PART 1 GENERAL

1.1 DESIGN DOCUMENTATION

.1 Design documentation for each system to include, as a minimum:

- .1 Narrative type of Sequence of Operation.
- .2 Control Description Logic (CDL).
- .3 Input/Output Summary Schedules.
- .4 Schematics.

1.2 EMCS LANGUAGE DESIGN CRITERIA

.1 Language: refer to Section 25 05 01 EMCS: General Requirements.

.2 Levels of EMCS Language

- .1 Level 1: alarm and operational messages to convey alarm conditions or operational messages.
- .2 Level 2: full names of equipment and control points. The various systems, their equipment and components and all control points are named in accordance with this section.
- .3 Level 3: system, equipment, component and control point descriptors: unique, alphanumeric identifiers derived from full names of corresponding system component and control point.
- .4 Level 4: commands: represent various computer functions and routines.
  - .1 Operational commands - relate to building operations and building system controls.
  - .2 Computer system commands - relate to computer maintenance, upgrading or development software used to improve and maintain the application software for the building site.
- .5 Level 5: machine language. Languages specific to each manufacturer's product, used internally to perform its functions and routines.

.3 Additional Equipment, Components and/or Control Points. Where additional equipment, components and/or control points are required on specific projects, the following procedures shall be adopted:

- .1 Full names of the equipment, component and control points shall be not more than 40 characters, including numerals.
- .2 SYSTEM descriptors shall be not more than 10 alphanumeric characters. INPUT and OUTPUT descriptors shall be not more than 10 alphanumeric characters. The letters shall be based upon the English/French language full name, and should, where possible, be the first letter of each word of the full name.

.4 The descriptor shall be unique.

.5 Descriptors and expansions: table lists standardized system identifiers and point identifiers.

.1 Table:

Identifiers and Expansions

English Identifier (10 characters max)	English Expansion (40 characters max)
OAD	Outside air damper
OAT	Outside air temperature
OAH	Outside air humidity
OAV	Outside air volume
RAD	Return air damper
RAT	Return air temperature
RAH	Return air humidity
RASP	Return air static pressure
MAD	** Mixed air dampers **
MAT	Mixed air temperature
MAPSP	Mixed air plenum static pressure

** MAD shall be used for applications where outside air and return air dampers are controlled from one (1) only output signal.

EAD	Exhaust air damper
PFPD	Pre-filter pressure drop
PFALM	Pre-filter pressure drop alarm
FFPD	Final filter pressure drop
FFALM	Final filter pressure drop alarm
HCVLV	Heating coil valve
HCVLVC	Heating coil valve control
HCVLVS	Heating coil valve status
BPD	Heating coil face and bypass damper
HCFA	Heating coil freeze alarm
CCVLV	Cooling coil valve
CCVLVC	Cooling coil valve control
CCVLVS	Cooling coil valve status
SVLV	Steam valve
SVLVC	Steam valve control
SVLVS	Steam valve status

SF#-C	Supply fan # control
SF#-S	Supply fan # status
SF#-VSD	Supply fan # VSD control
SF#-VSDF	Supply fan # VSD fault
SAV	Supply air volume
SAVC	Supply air volume control
SAT	Supply air temperature
SAH	Supply air humidity
SAVP	Supply air velocity pressure
SASP	Supply air static pressure
RF#-C	Return fan #control
RF#-S	Return fan # status
RF#-VSD	Return fan # VSD control
RF#-VSDF	Return fan # VSD fault
RAV	Return air volume
RAVC	Return air volume control
RAT	Return air temperature
RAH	Return air humidity
RAVP	Return air velocity pressure
RASP	Return air static pressure
EF#-C	Exhaust fan # control
EF#-S	Exhaust fan s# status
EXAT	exhaust air temperature
EXAV	exhaust air volume
Chiller #1:	
CH1F	flow rate
CH1LWT	leaving chilled water temperature
CH1LWP	Leaving chilled water pressure
CH1EWT	Entering chilled water temperature
CH1EWP	Entering chilled water pressure
CD1EWT	Entering condenser water temperature
CD1EWP	Entering condenser water pressure
CD1LWT	Leaving condenser water temperature
CD1LWP	Leaving condenser water pressure
CHP1F	Chilled water pump #1 flow rate
CHP1DP	Chilled water pump #1 discharge pressure
CHP1S	Chilled water pump #1 status
CP3C	Circulating pump #3 control
CP3F	Circulating pump #3 flow rate

CP3DP	Circulating pump #3 discharge pressure
CP3S	Circulating pump #3 status
HTA	High temperature alarm
LTA	Low temperature alarm
HTCO	High temperature cutout
LTCO	Low temperature cutout
HLA	High level alarm
LLA	Low level alarm
HLCO	High level cutout
LLCO	Low level cutout
HWF	Heating water flow rate
HWST	Heating water supply temperature
HWRT	Heating water return temperature
STP	Steam pressure
STF	Steam flow rate
RM-T	Room temperature
RM-H	Room humidity
RM-SP	Room static pressure (add reference point)

Examples of specific space conditions:

RM-TNPER 2	Space temperature, North Perimeter, 2nd floor
RM-SPSPER I9	Space static pressure, South Perimeter, 19th floor
RM-HEINT 9	Space humidity, East Interior, 9th floor
AFS	Air Flow Switch
AFM	Air Flow Monitor
F	Flow
P	Pressure
ST	Supply temperature
RT	Return temperature
FA	Fire alarm
FTA	Fire trouble alarm
CW	Chilled water system
CD	Condenser Water System
HWH	Hot water heating system
RADN	Radiation system
CDR	Condensate return system
HPS	Steam - High pressure system
LPS	Steam - Low pressure system

DCW	Domestic cold water system
DHW	Domestic hot water system
DHWR	Domestic hot water system Recirculation
SANP	Sanitary sewage - pumped system
STMP	Storm water - pumped system
SPRD	Sprinkler - Dry pipe system
SPRW	Sprinkler - Wet pipe system
FSTP	Fire standpipe & hose system
VBA	Volume Box Control Assembly

1.3 I/O SUMMARY SCHEDULES

.1 General:

.1 The EMCS contractor shall provide a complete I/O summary schedule similar to the one listed below, listing and describing all I/O's in detail. Contractor's standard schedule may be used provided all relevant information is provided.

.2 PCU no: identifies the PCU to which all points in the I/O Summary Schedule are wired.

.3 Building/Area: unique label given to each building forming part of a multi-building facility.

.4 Area/System Label: unique label given to each area of the building or to each system.

.1 Column 1: Point no: I/O Summary Schedule reference number.

.2 Column 2: Point label: unique label for each point in the system. Point labels may be repeated for other buildings or systems.

.3 Column 3: Description: describes the point label in expanded terms.

.4 Column 4: Type: (eg. AI, AO, DI, DO).

.5 Column 5: Eng. Units: Describes the engineering units used (eg. for AI, AO: C, kPa, Amp Volt. For DI, DO: OFF, ON).

.6 Column 6: Access level: Defines the level of access for varying complexity of functions. Usually associated with password feature. Usually assigned value between 0 (lowest) and 4 (highest).

.7 Column 7: Sensor type: describes in 2 or 3words.

.8 Column 8: Assoc. Point: Identifies/ describes points for purposes of alarm suppression, software interlocks.

.9 Column 9: Type: defines the type of alarm (eg. CR = CRITICAL, CA = CAUTIONARY, M = MAINTENANCE).

.10 Column 10: DI/DO, NO/NC: defines the NORMAL condition of alarm. (NC = NORMALLY CLOSED. NO = NORMALLY OPEN).

.11 Column 11: Limits: Defines alarm levels (eg. L2 = Low alarm, Level2. H1 = High alarm, Level1).

.12 Column 12: Alarm Mess: Defines alarm message number. This number is related to pre-composed message detailing the problem and describing the required action.

.13 Column 13: Maint Mess: defines maintenance message number. This number as related to pre-composed message detailing the problem and describing the required action.

.14 Column 14: Set Point: Defines the design set-point of the control loop.

.15 Column 15: Dead band: defines the range above or below the set-point at which no change in output signal is to occur.

.16 Column 16: Dev alarm limit: defines the limit on deviation of the measured value from the set-point (sometimes also referred to as the "error limit").

.17 Column 17: NC/NO: defines NORMAL condition when de-energized. NC - NORMALLY CLOSED. NO = NORMALLY OPEN. DA/RA: defines the form of action. DA = direct acting. RA = REVERSE ACTING.

.18 Column 18: Contacts: NO/NC: defines NORMAL condition when de-energized. NC = NORMALLY CLOSED. NO = NORMALLY OPEN.

.19 Column 19: Delay Succ starts: defines the time limits (usually in seconds). To prevent overheating of motors or equipment from frequent re-starting.

.20 Column 20: Heavy motor delay: defines the time (usually up to 60seconds). To prevent heavy electrical load from simultaneous starting of large consumption equipment.

.21 Column 21: auto-reset: A = AUTOMATIC. M=MANUAL.

.22 Column 22: Programs:

.1 Examples of Applications Programs include: Night set-back; optimum start/stop; demand limiting (load shedding).

.2 Optimization routines (eg. chiller optimization, supply air temperature optimization, enthalpy control) should be described as part of CDL's.

.3 Parameters for all application programs should be provided separately as part of the design documentation (eg. the Systems Operation Manual).

.4 Note requirements for computer totalization, recording, print-out of accumulated value of a point over a period of time. If totalization depends upon a number of analog points, include for pseudo energy points.

.5 Run time totals: for calculation of operation of digital points.

.6 Optimum start/stop: Example: HVAC unit to start before scheduled occupancy, based upon HVAC unit capacity, heat loss, interior and exterior environmental conditions, etc.

.1 Schedule:

INPUT/OUTPUT			SCHEDULE PCU NO.								(see 1.3.2)
PROJECT NO.			BLDG/AREA				NAME	(see 1.3.3)			
PROJECT NAME			AREA/SYSTEM				NAME	(see 1.3.3)			
POINT IDENTIFICATION								ALARMS			
1	2	3	4	5	6	7	8	9	10	11	
Point. No	Point Label	Descrip	Type	Eng. Unit	Access Level	Sensor type	Assoc Point	Type (M,CR)	DI/D0 NO/NC	Limits	

MESSAGES							DI/DO			
12	13	14	15	16	17	18	19	20	21	22
Alarm Limit	Maint	Set-Point MO/MA	Dead band start	Dev. alarm delay	NO/NC DA/RA	Cont's NO/NC	Delay succ.	Heavy Motor	Auto reset	Prog

1.4 CONTROL NARRATIVE SEQUENCE OF OPERATIONS

.1 Typical Hospital AHU Operation:

.1 The air-handling unit supply fan and associated return fan and exhaust fans shall normally operate on a preset daily schedule. When the unit is off, the outside air damper and exhaust air damper shall be closed, the return air damper shall be open, the heating coil valve shall be closed, the cooling coil valve shall be closed, the steam humidifier valve shall be closed, the heating coil pump shall be on. All temperatures and humidity sensors shall continue to monitor, but the high and low limits shall not alarm.

.2 To start the system, the EMCS controller shall command the system on. The outside air damper shall open. When the outside air damper end switch is closed, the supply fan shall start. The return fan shall start after a slight time delay. The return, exhaust and outdoor air dampers shall modulate to maintain the minimum fresh air position (set at 25%). The supply and return fan VSD's shall be gradually ramped to maintain the static pressure setpoint. (Set point to be determined on site after air balancing.)

.3 Should the supply or return fans current sensors fail to prove proper operation within a suitable time period after a start command (initially set at 60 seconds) an alarm signal shall be raised.

.4 Minimum outside air shall be maintained at 25% of design airflow by a software algorithm using inputs from the systems air flow measuring station(s), averaging temperature sensors located in the mixed air and return air streams, and the outdoor temperature sensor. The outside air algorithm shall not permit mixed air temperature to drop below 12°C.

.5 For all systems, the fresh air supply and return airflows shall be measured by flow measuring stations located in the ducts or fan inlets as indicated. Multiple flow stations on a systems fresh air supply or return will have to be totalized to obtain total system airflow.

.6 For temperature control in heating mode, the EMCS controller shall modulate the mixed air dampers and heating coil valve in sequence to maintain the supply air temperature setpoint (initially set at 13°C).

.7 For temperature control in the cooling mode, the EMCS controller shall modulate the mixed air dampers in the economizer mode to maintain the supply air temperature setpoint. When the outside air temperature rises above the economizer lock-out setpoint (initially set at 18°C), the outside air dampers shall revert to the minimum position to deliver 25% fresh air. On a further call for cooling, the EMCS controller shall modulate the cooling coil valve to maintain supply air setpoint.

.8 If the outdoor temperature falls below the cooling lockout setpoint (initially set at 13°C), the EMCS controller prevents the cooling coil valve from opening.

.9 If the outdoor temperature rises above the heating lockout setpoint (initially set at 18°C), the EMCS controller prevents the heating coil valve from opening.

.10 The system shall alarm if the supply air temperature falls below the low temperature alarm setpoint (initially set at 10°C) or rises above the high temperature alarm setpoint (initially set at 25°C).

.11 The systems EMCS controller shall employ a supply air temperature reset function which shall automatically reset the supply air temperature setpoint based on a statistical analysis of zone heating/cooling demands throughout the areas served by the system. The reset algorithm shall readjust leaving air temperature as necessary to maintain return relative humidity setpoint as sensed by the relative humidity sensors in the return air stream, and the relative humidity in Class 1 critical care areas below 60%.

.12 Should the heating coil pump fail as sensed by the pumps current sensing relay, an alarm shall be raised to warn the operator of the failure and instruct him to bring the standby pump on-line. Flow switches shall also be installed in the hot water supply line to each AHU heating coil to monitor flow and signal an alarm should a no flow or low flow condition exist when ambient air temperatures are below freezing.

.13 Prefilter bank and final filter bank status shall be monitored by the EMCS controller via differential pressure switches. An alarm signal to change filters shall be raised at a set differential pressure. (To be determined on site after air balancing.)

.14 The supply and return fans variable speed drives (VSD’s) shall receive their signal from the EMCS controller to adjust the speed of the fan motor to maintain the required static pressure in the system. The supply and return fan status shall be monitored via current sensing relays, and any VSD faults shall be monitored/alarmed by the EMCS controller.

.15 The EMCS controller will modulate the humidifier steam valve to maintain the return air humidity setpoint (initially set at 40% R.H.). The controller will signal the humidifier steam valve to close if the supply air humidity exceeds the supply air humidity high level setpoint of 85% R.H. or if the supply fan should fail (indicated by current sensing relay and differential pressure switch).

.16 Some systems serve areas which have reduced or no occupancy during nights and weekends. These areas shall be scheduled to receive reduced or shut off airflows

during these periods. Air flows to these areas shall be controlled via zone dampers and measured via airflow stations or by volume regulating boxes. The schedule of occupied/unoccupied periods shall be co-ordinated with the Owner. The zones to have occupied/unoccupied schedules include:

.1 Administration Area

.2 Support Areas

.3 Surgery Suite

.4 Lab/D.I./Pharmacy Areas

.5 E.R./Clinics Area

During reduced airflow hours, the duct pressure sensors, VAV boxes, duct airflow stations, zone dampers and supply/return fan variable speed drives to be utilized to maintain the required system airflows and differential pressures.

.17 The air handling systems shall be required to operate in a fire mode of operation as signaled automatically via the fire alarm system or manually via the fire department control panel. In general, during the fire mode of operation, the following shall occur:

.1 When a confirmed fire/smoke condition exists in a fire zone, as detected by the fire alarm system, the supply air to that zone shall be shut off by closing the smoke or combination fire/smoke dampers in the ducts supplying air to the zone or by shutdown of the supply fan (depending on the fire zone). Refer to fire alarm cause/affect chart.

.2 Return and exhaust air from the affected zone shall be maintained. The return air damper in the air handling units mixing box shall go fully closed and the exhaust air damper shall go fully open to exhaust 100% of the return air to the outside. This will maintain the area under negative pressure.

.3 For other fire zones not affected by the fire/smoke condition, (other than zones within the area of refuge), the air handling units serving these areas shall be shutdown.

.4 For the area of refuge, the return/exhaust fans serving these zones shall be shutdown while the supply fan(s) shall be kept running to pressurize the space. Supply air shall be 100% outside air (i.e. the AHU's mixing box return damper shall go fully closed).

.5 Should a fire/smoke condition occur within a fire zone inside the area of refuge, all smoke dampers in ducts feeding that zone shall close.

.6 Should smoke be detected by the smoke detection in the air supply of an air handling unit, that unit shall be shut down and the smoke dampers in the area served by that unit shall close.

.18 Miscellaneous Safeties and Alarms:

The supply and return fans shall stop and an alarm signal raised upon the following conditions:

.1 Smoke detector senses smoke

.2 Temperature low limit sensor detects temperature below 5°C

.3 Supply duct static pressure exceeds +1000 Pa.

.4 Return duct static pressure exceeds –1000 Pa.

.2 Outside Air Units (Hospitals)

.1 For AHUs which are 100% fresh air heat recovery units, basic unit control logic is the same as other units. However, these units shall employ a "cold corner" defrost control on the plate exchanger for freeze protection. A multi blade damper and modulating 24 V damper actuator are used to deflect cold air away from the cold corner based on the cold corner leaving air temperature. These units are also equipped with heat exchanger bypass dampers. These dampers to be controlled based on the heat exchanger leaving air temperature to prevent over-recovery. When the temperature leaving the heat exchanger on the supply air side exceeds its setpoint (initially set at 13°C), the bypass damper shall be modulated open.

.2 These systems are interconnected by bypass ducts c/w a normally closed damper. Should one of the units be taken out of service, the bypass damper shall open to allow the operating unit to handle air from the "off" units duct system. The airflow monitors and motorized dampers in the supply and return ducts shall be utilized to proportion the available air.

.3 Should one of the units be taken out of service, the corresponding interlocked return fan shall be shutdown (and visa versa). These units, which are operating in parallel, shall be provided with the necessary logic to ensure that each unit delivers 50% of the airflow despite minor variations in system pressures at each unit.

.3 Room Temperature Control

.1 Reheat or Radiation Only

.1 In rooms served only by duct reheat coils or radiation, a drop in room temperature as sensed by the rooms wall mounted temperature controller, causes the radiation or reheat coil valve to modulate/open to maintain the space temperature setpoint. (Operator adjustable within defined limits.)

.2 Space temperatures shall be set back during unoccupied periods by the EMCS system on a schedule to be approved by the owner. An override switch/pushbutton on the face of each room temperature controller shall permit a timed override of the night setback in each room.

.2 Radiation and Reheat

.1 In rooms served by both duct reheat coils and radiation, a drop in room temperature as sensed by the room wall mounted temperature controller, causes the radiation heating valve to open. On a further drop in room temperature, the reheat coil valve shall be modulated open to maintain the space temperature setpoint (operator adjustable within defined limits).

.2 Space temperatures shall be set back during unoccupied periods by the EMCS system on a schedule to be approved by the Owner. An override switch/pushbutton on the face of each room temperature controller shall permit a timed override of the night setback in each room.

.3 VAV Box Control with optional radiation/reheat

.1 In rooms served by VAV boxes, the box damper shall be closed if the associated air handling unit is off and reheat/radiation heater valves shall be open. Prior to start of the system, the VAV box damper shall open to its minimum position.

.2 On a call for cooling, the VAV box controller shall modulate the damper open to maintain the space temperature setpoint (Operator adjustable within defined limits). On a call for heating, the VAV box controller shall modulate the damper to its minimum position. On a further call for heat, the controller shall open the room's radiation heating valve (if applicable) to maintain space temperature setpoint. If the temperature still remains below setpoint, the controller shall modulate the reheat coil valve (if applicable) to maintain room temperature setpoint.

.3 For two position only boxes (occupied/unoccupied), the sequence of operation is similar to above. The operating position of the box shall be controlled centrally on a schedule by the EMCS system or by a local room occupancy switch.

.4 Space temperatures shall be set back during unoccupied periods by the EMCS system on a schedule to be approved by the owner. An override switch/pushbutton on the face of each room temperature controller shall permit a timed override of the night setback in each room.

.4 Penthouse/Electrical Room Heating/Ventilation Control

.1 When the room space temperature, as sensed by the wall mounted temperature controller, exceeds its setpoint of 24°C, the outside air damper shall open. On a further rise in room temperature, the exhaust fan shall start. On a drop in room temperature, the reverse sequence shall occur.

.2 When the space temperature drops below the heating setpoint of 15°C, the unit heater control valve shall open and the unit heater fan shall start.

.5 Unit Heater/Cabinet Heater Control Sequence

.1 On a call for heat as sensed by the room temperature controller, the heater control valve shall open and the fan shall start.

.2 Fan speed shall be manually adjustable from within cabinet enclosure (where applicable).

.6 Hot Water Heating Heat Exchanger Control

.1 One of the hot water heating primary pumps shall run continuously to circulate hot water through the primary heating loop. The pumps shall be alternated on a timed shared basis and the lag pump shall start should the lead pump fail.

.2 The heat exchanger steam valves shall be modulated as required to maintain the leaving hot water temperature at its setpoint. The leaving water temperature setpoint shall be reset based on an outside air temperature schedule.

.3 The exchangers must be able to operate in parallel or in isolation should one of the exchanger circuits be down for maintenance. Normal operation is for one heat exchanger to carry the load.

.7 Main Secondary Heating Loop Temperature/Pressure Control

.1 One of the hot water heating secondary pumps shall run continuously to circulate hot water through the secondary heating loop. The three pumps shall be alternated on a time shared basis and the lag pump shall start should the lead pump fail.

.2 One, two or three of the secondary pumps shall be run at a time as required to maintain the set differential pressure in the secondary loop as sensed by the differential pressure sensor. Sensor to be located near the far end of the heating loop.

.3 The hot water mixing valve shall be modulated as required to maintain the hot water supply temperature at its setpoint. The setpoint of the hot water supply temperature shall be reset based on an outside air temperature schedule.

.8 Reheat/Perimeter Heating Loop Temperature Control
(Typical for Administration/Support Area, Central Area, Patient Area)

.1 One of the two dedicated hot water heating pumps shall run continuously to circulate hot water through the heating loop. The pumps shall be alternated on a time shared basis and the lag pump shall start should the lead pump fail.

.2 The hot water mixing valve shall be modulated as required to maintain the hot water supply temperature at its setpoint. The setpoint of the hot water supply temperature shall be reset based on an outside air temperature schedule.

.9 High Pressure Steam Boilers

.1 Each coil tube steam boiler is provided with its own factory installed control panel and each boiler can be operated in a stand alone mode.

.2 However, normal operation is for all three boilers to interface with the EMCS system for operating setpoints, firing rates and lead/lag control sequencing. Each boiler shall have four points communicating with the EMCS, (for pressure, enable, firing rate and common alarm).

.3 The operators shall be able to change lead boilers, set point and sequence patterns at the local control panel (located near the boilers) or via the operator workstation.

.4 The system shall be controlled full modulation 4-20 mA for the firing rate and the logic shall determine the most efficient rate of firing prior to selecting the next boiler in sequence.

.5 On a boiler trip or alarm condition, the lead/lag system shall automatically start the next boiler in the sequence and alarm the trip condition.

.6 Status and elapsed time shall be provided for call for heat, low fire and maximum firing rate.

.7 The lead/lag system shall incorporate the ability for each boiler to be run under local (boiler) control panel only for testing purposes.

.8 The lead/lag system shall reset to commissioned operating conditions in the event of power interruption and automatically re-start and control the boilers to return to normal operation.

.10 Domestic Hot Water Heat Exchanger Control

.1 One of the domestic hot water pumps shall run continuously to circulate DHW from the tanks through the heat exchanger and back to tanks. The pumps shall be alternated on a timed schedule and the lag pump shall start should the lead pump fail.

.2 The heat exchanger steam valves shall be modulated as required to maintain the leaving water temperature at its setpoint of 70°C.

.3 The exchangers must be able to operate in parallel (normal) or in isolation should one of the exchanger circuits be down for maintenance. Normal operation is for one of the heat exchangers to operate to carry the load.

.11 Isolation Room Controls

.1 A volumetric air control system shall be used to control airflow offset, airflow tracking between supply and exhaust air variable volume boxes, provide stable room pressure and room environment, monitor room air pressure and environmental conditions and be capable of communications link with the EMCS.

.2 Volumetric control shall be capable of direct pressure reset applications.

.3 Isolation room control system to be complete with a EMCS based volumetric controller, velocity sensors for both supply and exhaust air flow, room pressure sensors to monitor pressure between both isolation room/anteroom and anteroom/hospital space, remote alarm panel, filter alarms for HEPA filters, and integration with room temperature control loop.

.4 Volumetric control shall receive signal from velocity sensors to regulate flow via control regulation of variable volume box dampers. Volumetric control to reset airflow differential setpoint through the direct pressure reset control loop.

.5 Room pressure sensor to be a through the wall device with one end monitoring the space and the other monitoring either the anteroom or the adjacent building corridor. Wall mounted room monitor controller shall receive differential pressure readings from each room pressure sensor at frequent intervals and display current value on the LCD display.

.6 Room monitor controller shall be complete with LCD display, key switch control for change in containment state (positive (+), negative (-), or neutral (no isolation), check and reset control, set point adjustment and alarm mute. Unit shall be complete with sensor cable.

.7 Sequence of Operation:

.1 When room monitor/controller is in the positive (+) room pressurization mode, (Protective Isolation) volumetric controller to adjust supply and exhaust air volume boxes to maintain a 10% higher supply than exhaust airflow differential.

.2 When room monitor/controller is in the negative (-) room pressurization mode Infectious Isolation) volumetric controller to adjust supply and exhaust air volume boxes to maintain a 10% higher exhaust than supply airflow differential.

.3 When room monitor/controller is in the neutral (no isolation) mode, volumetric controller to adjust supply and exhaust airflow to maintain a 0% airflow differential.

.4 Filter alarm signal to sound when static differential pressure across the supply airflow HEPA filter exceeds setpoint (initially set at 300 pa).

.5 Reheat coil valve to be modulated as required to maintain isolation room space temperature as sensed by room temperature sensor. Space temperature to be set back to an unoccupied setpoint (initially set at 18°C) when the room is not in use.

.6 Isolation control to signal building automation system when any alarm condition exists.

.12 Physiotherapy Area In-floor Radiation Temperature Control

.1 The heating water circulation pump shall be commanded to run when the space temperature controller calls for heating. Failure of the pump shall raise an alarm.

.2 The three way mixing valve shall modulate to maintain the supply water temperature to the in-floor heating loop at its setpoint (initially set at 35°C) as sensed by the water temperature sensor. Should the supply water temperature ever reach a high limit of 50°C, an alarm shall be raised and the three way valve shall revert to its normal position (preventing any hot water from entering the in-floor loop).

.3 The two-way heating valve shall modulate as required to satisfy the space temperature setpoint.

.13 Library/Work Room In-floor Radiation Temperature Control

.1 The heating water circulation pump shall be commanded to run when any of the space temperature controllers call for heating. Failure of the pump shall raise an alarm.

.2 The three way mixing valve shall modulate to maintain the supply water temperature to the in-floor heating loop at its setpoint (initially set at 38°C) as sensed by the water temperature sensor. Should the supply water temperature reach a high limit of 50°C, an alarm shall be raised and the three way valve return to its normal position (preventing any hot water from entering the in-floor loop).

.3 The modular heating loop valves shall be modulated as required to maintain the space temperature setpoint as sensed by the room temperature controller.

.14 Miscellaneous Equipment Alarm/Status Points

.1 The following equipment shall be monitored by the EMCS: (Refer also to I/O list)

.1 Deaerator control panel (common alarm)

.2 Surge tank control panel (common alarm)

.3 Air compressor control panel (common alarm)

.4 High pressure steam header (pressure status/alarm)

.5 Low pressure steam header (pressure status/alarm)

.6 Data room air conditioning unit (common alarm)

.7 Domestic cold water pressure status.

.8 Domestic water filters differential pressure.

.9 Medical Gas Common Alarms

.15 Patient Area In-floor Radiant Heating Loop Temperature Control

.1 One of the two dedicated hot water heating pumps shall run continuously to circulate hot water through the heating loop during the heating system. Above a preset outside air temperature (initially set at 20°C), both pumps shall be off. During operation, both pumps shall be alternated on a run time shared basis, and the lag pump shall start should the lead pump fail.

.2 The hot water mixing valve shall be modulated as required to maintain the supply temperature of the in-floor radiant heating loop at its setpoint (initially set at 35°C).

.16 Patient Area Rooms (with in-Floor Radiation) Temperature Control

.1 The modular heating loop valve serving the room shall be opened on a drop in room temperature as sensed by the room wall mounted temperature controller. On a further drop in room temperature, the reheat coil valve shall be modulated open to maintain the space temperature set point (operator adjustable within defined limits).

.17 Boiler Room Ventilation/Combustion Air

.1 This heating and ventilation unit provides combustion and ventilation air to the boiler room. The units supply fan shall be commanded to start when any one of the three boilers are operating or on a call for space cooling as sensed by the space temperature sensor. The units heating coil pump shall be interlocked to start when the fan starts.

.2 Prior to start up, the pressure relief dampers in the boiler room shall open. The EMCS system shall incorporate logic to modulate the fresh air and return dampers as required to satisfy the combustion air requirements with 1, 2 or 3 boilers running or the ventilation/cooling requirements to satisfy space temperature.

.3 For temperature control, the EMCS controller shall modulate the heating coil valve to maintain the supply air temperature setpoint (initially set at 15°C). Should the outside air temperature be below 3°C, the heating coil pump shall run (whether the fan is running or not) and the heating coil valve shall go fully open and the units face and by-pass dampers shall modulate to maintain the supply air temperature setpoint.

.4 Should the heating coil pump fail, an alarm shall be raised to notify the operator to manually change over to the spare pump. Should the supply air temperature drop below 5°C, the unit shall be shut down and an alarm raised. A flow switch shall also be installed in the hot water supply line

to the AHU heating coil to monitor flow and signal an alarm should a no flow or low flow condition exist when ambient air temperatures are below freezing.

.5 Should the H&V unit fail to run or be down for maintenance, the boiler room relief damper shall open as required to provide cooling (heat relief) or permit combustion air into the room when one or more of the boilers are running.

.6 The units filter bank shall be monitored by the EMCS system via a differential pressure switch. An alarm signal to change the filters shall be raised at a set differential pressure.

.18 Critical Care Area Environmental Control Sequence

.1 Each critical care area room, including OR's, LDRP's, Recovery, CCU rooms, Special Procedure, Endoscopy, Nursery, shall be provided with approved, flush mounted, polished stainless steel monitoring/alarm panels mounted within the space at a location approved by the Owner's Representative. Panel shall have concealed continuous hinges and keyed cylinder lock. Panels shall display room temperature, humidity and pressurization, contain an occupancy override push button, and temperature/humidity setpoint switches, and abnormal temperature/humidity, pressurization indicators.

.2 Occupied Mode:

.1 Supply/Return air flow rates, as sensed by the velocity sensors in the volume control boxes are maintained constant and independent of duct status pressure fluctuations by a volume regulating damper in the volume control boxes.

.2 A subtract software algorithm maintains a constant difference between the supply and return airflows equal to the difference in the design airflows shown on the floor plans.

.3 An alarm shall be raised should flow rates depart from setpoint by more than 5%. A flashing pilot light on the room panel shall alert room users to an abnormal airflow condition.

.4 On a drop in room temperature, the reheat coil valve shall modulate to maintain the setpoint space temperature as sensed by the room temperature sensor.

.5 OR's and LDRP's to have a "Full Heat" push button in the panel to permit full open operation of the heating control valve.

.6 A room humidity transmitter shall control the output of the booster humidifier serving the space. A duct mounted humidity transmitter located downstream of the booster humidifier shall act as a humidity high limit shut off to close the steam valve should the duct relative humidity reach 80%.

.7 (In the CCU suite, only one booster humidifier is provided in the common duct serving the suite and the humidity transmitter shall be mounted in the common return duct).

.8 For rooms provided with HEPA filters on the supply air, a differential pressure switch shall be used to signal an alarm when the HEPA filter pressure drop reaches the change out pressure.

.3 Unoccupied Mode:

.1 Supply airflow shall be reduced to 25% of their design valves. "Full Heat" and humidifiers shall be deactivated, and reheat coils controlled as normal to provide space heating. Return airflows shall be reduced to the supply airflow rate minus the airflow offset. Unoccupied space temperatures shall be 20°C.

.4 Pre-Occupancy Mode:

.1 At a pre-determined time in advance of occupancy, airflows shall increase to their design airflows, humidifiers shall be reactivated, and reheat coils shall be controlled to bring the space temperature to its normal occupied setpoint. "Full Heat" switches shall remain deactivated.

.19 Gas Scavenging Air Pressure Alarm

.1 Each room provided with a gas scavenging exhaust tube shall incorporate a static pressure switch in the general exhaust duct at the point where the scavenging tube is connected. The switch shall be field set to signal an alarm should the negative pressure in the duct drops below the set value. The alarm shall be signaled locally in the room and at the main EMCS control console.

.20 Cafeteria/Servery Air Volume Control

.1 The cafeteria/servery area is provided with a constant volume of supply air during the occupied periods. A volume control box is employed on the return air duct from the space to control the return air volume. When the kitchen exhaust hood fan is off, all the air is returned via the return air system. When the kitchen exhaust hood fan is on, the volume control box on the return air duct shall reduce the return air flow by the amount of air exhausted. This shall maintain the pressure balance in the cafeteria/servery area. The volume control box shall be interlocked with the exhaust hood fan.

.21 Lab Multi-Purpose Room Pressure Control

.1 The Lab multi-purpose room contains a bio-safety cabinet (BSC) that is used intermittently. The BSC recirculates 70% of its air through an internal HEPA filter, but 30% of the air is exhausted via roof fan. This fan shall be interlocked to run whenever the BSC fan is running. A volume control box shall be utilized on the return air duct from the room to reduce the return airflow rate when exhaust fan is on. The return air shall be reduced by an amount equal to the exhaust air rate. This shall maintain a proper pressure balance for the room. Supply air to the room shall be maintained at a constant flow rate by a volume control box.

.22 Chemo Prep/I.V. Additives Room Environmental Control Sequence

.1 Chemo Prep Room and I.V. Additives Room in the Pharmacy area are treated as clean rooms and must be maintained under positive pressure

when in use. Each room must be provided with a pressure monitoring status and alarm panel in the adjacent ante-room.

.2 Supply and return air flow rates, as sensed by the velocity sensers in the volume control boxes are maintained constant and independent of duct status pressure fluctuations by a volume regulating damper in the volume control boxes.

.3 A subtract software algorithm maintains a constant difference between the supply and return airflows equal to the difference in the design airflows shown on the floor plans.

.4 For the Chemo Prep Room, which contains a Bio Safety Cabinet (BSC) which shall be interlocked with its exhaust fan, the volume control boxes on supply and return shall modulate to maintain an adequate make-up air supply to the room while still keeping the room at a slight positive pressure (initially set at 25 pa), as monitored by the static pressure transmitters.

.5 An alarm shall be raised should the room's positive static pressure be lost for any extended time. Time delays shall be incorporated to prevent nuisance alarms due to opening/closing of the door. A flashing pilot light on the room's alarm panel shall indicate an abnormal airflow/pressure condition.

.6 On a drop in room temperature, the reheat coil valve shall modulate to maintain the set point space temperature as sensed by the room temperature sensor.

.23 Fuel Oil Tank Monitoring/Fuel Metering

.1 The fuel oil tank shall be provided with suitable level probes to measure oil and water levels.

.2 The EMCS system shall monitor both oil and water levels in the tank and signal alarms at set high/low oil levels, high water level.

.3 The EMCS system shall incorporate the necessary software to monitor fuel consumption based on fuel tank level changes over time and provide reports of fuel consumption over any given time period. Fuel consumption to be reconciled with fuel deliveries. The EMCS shall provide automatic fuel delivery reports after every fill up.

.4 The EMCS system shall also provide for a local (outside adjacent the oil tank) audible and visual alarm of high oil levels to help prevent overfilling. Alarm components outside to be housed in NEMA 4X enclosure.

.5 The EMCS system shall also monitor the vacuum pressure in the interstitial space on the tank and signal an alarm on low vacuum pressure.

1.5 INPUT/OUTPUT POINT SUMMARY TABLE

.1 The input/output table summarizes the Input/Output (I/O) points for the various systems as outlined within the EMCS specifications and control schematic drawings. However, the tables are not all inclusive as they do not list the typical room temperature sensors,

reheat coil valves, radiator valves, unit heater/force flow valves, terminal unit control assemblies, infloor heating manifold loop valves, etc. The number and location of these devices can be found on the floor plans and/or listed in relevant schedules. All points and field devices required to accomplish the specified sequence of operation shall be provided. Any discrepancies in I/O counts between the points list, specs and drawings shall be reported to the Owner's Representative.

1.6 CHILLER INTERFACE

.1 The EMCS system shall interface with the common chiller management panel supplied with the chillers to track all the basic chiller/condenser functions monitored by that panel. The EMCS shall be able to map a minimum of 32 I/O points per chiller/condenser. Coordinate with the chiller supplier for details of points monitored and hook up requirements.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION