit boards shall be of the plug in type, keyed to prevent incorrect installation. Terminal pins shall be gold plated. Printed circuit boards shall be replaceable without having to disconnect the field wiring.

8.12.2.4 System Software Programme

The specifications stated herein refers to the minimum requirement of the CCS system on the whole.

The CCS system shall be a web based application which allows for the following features:

- Password protection & authorization capability
- Web based man-machine interface
- Customised Web page capabilities
- Monitor & Control of BMS points
- Graphics Display of Information

The Sub-contractor shall provide standard software that is available off the shelf.

(a) Operating System

All workstations on the communications network shall adopt industry standard multi-tasking, multi-user Windows NT/XP/Vista as the Operating System (OS)

In particular, the System Server shall have Windows NT Advanced Server as its Operating System (OS).

Standard services supported by the OS shall include the following:

- Multi-tasking Multi-user support
- POSIX 1003.1 compliance
- TCP/IP, SLIP/PPP Network Support
- Network File System (NFS) Release 3.4
- OSF Windows support
- C ++ language compiler
- VB complier

The system shall be able to support multi-user environment in the Gigabit Ethernet LAN to allow a minimum of 50 concurrently users on the system for accessing the CCS data simultaneously.

The operating system shall provide a user friendly graphical system administration interface to assist the system administrator in the following tasks:

- Addition of users
- Auto Configuration of peripherals (Plug and Play)
- Auto Configuration of networks (Plug and Play)
- Manage software and hardware for all connected PCs over the network
- Managing process
- Other system maintenance task

The CCS shall provide, but not limit to, the following basic software programmes. Sub-Contractors unable to comply fully with these requirements shall state so under the Schedule of Deviation.

(b) User ID & Password

The system shall allow the definition of a minimum of 100 unique user ID and passwords.

The operator shall use the same password at all Operator Workstations and Hand Held Terminals.

When a password is added, deleted or modified, the change shall be automatically updated at all Operator Workstations and Hand Held Terminal Connections. The user shall not be required to update password definitions at multiple locations.

A minimum of five levels of access shall be supported:

- Level 1 = Data Access and Display
- Level 2 = Level 1 + Operator Overrides
- Level 3 = Level 2 + Database Modification
- Level 4 = Level 3 + Database Generation
- Level 5 = Level 4 + Password Add/Modification

User-definable, automatic log-off timers from 1 to 60 minutes shall be provided to protect against unauthorized access at unattended terminals.

(c) Real Time Database

A real time database shall be provided together with messages which enable application programs resident in the computer or resident in other computers in the network write to and read from the database. The real time database shall support peer to peer transfer of real time
data.

The database shall be in industry standard format supporting SQL, ODBC and OLE2.

It shall be possible to extract all or query part of the system databases, including those settings already encoded into the system internal RAM memory.

The real time database shall have sufficient capacity to handle all the assigned points associated with all the subsystems.

The real time database shall be uniquely addressable by either Point Name or Point Address. The Point Address shall be able to support up to a minimum of 16 characters.

The real time database shall support the following point types and their corresponding attributes:

- Digital input point (DI)
- Digital ouput point (DO)
- Analog input point (AI)
- Analog output point (AO)
- Pulse input point
- Tri-state input point
- Calculated analog input
- Calculated digital output

For analog points, the following attributes shall be supported:

i) Engineering Unit Conversion
   - Linear
   - Square root
   - Square

ii) Alarm Processing
   - Alarm limit
   - High limit
   - Low limit
   - Transducer high limit
   - Transducer low limit
   - Alarm level (minimum of 4 levels, depending.on critical nature of alarm)

The following data quality shall be associated with each of the point:

- Time stamp
- Bad data
- Substitute
- Suspect
- Alarm
- No alarm check
- Communication failure

The database shall support on-line changes and on-line back-up and snapshot. It shall also support:

Point linking, i.e. composite points may be formed by linking two DI points to a tri-state point, or a DI point may be linked to a DO point as a feedback flow etc.

Event linking, i.e. the point in the database may be linked to events which can executive user program, command digital output point to change state, command analog output point to be set to a specific value, execute a sequential action display graphics page etc.

(d) Dynamic Colour Graphic Display

A hierarchical linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation shall be provided. The interface shall utilize the mouse to provide "heads up operation" with pull down menus, dialog boxes, colouration and animation to facilitate operator understanding of the system. A minimum of twenty (20) levels of graphic penetration shall be provided with the hierarchy operator assignable (for example, area, building, wing, floor, air handler, sequence of operation pages, dynamic program display). Descriptors for graphics, points, alarms, etc shall be modified through the operator's station under password control.

The operator shall be provided with a means to directly access any graphic by assigning it to the Pull-down menu (to be able to customize), any point without going through the penetration path.

Dynamic and animated graphics for feedback information with global data with on-line help functions shall be used. Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.

Colour banding of screen displays shall be provided for display and differentiation of normal and abnormal conditions. This is to allow instant operator recognition and response to critical building operation quickly.

Graphic Screen Animation shall be included for symbols to contain motion to denote operational status. This would provide instantaneous confirmation to system operator of equipment status, eliminate guesswork and improve safety.

Multiple Display capability shall be provided to allow operator to observe multiple dynamic graphic screens at the same time to enable operator to have a bird-eye view of the adjourning floors of the alarm location or to manage several separate building operation tasks concurrently, or analyze related systems simultaneously.

Alarm class differentiation shall be provided that defines colouration, printout, and storage requirements for different alarms. This is to ensure that all alarm traffic is handled as per operation requirements to maximize building system and occupants' safety.

Graphic-driven point identification and selection shall be provided to allow operator to select a point by "clicking on" the graphic symbol representing the point type. A display shall appear to enable the operator to select the desired command. This is to maximize operator efficiency by increasing the speed with which operator can identify, select, and command points.

On-line Graphics Generation shall be a major requirement. On-line graphics generation shall be taken to mean that the operator shall have the ability to create new graphics on-site from a menu of symbols. Further, changes to existing graphics are included in this function.

The system shall include libraries of pre-engineered screens and symbols depicting standard air handling unit components (eg. fans,

cooling coils, filter, damper, etc). complete mechanical systems (eg. constant volume-terminal reheat, VAV, etc.) and electrical symbols.

The number and type of graphics to be provided shall be sufficient to cover day-to-day operation on all building services to be monitored and controlled by the CCS. The system shall be able to support at least 3000 graphics for control and monitoring.

As a minimum, the following graphics screens shall be provided:-

- Overview of site and building.
- Individual floor plan with ACMV equipment, duct and pipe layout.
- Individual floor plan with other M & E equipment and pipe layout.
- Individual floor plan with third party control system equipment layout.
- Individual floor plan with Fire Alarm system layout.
- Individual floor plan with Access Control layout.
- Schematic of individual systems and plantrooms.

The CCS shall supervise all operator inputs to ensure that all inputs are correctly and properly executed. Operator input assistance shall be provided whenever a command cannot be executed because of operator input errors. The CCS shall explain to the operator in words and phrases why the command cannot be executed.

The operator shall also have the capability through the keyboard/mouse to:

- Request displays of current values or status using a tabular or graphic format;
- Command selected equipment to a specified state;
- Initiate logs and reports;
- Change analog limits;
- Add, delete or change points within each DDC or application routine;
- Change point I/O descriptors, status, and alarm descriptors and engineering unit descriptors while the system is online;
- Add new DDCs to the system;
- Modify and setup maintenance scheduling parameters;
- Develop, modify, delete or display full range of colour graphic displays providing dynamic, animated displays. All development, editing and display work shall be performed with the system fully on-line and in full communications with the LAN;
- Select discrete or analog sample data from the field to be automatically archived in the assigned workstation. This archiving shall occur even if the workstation is running third party software such as word-processing or electronic spreadsheets;
- Invoke report writer capability at each workstation to sort and extract data from the archived files and to generate finished customer reports. Reports may either manually displayed and/or printed or they may be printed automatically. The system will have the capability to print reports on a daily, weekly, monthly, yearly or scheduled basis. This report writer shall provide the capability for statistical data manipulation

and extraction. As minimum, the custom report writer must provide the capability to generate four (4) types of reports.

- Statistical detail reports;
- Summary reports;
- Trend graphic plots for 4 variables;
- X-Y graphic plots;

- Have the option of selecting daily, weekly or monthly as a scheduled frequency to synchronize time and date in DDC. This function will be performed for dial-up, as well as direct connected locations.

- The operator may print a selected DDC database whenever desired. The operator may select any or all control parameters as needed.

(e) Time Command Programme

All start/stop function points shall be pre-set for start and stop time capacity of up to thirty (30) different 7-days time programme. The programme shall be able to accommodate special holiday provision, one month in advance and the programme shall automatically revert to the regular time command schedule when required. Change of status of any start/stop function points by the Operator shall not alter the programmed Time Command Schedule. However, a valid command entered by the operator shall override a programmed command.

(f) Event Initiated Command Programme

Each analog point shall have the following defined:

- High alarm limit
- High warning limit
- Low warning limit
- Low alarm limit
- Differential

When an analog point goes outside the High Warning or Low Warning Limit for more than the warning delay period, a user defined warning message shall be output to appropriate alarm printers and operator workstation.

When a setpoint is changed, the warning Kits shall also automatically change and the alarm limits shall not change.

When an analog point goes outside alarm limits or when a point goes into the alarm, a user defined alarm message shall be output to the alarm printers and to each operator workstation. Alarm messages shall require operator acknowledgement.

When a point is overridden by operator command from an operator workstation or a local workstation, an alarm message shall be output to the alarm printers and to each operator workstation. Alarm messages shall require operator acknowledgement.

Each alarm shall be displayed and printed with a user defined text message of not less than 65 characters.

When point returns to normal, the event shall be recorded in at each operator workstation.

The Operator Workstation shall be capable of displaying a list of all points in alarm for the building in a single summary. Systems which force the operator to make a separate alarm summary for each gateway shall not be accepted.

The operator shall be able to lock out alarm reporting on a point to eliminate nuisance alarms.

The operator shall be able to lock out control for any point to force it to remain in its current state.

A summary showing locked out points shall be available. This summary shall include points for which either alarm reporting or control has been locked out in a single summary. Systems which force the operator to make a separate lockout summary for each gateway shall not be accepted.

(g) Run Time Totalisation Programme

Run time totalising software programme shall be provided for each start/stop function points. The run hour meter shall be software counter initiated through a local voltage free status contact. The address selection plant equipment and its integration into the run hour programme shall be programmable through the Operator Terminal. When the total run time reach or exceeds the preset limit, a spontaneous alarm shall be printed in clear text instructing the operator regarding the maintenance work required. The system software shall also allow if necessary the total run time programme to be divided into a minimum of 5 stages (different limits) to signal the imminent maintenance work to be done. When the total run time set limit is reached, the software counter shall reset automatically starting from zero and running up to the same limit as before.

(h) Analog/Pulse Totalisation

The CCS shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

- Totalisation shall provide calculation and storage of accumulations of up to 99,999.9 units (eg KWH, gallons, KBTU, tons etc.)

- The Totalisation routine shall have a sampling resolution of one minute or less.

- The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

(i) Event Totaliation

The CCS shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalisation shall be performed on a daily, weekly or monthly basis.

- The Event Totalisation feature shall be able to store the records associated with a minimum of 9,999,999 events before rest.

- The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

(j) Power Failure Restart Programme

In the event of a normal power failure and upon the change over to essential power supply derived from the Standby Generator Sets, the Computer-based Control System shall be capable of automatically restarting the output a message indicating that the power failure had occurred and the time of occurrence. Under such circumstance, a software programme on Power Failure Restart Programme shall be provided to automatically initiate sequential starting of all equipment supplied with essential power supply.

(k) Summaries Logging Programme

The system shall be capable of performing summaries logging on colour monitor and/or Printer for all function point addresses, function groups between selected address, analogue high/low limits, time command schedule and event programmes, run time totalization of start/stop points, trend log, status and alarm functions in full or partially selected addresses.

The above specified logging functions shall be able to initiate on automatic time base, event base or manually through Operator Terminal.

(l) Trend Recording Programme

The trend feature shall be able to record any of the following parameters for any point:

- point value
- point alarm status
- controlling feature
- operator override flag
- on-line/off-line flag

The trend feature shall sample on an interval from 1 minute to 120 minutes.

The gateway shall automatically update the operator workstations at a regular interval for long term storage of samples. Trend data shall be kept in standard database format.

A report shall be available listing all trended points.

A trend for a point shall be able to be started either by operator command or according to a time schedule command. A trend for a point will end as a result of an operator command, time scheduled command or when the required number of samples has been collected.

Trend samples shall be displayed in either tabular or graphical format. A minimum of seven trended points (in seven colours) shall be able be displayed concurrently on a graph or in a report.

The trend graph display shall automatically scale the value and time axis to display all samples. From the trend graph, the operator shall be a able to select and read the instantaneous value of any previous sample.

(m) Continuous Point Histories

The CCS shall store Point History Files for all analog and binary inputs and outputs. The Point History routine shall continuously and automatically sample the value of all analog input at half hour intervals. Samples for all points shall be stored for the past 24 hours to allow the user to immediately analyze equipment performance and all problem-related events for the past day. Point History Files for binary input or output points and analog output points shall include a continuous record of the last ten status changes or commands for each point.

(n) Chiller Optimisation

The system offered shall include the following chiller optimisation programmes:

(i) Chiller Selection Programme

This programme shall monitor the actual total cooling load of the building and select the optimal number of chillers to be operated to meet the demand at any one time. Chillers shall be interlocked against each other, such that the hours of running of each chiller is about the same.

(ii) Chilled Water Temperature Reset Programme

This programme shall optimise the chiller efficiency by raising the chilled water supply temperature in accordance to the chilled water return temperature.

All software programmes provided shall be safe-guarded against unauthorised access. Alpha-numeric identification code features shall be provided, such that the alterations or modifications to the programmes can only be carried out by authorised representatives of the Employer. Unauthorised use of the Operators Terminal shall not affect any of the software programme. A minimum of five system access levels shall be provided.

In addition, nickel cadmium battery bank complete with automatic battery charger and plastic laminate lined battery cabinet shall be provided. The battery shall have capacity of 72 hours standing losses, and 2 hour of operation under full load condition. All necessary accessories for the automatic source and vice versa shall be supplied and installed as in integral part of the Works.

Tenderers are required to provide all temperature sensors, flow sensors, controller, interfacing facilities, etc. necessary for monitoring, control and execution of the above programmes.

8.12.3 Sequence And Capacity Control Of Water Chilling System

A sequence and capacity control system shall be provided which shall be capable of monitoring the chillers and their associated pumps and cooling towers in accordance

with the actual demand cooling rate. This system shall operate in conjunction with the "Time Command Programme" to provide flexibility in the operation of the chillers.

The system shall have the following minimum components and features:

8.12.3.1 Flow Sensor

A flow sensor shall be inserted in the main chilled water return pipe to measure the total flow rate of the chilled water system. An accuracy of better then ±2% of actual (instantaneous) flow rate shall be achieved.

8.12.3.2 Flow Transmitter

The "flow signal" shall be fed into a square root extractor for linearization, and the linearized flow signal shall be converted into pulse signal for transmission to the Heat Calculator. The pulse signal accuracy shall be better then ±2% of the actual flow.

8.12.3.3 Temperature Sensors

Temperature sensors shall be installed in the Main Chilled Water supply and return pipes to measure the respective temperatures. Platinum resistance sensors shall be a matched pair to prevent production tolerances from affecting the sensing accuracy. The two temperature signals shall be fed directly into the Heat Calculator.

8.12.3.4 Heat Calculator (BTU-HR meter)

The heat calculator shall be of totally solid-state type and shall compute the total instantaneous cooling load using input signals from the flow transmitter and the temperature sensors. A flow counter and a calorie counter shall be included. The total cooling load signal from the heat calculator shall be fed to Sequence/Capacity Controller.

8.12.3.5 Sequence/Capacity Controller

Controller device shall be capable of performing computation directly on the pulses received from the Heat Calculator. Each stage (corresponding to each chiller) shall be manually adjusted by a pair of digital switches for ON and OFF over the full range of the cooling load signal. When the system is started, the first stage shall come "ON" and shall pull in the chiller assigned to the first stage in the sequence. The second and subsequent stages shall come "ON" as the load is increased beyond the capacity of the first stage and shall be in accordance with the settings of the digital switches for each stage. Conversely, the appropriate number of stages shall drop out as the load is decreased. The control system shall include the following features:

(a) Digital Load Indicator

Indicates the instantaneous total cooling load of the system as a percentage of design load.

(b) Sequence Setting

Allows the operator to select the controlled machines in any sequence.

(c) Manual Start-Stop Switch

Allows the operator to start or stop individual units when the system is in the "manual" mode.

(d) Forced Operation Setting Switch

Allows the operator to set the maximum number of stages that can come on for initial start-up purposes.

(e) "Skip" Operation

Allows stage to be omitted if the controlled unit returns a "failed" signal and carry on the sequence to the next stage.

8.12.4 Alarm Management

Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each IFS shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the network's ability to report alarms be affected by either operator activity at a workstation or local I/O device, or communications with other panels on the network.

a) Point Change Report Description

All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.

b) Prioritization

The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. The CCS shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.

The user shall also be able to define user which conditions point changes need to be acknowledge by an operator. And/or sent to follow-up files for retrieval and analysis at a alter date.

c) Report Routing

Alarm reports, messages, and files will be directed to a user-defined list of operator devices or PCs used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.

d) Alarm Messages

In addition to the point descriptor and the time and date, the user shall be able to print, display or store a 65 character alarm message to more fully describe the alarm condition or direct operator response.

Each standalone IFS shall be capable of storing a library of at least 250 Alarm Messages. Each message may be assignable to any number of points in the panel.

e) SMS Autopaging/Alert System

The SMS paging/alert system shall be provided to notify the authorized and assigned duty personnel in the event of specific problems and/or alarms. The

paging/alert system shall be suitable for notification to handphone and alphanumeric pager. The paging/alert system shall be capable of identifying the personnel(s) on duty, depending on the duty roster, and alert/notify the personnel(s) until an acknowledgment is received. If the designated personnel(s) do not acknowledge the call within the pre-set time, the system shall page/alert for the person again for every time-out interval until the person acknowledges the call. The acknowledge interval shall be adjustable.

Only critical alarms shall initiate a call to a remote operator device. In all other cases, call activity shall be minimized by time-stamping and saving reports until an operator scheduled time, a manual request, or until the buffer space is full. The alarm buffer must store a minimum of 50 alarms.

The handphones and pagers shall be of those readily available from any of the major Telecommunication Service Provider to ease equipment approval and system compatibility.

Reports on activities and roster lists shall be printed on an alarm log printer. So, no matter where the operators are, the paging/alert will send the right page/alert to the right people at the right time, hence, ensuring the operations running smoothly.

8.12.5 Tenant Management System

The tenant management system shall reside on the same Intranet server or dedicated server to provide building users to interact with the CCS & the other service through a web based interface. It shall have the following:

Tenant Mode

(a) Password protection & authorization capability
(b) Extended operation of facilities, e.g., NC, lighting etc
(c) Automate trigger of related services in relation to the request, e.g. Lighting, AIC, Door access etc
(d) Consolidate detail on the request & forwarding the info. to the Billing system
(e) Confirmation of the said request through' e-mail.
(f) Through the billing module, forward monthly billing on exceptional usage, e.g., extended operation, booking, energy consumption etc.
(g) Information display on temperature, relative humidity, setpoint, operation hours, etc.
(h) Tenant control on setpoint & command on facilities based on authorization level.
(i) Information display & control based on user's access or authorisation level
(j) Provide general info access, e.g.; outdoor temperature etc to general users.
(k) Accept comments/compliant to facility manager via email.

Administration Mode

(a) Audit trail of all transactions
(b) It shall have the following capabilities:
(c) Overriding capabilities of all requests manually
(d) Customisation of web page template
(e) Define the range & limit of the setpoint adjustable by the users.
(f) Define all allocated password & authorization level of users
(g) Define activation of services in relation to services that is made available to the users.
(h) Insert administration rules & regulations of the booking system

8.12.6 Facility Booking System (FBS)

The user shall be able to book the following services through the Facility Booking System:

- Meeting rooms
- Projection facilities and
- Other Convention Hall etc.

The CCS will provide integration between the facility booking system, the security system, the aircon system & lighting system. Whenever a booking is made, the CCS will pass the information to the security system for verification and approval. Upon the receipt of approval from security system, the CCS will send the approval to facility booking system and the complete interaction required by the booking between the various services (eg; aircon & lighting).

The system will provide booking facility for meeting and function room & other shared resources such as vehicles, portable equipment etc. If any VIP will to do a priority booking on a already booked schedule, the other persons will be notified to find an alternative and the booking will be prioritised to the VIP.

The Facility Booking System (FBS) shall be provided on a dedicated Intranet server. The occupants of the building shall be able to access the system through the IT system using a web browser. The FBS system shall have the following:

Tenant Mode

(a) Password protection & authorization capability
(b) Facilitate tenants to book resources, rooms, equipment etc
(c) Display requestor monthly booking activities & outstanding bill to-date.
(d) View resources availability with regard to date, time & authorization level
(e) Automate trigger of related services in relation to the booking, e.g. Lighting, AIC, Door access etc.
(f) Automatic e-mail to security officer for manual clearance on the booking/cancellation of the secured room & return acknowledgement electronically by the officer to the booking system.
(g) Consolidate detail on booking & forwarding the info. to the Billing module
(h) Confirmation of the said booking/cancellation through e-mail back to requestor with details of the booking.
(i) Notification of the said booking/cancellation to secondary users as defined by the primary user.
(j) VIP tenant priority override. Overridden booking by an earlier least priority user will be informed of cancellation via e-mail.

Administration Mode

(a) Audit trail of all transactions
(b) Overriding capabilities of all bookings manually
(c) Customisation of web page template
(d) Define the parameter on the period between the bookings on the same room.
(e) Define the rates on different resources & time usage.
(f) Define all allocated password & authorization level of users
(g) Define resource available for booking
(h) Define activation of services in relation to resources been booked
(i) Insert administration rules & regulations of the booking system

8.12.7 Maintenance Management System

The Sub-contractor shall provide a Maintenance Management System which shall be a customisable standard software off the shelf.

The Maintenance Management System (MMS) shall provide the following functions:

1. Inventory facility equipment and resources (Know what you are working with)
2. Determine maintenance practices (Determine what you want to do)

3. Keep history of activities (Evaluate what you have done)
4. Update operations (Revise what you want to do)

The equipment and maintenance history data bases of the automated maintenance management system contribute to items 1 and 2 of the iterative process by making it possible to compile critical information about equipment and procedures. Based on this information, the data bases are used to create an initial maintenance schedule.

Normally, the data bases are structured to permit a phased installation. This means that users need to enter only a small portion of the data base initially. Then, as the need for more sophisticated data arises, additional information is added. This reduces the "computer shock" that is sometimes experienced when an automated maintenance management system totally replaces a manual system. Phased installation provides users with an opportunity to become comfortable with the system in small, easily digested portions. Installing a system in phases, in effect, results in maximum comprehensiveness, flexibility and effectiveness. Once the data bases have been installed, the maintenance management system is used to issue planned work orders and scheduled work orders. Planned work orders are issued on a calendar basis and scheduled work orders are issued on an "as requested" basis.

Although work order generation is an important part of any automated maintenance management system, the system also provides a capability of not only scheduling work but also analysing, managing and optimising it. It is this capability which separates an automated maintenance management system from simple maintenance scheduling.

This leads to item 3 of the iterative process. The maintenance history data base contributes to this step by providing the raw data necessary to perform analyses. Standard reports produced as part of this step should be supplemented by the use of a custom report writer, which makes it possible to obtain data in situations where standard reports do not offer the required information in the desired format.

Uses of Automated Maintenance Management

Weekly scheduling and work order issue : The system will look at the maintenance strategies and print the appropriate work orders with all of the necessary information. The printing of work orders is typically done on a weekly basis.

Annual workload management : The system provides the reports which show, by skill group, the amount of scheduled hours per week. This information can be useful in justifying additional staff.

Backlog management : One of the most difficult aspects of a manual system is ensuring that the planned work was actually done. With a computer, nothing will slip between the cracks.

Budget preparation : With pressures to reduce costs, it is often necessary to justify maintenance budgets. An automated maintenance management package can produce the appropriate report.

Equipment analysis : You may suspect that cheap component is actually more expensive in the long run because of increased maintenance costs. This kind of information is readily available.

Program analysis : A maintenance strategy is not a static thing. Using the iterative management process, we should be constantly refining our strategies. An automated maintenance management program can provide the feedback necessary to fine tune the strategies.

Personnel evaluation : An automated maintenance management program can assign estimated items to tasks and compare the actual times taken to identify training needs and finther refine the estimated times.

Work Orders

Preventive Maintenance Work Orders

Preventive Maintenance work orders are opened either by a calendar date or based on equipment run-time. When maintenance is based on calendar date, the maintenance operation is divided into work cycles, which are typically 7 days. For example, on Monday morning, the automated maintenance management software will open all work orders which are to be completed before the following Monday.

When maintenance is based on equipment run-time, work orders for all equipment for which the run time is expected to reach its target in the following work cycle are opened. The equipment run time can be entered automatically through an interface with a Building Automation System or calculated based on the most recent run time meter reading and an estimated running hours per week.

The user can choose to open all work orders which are due or to only open work orders for a selected department or skill group, such as electricians. When work orders are opened, any required material is flagged as RESERVED in the inventory system.

If all of the procedures listed on the work order have not been completed before the end of the work cycle, the work order will be placed on a "Repeats List". This report is invaluable in managing the backlog of uncompleted work orders.

Scheduled Work Orders

Scheduled work orders are for work which is necessary but is not included as part of preventive maintenance work orders. These are one-time jobs and can be classified as Scheduled, Unscheduled or Breakdown work orders. An example of each might be as follows:

Scheduled	- overhaul to be done during planned shutdown
Unscheduled	- investigate complaint from tenant
Breakdown	- equipment failure requiring immediate repair

A priority code can be entered such as "Major Repairs" or "Project Work". These codes appear on the "Work Load Scheduling Report" and "Labour Performance Report". The user can specify the employee or the skill group, such as electrician, required for the work order. For maintenance departments which allocate costs back to other departments, an account number can be entered for reference. Finally, the user enters the procedures and parts required for the work order.

Completed Work Orders

Once the craftsmen have completed the work orders, either Preventive Maintenance or Scheduled, and returned them to the system operator, it is necessary to enter the information into the system. To speed this process, it is recommended that the list of codes be printed on the back of the work order so the craftsman is able to use them when completing the work order.

When entering a completed work order, the user is prompted with each of the procedures listed on the work order and asked if the procedure was done or not. If the procedure was not done, the user enters a "**Reason Not Done Code**" such as ND (downtime not possible), NM (manpower not available), NP (parts not available), NS (insufficient skills) or NT (tools not available).

The user can also enter the date completed, employee and time taken for each procedure. Alternatively, the time taken for the entire work order, rather than for each procedure could be entered.

A "**Remedial Action Code**" can also be entered if appropriate. Examples of these codes might include: A (adjusted), AT (adjusted tension), RB (replacedfrebuilt), RC (recalibrated), RL (repaired leak), RN (replaced new) or T (tightened).

The user will also enter the parts used and the location from which they were taken. This information will automatically update the inventory system. Before sending the work order to the equipment history file, the user can enter a "**Failure Code**" and a "**Solution Code**". Examples of "**Failure Codes**" are: B (bearing failure), C (corrosion), D (distortion), DF (design flaw), F (fatigue), G (gear failure), SE (seal failure), SH (shaft failure), TR (temperature related) or W (wear failure). Examples of "**Solution Codes**" are: AC (applied coating), HT (heat treatment), IL (increased lubrication frequency), RD (redesign), RP (reduce pressure), RT (reduce temperature) or UM (upgrade materials). Finally, a narrative can be entered for inclusion in the equipment history file.

Inventory

Inventory Data Base

For each item in the inventory data base, three types of information must be entered:

- Part definition
- Ordering information
- Level information

The part definition information consists of a part number, units (EA, BOX, DOZEN, etc.), an alphanumeric part description and the equipment that this part might be used on. When choosing the part number, it is best not to follow manufacturer's part numbers but rather to come up with a numbering system which has been planned for your facility. Since many reports are sorted by part number, having a planned numbering scheme will allow data on reports to be grouped in a logical manner.

The ordering information will keep track of the average cost of the part. The average cost is updated as new parts arrive at new prices. The economic order quantity (EOQ), the last order date and the last P.O. number can also be kept on file. The ordering information will keep track of multiple vendors. For each vendor, the vendor's part number and last price can be stored.

The level information will record the part status in multiple locations. 'For each location, the on-hand balance and the minimum required balance are stored. From this information, the system will calculate the total on-hand and the overall minimum requirement. The system will also keep record a maximum desired stock level for the part and indicate the number on order and the number reserved.

Inventory Inquiry

The inventory control program allows the operator to display information from the data base. The operator can choose to have one line of information about each part number or a full screen of information for each part number.

The operator can inquire by:

- .Part number
- .Part description
- .Stock location

The operator does not have to enter the complete key for the search to be successful. For example, if the operator enters a key of "BE" for an inquiry by part description, the system display will include all BELTS and BEARINGS.

Inventory Ordering

An "**Inventory Reorder Report**" is a list of inventory items which need to be ordered because their total available quantity is at or below the total specified minimum stocking level. The term "**available quantity**" means the on-hand item count minus the quantity reserved for PM work orders and scheduled work orders. For example, if you have 100 pieces of an item on hand and you have created PM work orders and scheduled work orders requiring a total of 80 pieces, your available quantity will be 20. If the minimum stocking level is set at 50 for this item, you will need to order at least 30 pieces of this item.

The automated maintenance management system will generate and print the purchase order. The software includes the ability to track the purchase orders and enter receipts (with or without a purchase order). A database of vendors is also maintained.

Inventory Reports

The system can provide an "**Inventory Master List**" to give an overview of the inventory. The user can choose to include all items or to only include a range of item numbers, items from a particular vendor or items used on a specified piece of equipment.

A "**Daily Issues Journal**" lists the items which have been issued from inventory over a day or weekend. This report should be reviewed daily by management looking for out of place entries. This report allows management to be able to react quickly to inventory problems.

The inventory system keeps a record of the details of all items issued. To avoid filling up the hard disk, the details of the transactions should be cleared monthly. Before clearing the details of the transactions, the operator should run a "**Monthly Issues Journal**" to get a permanent record of the details of all items issued since the last time the file was cleared.

The inventory system also keeps a record of all of the details of each receipt. Since the details of receipts need to be cleared occasionally, a "**Receipts Report**" is available to provide a permanent record of the details of each receipt since the last time the file was cleared.

As an audit trail of user activity, a record of the user transactions including ADD, CHANGE and DELETE is stored. Since the details of user transactions need to be cleared occasionally, an "**Add/Change/Delete Report**" is available to provide a permanent record of the details of each user transaction since the last time the file was cleared.

One of the most useful reports from the Inventory system is the "**Activity Report**". This report provides the on-hand stock level and the issues and receipts for the previous month to date and the previous 12 months. The inventory manager can use this report to identify slow moving parts which may be obsolete. The manager can also use this report to identify quick moving parts for which ordering frequency could be increased to reduce average stock levels.

A "**Warranty Report**" will list parts which are covered by a manufacturer's warranty and have been installed on equipment. If a part was replaced due to failure during the warranty period, this will be indicated on the report as well.

The "**Receipts History**" lists the vendor, quantity, date,.price and PO# for receipts for a item. This information is useful in identifying trends in pricing and for negotiating with suppliers.

A very important report in the inventory system is the "**Restock Report**". This report lists items which need to be shifted from one location to another because the on-hand

quantity is at or below the specified minimum. This report is used to trigger stock transfers.

Physical Count

One of the most onerous tasks facing a manager of inventory is the annual physical count. This is a very tedious procedure, but the inventory software can help. To assist with the actual count, the inventory software can print the "count sheets", which list items, their description and location, and leave space for the employee to write in the actual count for each item and put his initials. "Count sheets" can be printed by location or for a range of item numbers.

Once the physical counts have been entered into the inventory software, the system can generate a "**Physical Count Variance**" which itemize the differences between the physical count totals, taken from the "count sheets" and the calculated on-hand balances. For the accountants, the most important variance is the change in book value of the inventory and this is printed on the report. A second reported statistic which is of more interest to the manager of the inventory is the percentage of items with variance. Once the physical count has been completed, the user can update all of the on-hand balances to the physical count totals.

Print Inventory Labels

Labels can be printed for all items. These labels indicate the item number, item description, equipment the item is used on, vendor, date last received and the location. The cost of the item can also be optionally included on the label. Labels can also be printed for the bins used to store the items.

Management Reports

Custom Report Writer

Using the custom report writer, the user has access to all current and historical data bases in the system. The user can use logical and arithmetic operators to derive new values including statistical values.

The user can define the format of the output report by specifying text and variable positions on the page. In addition, the custom report writer has built-in routines to-present data as an X-Y graph or as a histogram.

Planning/Scheduling Reports

"**Open Work Order Report**": The user can review all open work orders or use selection criteria to review work orders matching specific skills, priorities, equipment, etc.

"**Scheduled Work Order Summary**": This report lists the number of procedures outstanding for each department, including both current and repeat (backlogged) procedures.

"**Preventive Maintenance Forecast**": This report allows the user to review the labour hour requirements and skill code requirements to complete Preventive Maintenance work orders in the selected time frame.

"**Material Requirement List**": This report tells the user what parts will be required to complete the scheduled procedures.

"**Work Load Scheduling**": This report compares the manpower actually available with the work already scheduled by skill code.

"**Quarterly/Annual Maintenance Schedule**": This report lists the skill code requirements and manpower availability over the next 13 weeks or 13 months.

"**Quarterly/Annual Downtime Forecast**": This report shows the downtime needed for preventive maintenance during the current 13 weeks or 13 months.

Performance Reports

"**Maintenance Distribution Graph**": This report summarizes the distribution of completed procedures in bar graph form, listing the procedures by type.

"**Labour Performance Report**": This report summarizes labour performance by skill code in either labour hours or labour cost. It gives a comparison of the actual hourslcost compared with the estimated amount and the amount of the variance.

"**Job Standards Report**": This is a list of all work orders completed between the specified dates. The work orders are sorted by supervisor and then by work order number. It also compares the actual labour hours with the estimated labour hours for each employee.

"**Manpower Tracking**": This report lists each employee and the work orders which that employee has worked on. The work orders will be sorted by employee and then by date.

"**Work Orders Journal**": This is a sequential listing of all work orders. It may also be sequenced by equipment ID.

"**Labour Hours Report**": This is a status report giving actual and estimated hours, date entered and date completed for work orders in the current work cycle.

"**Budgeted Maintenance Hours Analysis**": This report compares the budgeted and actual amounts for labour, man-hours and material for the current month, summarised by department.

"**Maintenance Cost to Date by Department**": This report provides a month to date and year to date summary for material, labour and man-hours for each department.

"**Maintenance Cost History**": This report summarises maintenance cost for scheduled and other maintenance. It allows the user to compare hours, labour cost, material cost and total cost for the current year to date, last year and two years ago.

"**Equipment Downtime**": This report lists each selected equipment id showing the downtime for the current week and month and for the year to date.

"**Equipment Case History**": This report prints a chronological history of the maintenance activity for each selected equipment.

8.12.8 System Integration

The CCS shall be designed such that all - other subsystems not supplied and installed by the Sub-Contractor shall work independent of each other and yet shall have data interchange capability through the CCS Local Area Network to achieve the overall building management functions.

All the subsystems shall be fully stand-alone as well as able to be integrated with the CCS LAN to form a homogeneous environment through seamless integration. The subsystems shall be connected/integrated to the Industry standard Gigabit Ethernet (IEEE 802.3u)TCP/ IP LAN.

The CCS LAN shall support integration to the subsystems via one or combination of the following linking methods:

- Network API over Gigabit Ethernet TCP/IP
- nDDE
- OLE
- OPC
- Dedicated protocol (one or two way communication)

Integration Via Network Application Program Interface (API)

The Sub-contractor shall liaise with the Subsystem contractors for the standardized Network Application Interface (API) to be provided by the Sub-contractor for interfacing with the CCS services. The supplied Network API shall contain calls for the System Server to access the Subsystem's database over the Gigabit Ethernet TCP/IP LAN. These API calls should follow the OSI Model Application Layer (Layer 7) standards.

With these calls the System Server can read from and/or write into the Subsystem database (if required). All these network API call should follow the TCP/IP protocol suite using socket streams.

As multiple Subsystems have to interface the System Server, it is highly recommended to agree on a standardized common core API providing the main interface mechanisms and data exchange principles, to be used by all subsystems, which shall then be enhanced with subsystems specific function calls and/or data structures.

On the subsystems, it is the responsibility of the subsystems to use the necessary network calls within their system to send critical alarm point data to the System Server at any point in time. The System Server shall serve the Subsystem on request using the Network API calls.

Network API Library

The Network API delivered by the subsystem vendor should be a library of function calls in ANSIC programming language or Visual Basic. It should support or be compatible with the major operating system such as MS Windows NT 4.0 or higher. All the header files defining the data structure for communication packets should also be available. The Network API shall use TCP/IP socket streams for error free and reliable data transfer across the network API shall use TCP/IP socket streams for error free and reliable data transfer across the network.

The Network API shall include functions to get and put values of individual point parameters of fields within the Subsystem's database. The points could be either input or output of digital, analog, totalization or software generated type and any user file or table.

There should be function calls to read and write point-data, accessing point parameters and attributes, to get historical information of any point and accessing user file or table information.

In case of user records, either a field or the whole record shall be accessed at a time. This is in order to reduce the number of network calls to get a user record over the network.

Example of Network API functions

The subsystem's Network API may include the following type of functions:

For accessing points & parameters

Function Name	Issued	By Purpose

Readpoint	CCS	returns point data (e.g.value/state) from the Subsystem
Updatepoint	CCS/subsystem	writes point updates to the other system
GetParam	CCS	returns parameter data from the Subsystem
Putparam	CCS	updates a parameter in the Subsystem

Each of the above functions may be associated with parameters such as

- Destination host-name/ID
- Sender host-name/ID
- Date/Time stamp (at the moment of function call)
- return-code of the specific function call, used for error handling (end-to-end reliability)
- data structures appropriate to reach function call.

Integration Via Dynamic Data Exchange (DDE)

The sub-system vendor shall provide the Sub-contractor with the appropriate protocols for transferring data from the sub-- database to the System Server's database directly or into an Excel Spreadsheet residing in the subsystem server.

Integration Via Object Linking & Embedding (OLE) Automation

The Sub-contractor shall provide a commercially available OLE automation development tool kit (software) for developing the Control Network Driver (CND) for each sub-system that is required to be integrated for centralized information management.

The CCS shall be responsible for developing and commissioning the individual sub-system's CND software for system integration. The subsystem vendors on the other hand, shall supply the Sub-contractor with the required communications protocol to achieve the said purpose.

The CND shall be able to support a variety of data types, including floating point, 16 and 32 bit signed and unsigned integers, and ASCII text, when supported by the sub-system interfacing.

The Subsystem Server where the CND software will be residing shall support up to not more than four (4) sub-systems.

Integration Via OPC (OLE for Process Control)

OPC stands for "OLE for Process Control". OPC is a communication standard based on OLE that fosters greater interoperability between automation/control applications, field systems/devices, and business/office applications. OPC defines standard objects, methods, and properties built on OLE Component technologies for servers of real-time information like DCS, PLCs, smart field devices, and analyzers to communicate the information they contain to standard OLE-enabled clients.

For software application users, OPC has the potential to make "plug and play" software a reality. OPC will allow different applications written in different languages running on different platforms to integrate. OPC compliant applications will also integrate with the Microsoft suite of Office and Back Office products.

Hardware users will also benefit. Process device hardware vendors will develop OPC compliant interfaces, much like PC printer vendors provide printer drivers that are able to work with multiple Windows applications. Users will be able to choose best-in-class hardware components for a given application and painlessly integrate information from these devices with software applications across the enterprise.

Vendors will benefit by reducing development cost associated with developing multitudes of drivers to different hardware devices and software applications. Instead, vendors will be able to focus on the value-added product functionality improvements which users are demanding.

OLE for Process Control (OPC) defines standard objects, methods, and properties for meeting the interoperability requirements of real time process automation applications. These requirements include a standard technique for addressing information contained in process control devices/systems, efficient transfer of data from a process device to an application, the ability for a client to use several servers simultaneously, and server-specific configuration support.

Integration Via Dedicated Protocol

Interfacing the CCS through one of the following field proven industry standard protocol provides the advantage of a secure poll-response operation with a full set of supported functionality.

- Modbus
- Modbus Plus
- C-Bus
- LON
- BACnet

These protocols shall either be supported by the subsystem at controller level or software emulated by the supervisory computer central.

On CCS side, it shall allow homogeneous handling of the complete external subsystem which, although keeping its complete stand-alone features, is perceived and handled by the CCS in a standard way similar to any connected bus.

Integration Via RS232C Serial Interface

In the event where the subsystem could not provide Network API at Gigabit Ethernet TCP/IP level and Dedicated proven protocol like BACnet, a special RS232 serial interface shall be provided to achieve the interfacing requirement. The subsystem supplier shall release all communication protocol information to the BMS contractor to enable the proper development of handshaking program can be written.

8.12.9 Integration With IT InfraStructure

The Sub-contractor for CCS shall make all necessary provisions to support integration of the CCS to the IT infrastructure. The CCS shall provide a Intranet Server where the occupants of the building shall be able to access the BMS system through the IT infrastructure for booking of conference/meeting rooms etc., changing of the temperature set-points and overriding of lighting control. The CCS shall also be linked to the IT infrastructure for the Facilities Management System functions.

The Sub-contractor for CCS shall ensure a comprehensive user interface can be delivered to achieve the desired functionality. The CCS Sub-contractor shall also work closely together with the IT sub-contractor (to be appointed later) to ensure smooth integration.

In order to maintain a uniform network communication platform between the CCS and IT infrastructure. The CCS infrastructure shall provide and support the following standard communication hardware and software interfacing:

(i) Inter-network Routing Procedure

The BMS network shall provide the appropriate bridging and routing device (gateway) to enable the desired IT infrastructure workstation gain access to the BMS server through Gigabit Ethernet TCPAP protocol. Both the IT infrastructure and BMS devices shall conform to the Media Access Control (MAC) specifications of the IEEE 802 standard for MAC-layer bridging (Data-Link Layer relative to the OSI protocol model).

(ii) Network Management

The System Server shall be SNMP manageable such that the network management station can gather the information such as packet transmissions, error condition, connection status, etc. from the IT infrastructure bridging and routing devices as well as BMS server. This information shall then be presented to the network administrator or supervisor for evaluation to ensure that the IT infrastructure and CCS communication link is healthy and error free.

(iii) Application Interfaces

The CCS Sub-contractor shall supply Application Interface in the form of OPC (OLE for process control) to allow application program to communicate between IT infrastructure and CCS. CCS shall provide high level if subroutines calls to allow read/write access to the System Server. The System Server shall also be web-enabled for the IT infrastructure.

(iv) Workstation User Interface

The CCS shall support multiple user interfaces. Typically, it shall support Windows NT & Windows XP/Vista. Regardless of which OS the IT infrastructure terminals using the application program shall be seen as identical by the user. Internet Explorer (IE) will be the user interface when IT infrastructure terminals access the CCS application programs.

(v) IT Infrastructure

The IT infrastructure shall supply a network port at the BMS room for BMS to be connected to the IT infrastructure. The BMS contractor shall provide the necessary cabling for connection of the BMS network to the IT infrastructure port.

The CCS Sub-contractor shall provide the Facility Booking System and the Facility Management System. The CCS Sub-contractor shall be responsible for working with the IT specialist/vendor to allow for the complete operation and functioning of Facility Booking System and the Facility Management System.

The CCS Sub-contractor shall provide the OPC subroutine calls to the IT vendor for data and command exchange between the CCS and IT infrastructure.

8.12.10 Subsystem Integration

The Contractor shall be responsible for the full integration of the following subsystems with the CCS:

- ACMV/BAS System

- Security System
- Fire Alarm System
- Electrical System
- Lighting Control System
- Lift & Escalator System
- Plumbing & Sanitary System
- SMS Autopaging & Alert System
- Maintenance Management System
- Facilities Booking System
- Tenant Management System
- OA Interface via Web Browser

Detailed point required to be mapped back to the CCS is as per BAS Point Schedule as attached.

ACMV System

The CCS shall be integrated to the ACMV system through the following mean:

High level integration to traditional BAS
DDC controller directly support by the CCS

The details on the control & monitoring functions will be indicated on the controls for ACMV, schematic drawings & point schedules.

Security System

The security system shall retain the full autonomy on its operation by the security operators & manager. However, a list of designed points as in the point schedule shall be made accessible to the CCS for information & processing for interaction of global interaction strategies. It shall obtain the data via high level integration through the enterprise infrastructure network.

Fire Alarm System

The CCS shall be integrated with the Fire Alarm Control console located at FCC through high level interface via any one of the methods as described in the section on System Integration for alarm processing and management purposes.

The type of points to be monitored shall be as specified in the Points Schedule.

Electrical System

The CCS shall control/monitor the electrical services as detailed in the Points Schedule. The CCS shall provide recording and historical data of energy consumption of listed points and other information for energy management. The Electrical Sub-contractor shall provide the control/monitor points as dry contacts in dedicated compartments of the electrical Switch Boards. The CCS Sub-contractor shall provide DDCs in each electrical switchrooms and connect the control/monitor points from the compartment in the switch board to the DDCs as well as from the DDCs to the BMS system. All the electrical DDCs shall be connected to a terminal computer before connection to the CCS system.

Lighting Control System

All necessary wiring from the interface panel in the electrical switch board to the circuit and all necessary auxiliary contacts and contactors shall be provided by the Electrical Sub-contractor. The electronic ballast required for dimming the fluorescent lights are provided by Electrical contractor. The CCS Sub-contractor shall liaise with them when connecting the control cables. Amplifier units required to be used with the HF

Electronic Regulating Ballasts shall be designed, supplied and installed by Sub-contractor. Each phase (R, Y, B) per row shall come complete with their own amplifier. It shall have an input control terminal which accepts 0-10V DC voltage. The amplifier shall operate both mains supply of 230V 50Hz. It shall not have power consumption more than 1.2W. It shall withstand the ambient temperature of at least 40°C.

The CCS system shall also be provided with the hardware and software to interface with Lighting Controller through Echelon Lon Controllers.

Lift & Escalator System

The lifts alarms and other required signals as indicated in the Points Schedule shall be tied to CCS via high level interface from the Lift & Escalator Control System by the interfacing methods as described in the Section on System Integration. Should an emergency alarm originate from an individual lift or escalator, an audible alarm shall sound at the BMS Room. The alarm shall also be printed and displayed on the monitor. Should the high level interface be not possible, the point shall be wired to the DDC as specified in the electrical interface.

Plumbing & Sanitary System

The CCS shall interface to the plumbing & sanitary system for control & monitoring as indicated in the point schedule using DDC from CCS.

