PART 1 - GENERAL

1.1 SUMMARY

.1 Section includes:
.1 Materials, installation and procedures for Mechanical Control System provided as part of the Division 23 Scope of Work.

.2 Related Requirements:
.1 Section 23 81 24 - Multiple Split Air Conditioning System.
.2 Division 26, various sections.

1.2 GENERAL

.1 The Mechanical Contractor is advised that this facility will not be equipped with an Energy Management and Control System(EMCS). However, many of the functions and equipment normally provided as part of an EMCS are nonetheless required, and are to be provided by the Mechanical Contractor. Such functions and equipment are to be provided as part of the Variable Refrigerant Flow (VRF) system, shall form an integral apart of the VRF package, and shall hereafter be referred to as the Mechanical Control System (MCS).

.2 All systems and system components supplied under Section 23 81 24 - Multiple Split Air Conditioning System, and Section 23 81 25 - Mini-Split Air Conditioning System, shall comply with all the requirements of this specification section.

.3 Generally all control devices, wiring and conduit below 50V and which are related to mechanical equipment and systems are to be supplied and installed by this Contractor, except where otherwise noted herein and/or elsewhere within the drawings and specifications.

.4 Generally, all control and low voltage wiring shall be installed in conduit. All control wiring and conduit is specified in, and shall be in accordance with, Division 26. Refer to and comply with Division 26 for quality of materials and workmanship.

1.2 GENERAL (Cont'd)

.5 The Mechanical Contractor shall review and become familiar with the electrical drawings, so as to ensure that these drawings accurately and completely depict the electrical work required for the mechanical systems and equipment; and immediately advise the Departmental Representative(as well as other trades affected) of any potential conflicts, incompatibilities, errors or omissions.

.6 The Mechanical Contractor shall convey to the Electrical Contractor, in a timely manner, all available information pertaining to the mechanical systems and equipment proposed, as well as any additional information which may be requested by the the Electrical Contractor.

.7 Where a change to the mechanical systems and equipment results in the need for changes to the electrical work in any way, such changes shall be wholly the responsibility of the Mechanical Contractor. Examples of such changes would include, but not be limited to: substitution of mechanical components or equipment; change in the control arrangement of, or interconnection of, mechanical components; change in the location of mechanical components. All such proposed changes shall be communicated with, and subject to the approval of, the Departmental Representative. Any and all such costs associated with such changes shall be borne by the Contractor, and shall not be used as the basis for any additional costs to the Owner.

1.3 REFERENCES

.1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
.1 ANSI/ISA 5.5-1985, Graphic Symbols for Process Displays.

.2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).
.1 ANSI/IEEE 260.1-1993, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).

1.3 REFERENCES (Cont'd)

.3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
.1 ASHRAE STD 135-R2001, BACNET - Data Communication Protocol for Building Automation and Control Network.

.4 Canadian Standards Association (CSA International).
.1 CAN/CSA-Z234.1-89(R1995), Canadian Metric Practice Guide.

.5 Consumer Electronics Association (CEA).
.1 CEA-709.1-B-2002, Control Network Protocol Specification.

.6 Department of Justice Canada (Jus).
.1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
.2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

1.4 ACRONYMS AND ABBREVIATIONS

.1 Acronyms used in EMCS:
.1 AEL - Average Effectiveness Level.
.2 AI - Analog Input.
.3 AIT - Agreement on International Trade.
.4 AO - Analog Output.
.5 BACnet - Building Automation and Control Network.
.6 BC(s) - Building Controller(s).
.7 BECC - Building Environmental Control Center.
.8 BIM - Building Interface Module.
.9 CAD - Computer Aided Design.
.10 CDL - Control Description Logic.
.11 CDS - Control Design Schematic.
.12 COSV - Change of State or Value.
.13 CPU - Central Processing Unit.
.14 DI - Digital Input.
.15 DO - Digital Output.
.16 DP - Differential Pressure.
.17 ECU - Equipment Control Unit.
.18 HVAC - Heating, Ventilation, Air Conditioning.
.19 IDE - Interface Device Equipment.
.20 I/O - Input/Output.
.21 ISA - Industry Standard Architecture.
.22 LAN - Local Area Network.
.23 LCU - Local Control Unit.

1.4 ACRONYMS AND ABBREVIATIONS (Cont'd)

.1 (Cont'd)

.24 MCU - Master Control Unit.
.25 MCS - Mechanical Control System.
.26 NC - Normally Closed.
.27 NO - Normally Open.
.28 OS - Operating System.
.29 O&M - Operation and Maintenance.
.30 OWS - Operator Work Station.
.31 PC - Personal Computer.
.32 PCI - Peripheral Control Interface.
.33 PCMCIA - Personal Computer Micro-Card Interface Adapter.
.34 PID - Proportional, Integral and Derivative.
.35 RAM - Random Access Memory.
.36 SP - Static Pressure.
.37 ROM - Read Only Memory.
.38 TCU - Terminal Control Unit.
.39 USB - Universal Serial Bus.
.40 UPS - Uninterruptible Power Supply.

1.5 DEFINITIONS

.1 Point: may be logical or physical.
.1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.
.2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.

.2 Point Name: composed of two parts, point identifier and point expansion.
.1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor. Database must provide 25 character field for each point identifier. "System" is system that point is located on.
.1 Area descriptor: building or part of building where point is located.
.2 System descriptor: system that point is located on.
.3 Point descriptor: physical or logical point description. For point identifier "area", "system" and "point"

1.5 DEFINITIONS (Cont'd)

.2 Point Name:(Cont'd)
.1 Point identifier:(Cont'd)

will be shortforms or acronyms. Database must provide 25character field for each point identifier.
.2 Point expansion : comprised of three (3) fields, one (1) for each descriptor. Expanded form of shortform or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide 32 character field for each point expansion.
.3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.
.1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.

.3 Point Object Type: points fall into following object types:
.1 AI (analog input).
.2 AO (analog output).
.3 DI (digital input).
.4 DO (digital output).
.5 Pulse inputs.

.4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.
.1 Printouts: to ANSI/IEEE 260.1.

1.6 SYSTEM DESCRIPTION

.1 Refer to control schematics and plans for system architecture.

.2 Work covered by sections referred to above consists of fully operational MCS, including, but not limited to, following:
.1 Building Controllers.
.2 Control devices as listed in I/O point summary tables.
.3 OWS(s).
.4 Data communications equipment necessary to effect MCS data transmission system.
.5 Field control devices.

1.6 SYSTEM DESCRIPTION (Cont'd)

.2 (Cont'd)
.6 Software/Hardware complete with full documentation.
.7 Complete operating and maintenance manuals.
.8 Training of personnel.
.9 Acceptance tests, technical support during commissioning, full documentation.
.10 Wiring interface co-ordination of equipment supplied by others.
.11 Miscellaneous work as specified in these sections and as indicated.

.3 Design Requirements:
.1 Design and provide conduit and wiring linking elements of system.
.2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Departmental Representative prior to installation.
.3 Location of controllers as reviewed by Departmental Representative prior to installation.
.4 Provide utility power to MCS as indicated.
.5 Metric references: in accordance with CAN/CSA Z234.1.

.4 Language Operating Requirements: Design Manual (MD 13800).
.1 Provide English operator selectable access codes.
.2 Use non-linguistic symbols for displays on graphic terminals where indicated. Other information to be in English unless otherwise specified.

1.7 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit for review:
.1 Equipment list and systems manufacturers within 48 h after award of contract.
.2 Preliminary Shop Drawings within fourteen (14) days after award of contract.

1.7 ACTION AND INFORMATIONAL SUBMITTALS (Cont'd)

.2 Submit for review:(Cont'd)

.3 Preliminary Shop Drawings to include the following:

.1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations,specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.

.2 Detailed system architecture showing all points associated with each controller.

.3 Spare point capacity of each controller by number and type.

.4 Controller locations.

.5 Auxiliary control cabinet locations.

.6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.

.7 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).

.8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.

1.8 QUALITY ASSURANCE

.1 Have local office located within the island of Newfoundland, staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems.

.2 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.

1.8 QUALITY ASSURANCE (Cont'd)

.3 Have access to local supplies of essential parts and provide seven (7) year guarantee of availability of spare parts after obsolescence.

.4 Work to be performed by manufacturer's factory trained and certified personnel. Such personnel to submit certification upon request and are subject to approval of Departmental Representative.

.5 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

1.9 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide Departmental Representative with schedule within two (2) weeks after award of Contract.

.2 Equipment delivered to site to be stored indoors, not within contact with the ground, and protected from moisture and freezing temperatures.

1.10 COMMISSIONING

.1 Do commissioning in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.

1.11 AS-BUILTS

.1 Provide one (1) copy of detailed shop drawings and include:
.1 Changes to contract documents as well as addenda and contract extras.
.2 Changes to interface wiring.
.3 Routing of conduit, wiring and control air lines associated with MCS installation.
.4 Locations of obscure devices to be indicated on drawings.
.5 Listing of alarm messages.
.6 Panel/circuit breaker number for sources of normal/emergency power.
.7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.

1.11 AS-BUILTS (Cont'd)

.1 (Cont'd)
.8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports.
.9 Basic system design and full documentation on system configuration.

.2 Submit for final review by Departmental Representative.

.3 Provide before acceptance four (4) hard and one (1) soft copy incorporating changes made during final review.

1.12 O&M MANUALS

.1 Custom design O&M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.

.2 Provide two (2) complete sets of hard and soft copies prior to system or equipment tests.

.3 Include complete coverage in concise language readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.

.4 Functional description to include:
.1 Functional description of theory of operation.
.2 Design philosophy.
.3 Specific functions of design philosophy and system.
.4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.
.5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.

1.12 O&M MANUALS (Cont'd)

.4 Functional description to include:(Cont'd)

.6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented or planned for implementation in automatic mode.

.5 System operation to include:

.1 Complete step-by-step procedures for operation of system including required actions at each OWS.

.2 Operation of computer peripherals, input and output formats.

.3 Emergency, alarm and failure recovery.

.4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.

.6 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware's, plus diagnostics and repair/replacement of system hardware.

.7 System configuration document:

.1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.

.2 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.

1.13 MAINTENANCE SERVICE DURING WARRANTY PERIOD

.1 Provide services, materials, and equipment to maintain MCS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.

.2 Emergency Service Calls:
.1 Initiate service calls when MCS is not functioning correctly.
.2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
.3 Furnish Departmental Representative with telephone number where service personnel may be reached at any time.
.4 Service personnel to be on site ready to service MCS within 24 hours after receiving request for service.
.5 Perform Work continuously until MCS restored to reliable operating condition.

.3 Operation: provide proper sequencing of equipment and satisfactory operation of MCS based on original design conditions and as recommended by manufacturer.

.4 Work requests: record each service call request, when received separately on approved form and include:
.1 Serial number identifying component involved.
.2 Location, date and time call received.
.3 Nature of trouble.
.4 Names of personnel assigned.
.5 Instructions of work to be done.
.6 Amount and nature of materials used.
.7 Time and date work started.
.8 Time and date of completion.

.5 Provide system modifications in writing.
.1 No system modification, including operating parameters and control settings, to be made without prior written approval of Departmental Representative.

1.14 TRAINING

.1 Departmental Representative reserves right to approve instructors.

.2 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of MCS installed.

.3 Training to be project-specific.

.4 Provide equipment, visual and audio aids, and materials for classroom training.

.5 Training to be delivered in two (2) phases as follows.

.6 Phase 1: two (2) day program to begin before thirty (30) day test period at time mutually agreeable to Contractor, Departmental Representative and PWGSC Commissioning Manager.
.1 Train O&M personnel in functional operations and procedures to be employed for system operation.
.2 Supplement with on-the-job training during thirty (30) day test period.
.3 Include overview of system architecture, communications, operation of computer and peripherals, report generation.
.4 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.

.7 Phase 2: two (2) day program to begin eight (8) weeks after acceptance for operators, equipment maintenance personnel and programmers.
.1 Provide multiple instructors on pre-arranged schedule. Include at least the following:
.1 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.
.2 Equipment maintenance training: provide personnel training in maintenance of MCS equipment, including general equipment layout, trouble shooting and preventive maintenance of MCS components,

1.14 TRAINING (Cont'd)

.7 Phase 2:(Cont'd)
.1 (Cont'd)

maintenance and calibration of sensors and controls.
.3 Programmers: provide personnel with training in following subjects in approximate percentages of total course shown:
.1 Software and architecture.
.2 Application programs
.3 Controller programming.
.4 Troubleshooting and debugging.
.5 Colour graphic generation.

.8 Additional training: list courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personneL.

PART 2 - PRODUCTS

2.1 MASTER CONTROL UNIT (MCU)

.1 Supplied by VRF manufacturer as an integral part of the VRF operating system.

.2 For additional information regarding the MCU, see "VRV Centralized Controller" in Section 23 81 24 - Multiple Split Air Conditioning System.

.3 MCU shall control all VRF functionality as described herein. In addition, the MCU shall perform all Mechanical Control System (MCS) control functions via an interface module. Provide all necessary adapters, interfaces, wiring, hardware and software as required to ensure that the MCS performs as a complete and functional system for the control of all building operating requirements.

2.2 BUILDING INTERFACE MODULE (BIM)

.1 The Building Interface Module (BIM) shall enable the MCU to control all non-VRF devices and systems. The BIM shall be connected to the MCU via a high speed communications bus.

.2 The BIM shall be equipped with terminal boards with sufficient I/O points to support all MCS control functions, with no less than 25% spare capacity for future use.

.3 I/O points may be either analog or digital, inputs or outputs. Points shall be configurable as DI, AI, DO, or AO as required to meet MCS needs.

.4 The BIM shall be expandable by the insertion of additional terminal boards if required.

.5 The BIM shall be supplied by the VRF manufacturer as an integral part of the VRF operating system.

2.3 LOCAL CONTROL UNIT (LCU)

.1 Local Control Units shall be provided within each indoor VRF unit and elsewhere as required.

.2 LCU to communicate directly with the MCU (or via the VRF outdoor unit) through the VRF LAN.

.3 LCU to be capable of operating independently of MCU (ie. maintaining space temperature) in case of communication failure.

.4 For additional information regarding the LCU, see Section 23 81 24 - Multiple Split Air Conditioning System.

2.4 FIELD CONTROL DEVICES

.1 Temperature Sensors:

.1 General: except for room sensors to be resistance or thermocouple type to following requirements:

.1 Thermocouples: limit to temperature range of 200 C and over.

.2 RTD's: 100 or 1000 ohm at 0°C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, three (3)

2.4 FIELD CONTROL DEVICES (Cont'd)

.1 (Cont'd)

.1 (Cont'd)

.2 RTD's:(Cont'd) integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm °C.

.3 Sensing element: hermetically sealed.

.4 Stem and tip construction: copper or type 304 stainless steel.

.5 Time constant response: less than 3 seconds to temperature change of 10°C.

.6 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100, 150 mm as indicated.

.2 Room temperature sensors and display wall modules.

.3 Room temperature sensors.

.1 Wall mounting, in slotted type covers having brushed aluminum, brushed stainless steel finish, with guard as indicated.

.2 Element 10-50 mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000 ohm, accuracy of plus or minus 0.2°C.

.4 Duct temperature sensors:

.1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length 460 mm.

.2 Averaging duct type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length 600 mm. Bend probe at field installation time to 100 mm radius at point along probe without degradation of performance.

.3 Outdoor air temperature sensors:

.1 Outside air type: complete with probe length 100 - 150 mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in NEMA 4 enclosure.

.2 Humidity Sensors:

2.4 FIELD CONTROL DEVICES (Cont'd)

.2 Humidity Sensors:(Cont'd)

.1 Room and Duct Requirements:

.1 Range: 5 - 90% RH minimum.

.2 Operating temperature range: 0 - 60°C.

.3 Absolute accuracy: plus or minus 2%.

.4 Sheath: stainless steel with integral shroud for specified operation in air streams of up to 10 m/s.

.5 Maximum sensor non-linearity: plus or minus 2% RH with defined curves.

.6 Room sensors: wall mounted as indicated.

.7 Duct mounted sensors: locate so that sensing element is in air flow in duct.

.8 Transmittor:

.1 Input signal: from RH sensor.

.2 Output signal: 4 - 20 mA onto 500 ohm maximum load.

.3 Input and output short circuit and open circuit protection.

.4 Output variations: not to exceed 0.2% of full scale output for supply voltage variations of plus or minus 10%.

.5 Output linearity error: plus or minus 1.0% maximum of full scale output.

.6 Integral zero and span adjustment

.7 Temperature effect: plus or minus 1.0% full scale/6 months.

.8 Long term output drift: not to exceed 0.25% of full scale output/6 months.

.3 Elctro-mechanical Relay:

.1 Double voltage, DPDT, plug-in type with termination base.

.2 Coils: rated for 120V AC or 24V DC. Other voltage: provide transformer.

.3 Contacts: rated at 5 amps at 120 V AC.

.4 Relay to have visual status indication

.4 Solid State Relays:General:

.1 Relays to have LED Indicator

.2 Input and output Barrier Strips to accept 14 to 28 AWG wire.

2.4 FIELD CONTROL DEVICES (Cont'd)

.4 Solid State Relays: (Cont'd)
.3 Operating temperature range to be -20°C to 70°C.
.4 Relays to be CSA Certified.
.5 Input/output Isolation Voltage to be 4000 VAC5 at 25°C for 1 second maximum duration.
.6 Operational frequency range, 45 to 65 HZ.
.7 Input:
.1 Control voltage, 3 to 32 VDC.
.2 Drop out voltage, 1.2 VDC.
.3 Maximum input current to match AO (Analog Output) board.
.8 Output.
.1 AC or DC Output Model to suit application.

.5 Current Sensing Relays:
.1 Suitable to detect belt loss or motor failure.
.2 Trip point adjustment, output status LED.
.3 Split core for easy mounting.
.4 Induced sensor power.
.5 Relay contacts: capable of handling 0.5 amps at 30 VAC / DC. Output to be NO solid state.
.6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.
.7 Adjustable latch level.

.6 Electronic Damper Actuators:
.1 Direct mount proportional type as indicated.
.2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.
.3 Operator: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.
.4 Power requirements: 5 VA maximum at 24 V AC.
.5 Operating range: 0 - 10 V DC or 4 - 20 mA DC.
.6 Damper actuator to drive damper from full open to full closed in less than 120 seconds.

2.4 FIELD CONTROL DEVICES (Cont'd)

.7 Carbon Dioxide Alarm:
.1 Wall mounted CO2 monitoring and alarm unit with infrared sensor: LCD display of CO2 level and unit status; three stage visual display of alarm status via green, yellow and red LEDs; audible alarm with mute button; 0-10 VDC analog output.
.2 Electrical: 24 VAC suitable for mounting in a standard junction box.

.8 Duct Airflow Measurement:
.1 Duct mounted, thermal disperson, airflow measurment station with precision thermistors; aerodynamic sensor aperture; encapsulated sensor assembly for rugged environments and ease of cleaning without damage; unit-mounted output display; dual analog outputs and optional alarm output.
.2 Electrical: 24 VAC.

2.5 MCS LOCAL AREA NETWORK (LAN)

.1 MCS Local Area Network (MCS-LAN).
.1 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis in accordance with IEEE 802.3/Ethernet Standard.
.2 MCS-LAN to: BACnet, Proprietary Protocol.
.3 Each MCS-LAN to be capable of supporting at least 50 devices.
.4 Support of combination of MCUs and OWSs directly connected to MCS-LAN.
.5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10 Megabits per second minimum.
.6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.
.7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.

2.5 MCS LOCAL AREA NETWORK (LAN) (Cont'd)

.2 Dynamic Data Access.
.1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.
.2 Access to data to be based upon logical identification of building equipment.

.3 Network Medium: twisted cable , shielded or non-shielded or fibre optic cable as required to suit VRF manufacturer's requirements.

.4 MCS shall also connect and interface with the building LAN. Provide adapters, router, gateways and additional hardware and software as required to enable full MCS access via the MCU, both for workstations within the building (hardwired to the LAN) and data devices not within the building (via remote access to the LAN).

2.6 OPERATOR WORKSTATION (OWS)

.1 Owner shall designate one or more workstations within the building at MCS as Operator Workstations (OWS).

.2 OWS shall communicate with the MCS via the MCU through the building's LAN.

.3 This Contractor shall provide the Owner with all the necessary information and minimum equipment requirements to ensure that the designated workstation(s) can function effectively as the OWS. The OWS software to operate in "Windows" based operating environment. Supply and install any additional proprietary hardware and/or software as required to ensure functionality.

2.7 OWS CONTROL SOFTWARE

.1 OWS is not to form part of real-time control functions either directly or indirectly or as part of communication link. Real-time control functions to reside in MCUs, LCUs, and TCUs with peer to peer communication occurring at MCU to MCU device level.

2.7 OWS CONTROL SOFTWARE (Cont'd)

.2 Time Synchronization Module.
.1 System to provide Time Synchronization of real-time clocks in controllers.
.2 System to perform this feature on regular scheduled basis and on operator request.

.3 User Display Interface Module.
.1 OWS software to support "Point Names".
.2 Upon operator's request in either text, graphic or table mode, system to present condition of single point, system, area, or connected points on system to OWS. Display analog values digitally to 1 place of decimal with negative sign as required. Update displayed analog values and status when new values received. Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm. Refresh rate of screen data not to exceed 5 seconds from time of field change and system is to execute supervisory background scan every 20 seconds to verify point data value.

.4 General Event Log Module: to record system activities occurring at OWS or elsewhere in system including:
.1 Operator Log-in from user interface device.
.2 Communication messages: errors, failures and recovery.
.3 Event notifications and alarms by category.
.4 Record of operator initiated commands.

.5 General Event Log:
.1 Hold minimum of four (4) months information and be readily accessible to operator.
.2 Able to be archived as necessary to prevent loss of information.

.6 Operator Control Software Module: to support entry of information into system from keyboard and mouse, disk, or from another network device. Display of information to user; dynamic displays, textual displays, and graphic displays to display logging and

2.7 OWS CONTROL SOFTWARE (Cont'd)

.6 Operator Control Software Module:(Cont'd) trending of system information and following tasks:

.1 Automatic logging of digital alarms and change of status messages.

.2 Automatic logging of analog alarms.

.3 System changes: alarm limits, set-points, alarm lockouts.

.4 Display specific point values, states as selected.

.5 Provide reports as requested and on scheduled basis when required.

.6 Display graphics as requested, and on alarm receptions (user's option).

.7 Display list of points within system.

.8 Display list of systems within building.

.9 Direct output of information to selected peripheral device.

.10 On-line changes:

- .1 Alarm limits.
- .2 Setpoints.
- .3 Deadbands.
- .4 Control and change of state changes.
- .5 Time, day, month, year.
- .6 Control loop configuration changes for controller-based CDLs.
- .7 Control loop tuning changes.
- .8 Schedule changes.
- .9 Changes, additions, or deletions, of points, graphics, for installed and future systems.

.11 According to assigned user privileges (password definition) following functions are to be supported:

- .1 Permit operator to terminate automatic (logic based) control and set value of field point to operator selected value. These values or settings to remain in effect until returned to automatic (logic based) control by operator.
- .2 Requests for status, analog values, graphic displays, logs and controls to be through user interface screens.

.12 Software and tools utilized to generate, modify and configure building controllers to be installed and operational on the OWS.

2.7 OWS CONTROL SOFTWARE (Cont'd)

.7 Dial-up host Module for off site OWSs.
.1 Operators at dial-up OWS to be able to perform control functions, report functions, data base generation and modification functions as described for OWS's connected via LAN. Provide routines to automatically answer calls and either file or display information sent from remote panels.
.2 Operator to be able to access remote buildings by selection of facility by its logical name. Dial-up module to maintain user-definable cross-reference of buildings and associated telephone numbers without manual dialing.
.3 Local OWS may serve as dial-up host for remotely connecting OWSs, remote controllers or networks. Alarms and data file transfers handled via dial-up transactions must not interfere with local LAN activity. LAN activity not to prevent work-station from handling incoming calls.

.8 Message Handling Module - and Error Messages: to provide message handling for following conditions:
.1 Message and alarm buffering to prevent loss of information.
.2 Error detection correction and retransmission to guarantee data integrity.
.3 Informative messages to operator for data error occurrences, errors in keyboard entry, failure of equipment to respond to requests or commands and failure of communications between MCS devices.
.4 Default device definition to be implemented to ensure alarms are reported as quickly as possible in event of faulty designated OWS.

.9 Access ControlModule.
.1 Multiple levels of password access protection to limit control, display, or data base manipulation capabilities. Following is preferred format of progression of password levels:
.1 Guest: no password data access and display only.
.2 Operator Level: full operational commands including automatic override.

2.7 OWS CONTROL SOFTWARE (Cont'd)

.9 (Cont'd)

.1 (Cont'd)

.3 Technician: data base modifications.

.4 Programmer: data base generation.

.5 Highest Level : system administration - password assignment addition, modification.

.2 User-definable, automatic log-off timers from 1 to 60 min. to prevent operators leaving devices on-line inadvertently. Default setting = 3 minutes.

.10 Trend Data Module: includes historical data collection utility, trend data utility, control loop plot utility. Each utility to permit operator to add trend point, delete trend point, set scan rate.

.1 Historical data collection utility: collect concurrently operator selected real or calculated point values at operator selectable rate 30-480 minutes. Samples to include for each time interval (time-stamped), minimum present value, maximum present value, and average present value for point selected. Rate to be individually selectable for each point. Data collection to be continuous operation, stored in temporary storage until removed from historical data list by operator. Temporary storage to have at least 6 month capacity.

.2 Trend data utility: continuously collect point object data variables for variables from building controllers as selected by operator, including at minimum; present value of following point object types - DI, DO, AI, AO set points value, calculated values. Trend data utility to have capacity to trend concurrently points at operator-selectable rate of 05seconds to 3600 seconds, individually selectable for selected value, or use of COSV detection. Collected trend data to be stored on minimum 96 h basis in temporary storage until removed from trend data list by operator. Option to archive data before overwriting to be available.

.3 Control loop plot utility: for AO Points provide for concurrent plotting of Measured value input - present value, present value of output, and AO setpoint. Operator selectable sampling interval to be selectable between 1

2.7 OWS CONTROL SOFTWARE (Cont'd)

.10 Trend Data Module: (Cont'd)

.3 Control loop plot utility: (Cont'd) second to 20 seconds. Plotting utility to scroll to left as plot reaches right side of display window. Systems not supporting control loop plot as separate function must provide predefined groups of values. Each group to include values for one control loop display.

.4 Trend data Module to include display of historical or trend data to OWS screen in X Y plot presentation. Plot utility to display minimum of 6 historical points or 6trend points concurrently or 1 Control Loop Plot. For display output of real time trend data, display to automatically index to left when window becomes full. Provide plotting capabilities to display collected data based on range of selected value for (Y) component against time/date stamp of collected data for (X) component.

.5 Provide separate reports for each trend utility. Provide operator feature to specify report type, by point name and for output device. Reports to include time, day, month, year, report title, and operator's initials. Implement reports using report module. Ensure trend data is exportable to third party spreadsheet or database applications for PCs.

.11 Report Module: reports for energy management programs, function totalization, analog/pulse totalization and event totalization features available at MCU level.

.1 Reports to include time, day, month, year, report title, operator's initials.

.2 Software to provide capability to:

.1 Generate and format reports for graphical and numerical display from real time and stored data.

.2 Print and store reports as selected by operator.

.3 Select and assign points used in such reports.

.4 Sort output by area, system, as minimum.

.3 Periodic/automatic report:

.1 Generate specified report(s) automatically including options of start time and date, interval between reports (hourly, daily, weekly, monthly), output

2.7 OWS CONTROL SOFTWARE (Cont'd)

.11 Report Module: (Cont'd)

.3 Periodic/automatic report: (Cont'd)

.1 (Cont'd)

device. Software to permit modifying periodic/automatic reporting profile at any time.

.2 Reports to include:

.1 Power demand and duty cycle summary: see application program for same.

.2 Disabled "Locked-out" point summary: include point name, whether disabled by system or by operator.

.3 Run time summary: summary of accumulated running time of selected equipment. Include point name, run time to date, alarm limit setting. Run time to accumulate until reset individually by operator.

.4 Summary of run time alarms: include point name, run time to date, alarm limit.

.5 Summary of start/stop schedules: include start/stop times and days, point name.

.6 Motor status summary.

.4 Report types:

.1 Dynamic reports: system to printout or display of point object data value requested by operator. System to indicate status at time of request, when displayed, updated at operator selected time interval. Provide option for operator selection of report type, by point name, and/or output device. Ensure reports are available for following point value combinations:

.2 Points in accessible from this OWS (total connected for this location), multiple "areas".

.3 Area (points and systems in Area).

.4 Area, system (points in system).

.5 System (points by system type).

.6 System point (points by system and point object type).

.7 Area point (points by system and point object type).

.8 Point (points by point object type).

2.7 OWS CONTROL SOFTWARE (Cont'd)

.11 Report Module: (Cont'd)

.5 Summary report: printout or display of point object data value selected by operator. Report header to indicate status at time of request. Ensure reports are available on same basis as dynamic reports. Provide option as to report type, point name, output device.

.6 Include preformatted reports as listed in Event/Alarm Module.

.12 Graphics Display Module: graphics software utility to permit user to create, modify, delete, file, and recall graphics.

.1 Provide capacity for 100% expansion of system graphics. Graphic interface to provide user with multiple layered diagrams for site, building in plan view, floor furniture plan view and building systems, overlayed with dynamic data appropriately placed and permitting direct operator interaction. Graphic interface to permit operator to start and stop equipment, change set points, modify alarm limits, override system functions and points from graphic system displays by use of mouse or similar pointing device.

.2 Display specific system graphics: provide for manual and/or automatic activation (on occurrence of an alarm). Include capability to call up and cancel display of graphic picture.

.3 Library of pre-engineered screens and symbols depicting standard air handling components (fans, coils, filters, dampers, etc.), complete mechanical system components (condensers, pumps, etc.), electrical symbols.

.4 Graphic development, creation, modification package to use mouse and drawing utility to permit user to:

.1 Modify portion of graphic picture/schematic background.

.2 Delete graphic picture.

.3 Call up and cancel display of graphic picture.

.4 Define symbols.

.5 Position and size symbols.

.6 Define background screens.

.7 Define connecting lines, curves.

.8 Locate, orient, size descriptive text.

2.7 OWS CONTROL SOFTWARE (Cont'd)

.12 Graphics Display Module:(Cont'd)

.4 (Cont'd)

.9 Define, display colours of elements.

.10 Establish co-relation between symbols or text and associated system points or other graphic displays.

.5 User to be able to build graphic displays showing on-line point data from multiple MCU panels. Graphic displays to represent logical grouping of system points or calculated data based upon building function, mechanical system, building layout, other logical grouping of points which aids operator in analysis of facility operation. Data to be refreshed on screen as "changed data" without redrawing of entire screen or row on screen.

.6 Dynamic data (temperature, flow, status) to be shown in actual schematic locations, to be automatically updated to show current values without operator intervention.

.7 Windowing environment to allow user to view several graphics simultaneously to permit analysis of building operation, system performance, display of graphic associated with alarm to be viewed without interrupting work in progress.

.8 Utilize graphics package to generate system schematic diagrams. In addition provide graphics for schematic depicted on mechanical plan flow diagrams, point lists and system graphics. Provide graphic for floor depicting room sensors and control devices located in their actual location.

.9 Provide complete directory of system graphics, including other pertinent system information. Utilize mouse or pointing device to "point and click" to activate selected graphic.

.10 Provide unique sequence of operation graphic or pop-up window for each graphic that is depicted on OWS. Provide access to sequence of operation graphic by link button on each system graphic. Provide translation of sequence of operation, a concise explanation of systems operation, from control descriptive logic into plain English.

2.7 OWS CONTROL SOFTWARE (Cont'd)

.13 Event/Alarm Module : displays in window alarms as received and stored in General Event Log.

.1 Classify alarms as "critical", "cautionary", "maintenance". Alarms and alarm classifications to be designated by personnel requiring password level.

.2 Presentation of alarms to include features identified under applicable report definitions of Report Module paragraph.

.3 Alarm reports.

.1 Summary of points in critical, cautionary or maintenance alarm. Include at least point name, alarm type, current value, limit exceeded.

.2 Analog alarm limit summary: include point name, alarm limits, deviation limits.

.3 Summary of alarm messages: include associated point name, alarm description.

.4 Software to notify operator of each occurrence of alarm conditions. Each point to have its own secondary alarm message.

.5 MCS to notify operator of occurrence of alarms originating at field device within following time periods of detection:

.1 Critical - 5 seconds.

.2 Cautionary - 10 seconds.

.3 Maintenance - 10 seconds.

.6 Display alarm messages in English.

.7 Primary alarm message to include as minimum: point identifier, alarm classification, time of occurrence, type of alarm. Provide for initial message to be automatically presented to operator whenever associated alarm is reported. Assignment of secondary messages to point to be operator-editable function. Provide secondary messages giving further information (telephone lists, maintenance functions) on per point basis.

.8 System reaction to alarms: provide alarm annunciation by dedicated window (activated to foreground on receipt of new alarm or event) of OWS with visual and audible hardware indication. Acknowledgement of alarm to change visual indicator from flashing to steady state and to silence audible device. Acknowledgment of alarm to be time, date and operator stamped and stored in General Event Log. Steady state

2.7 OWS CONTROL SOFTWARE (Cont'd)

.13 Event/Alarm Module :(Cont'd)

.8 System reaction to alarms:(Cont'd) visual indicator to remain until alarm condition is corrected but must not impede reporting of new alarm conditions. Notification of alarm not to impede notification of subsequent alarms or function of Controller's/CDL. Do not allow random occurrence of alarms to cause loss of alarm or over-burden system. Do not allow acknowledgment of one alarm as acknowledgement of other alarms.

.9 Controller network alarms: system supervision of controllers and communications lines to provide following alarms as minimum:

.1 Controller not responding - where possible delineate between controller and communication line failure.

.2 Controller responding - return to normal.

.3 Controller communications bad - high error rate or loss of communication.

.4 Controller communications normal - return to normal.

.10 Digital alarm status to be interrogated every two (2) seconds as minimum or be direct interrupting non-polling type (COV). Annunciate each non-expected status with alarm message.

.14 Archiving and Restoration Module.

.1 Primary OWS to include services to store back-up copies of controller databases. Perform complete backup of OWS software and data files at time of system installation and at time of final acceptance. Provide backup copies before and after Controller's revisions or major modifications.

.2 Provide continuous integrity supervision of controller data bases. When controller encounters database integrity problems with its data base, system to notify operator of need to download copy data base to restore proper operation.

.3 Ensure data base back-up and downloading occurs over LAN without specialized operator technical knowledge. Provide operator with ability to manually download entire controller data base, or parts thereof as required.

2.7 OWS CONTROL SOFTWARE (Cont'd)

.15 CDL Generator and Modifier Module.
.1 CDL Generator module to permit generation and modification of CDLs.
.2 Provide standard reference modules for text based systems module that will permit modification to suit site specific applications. Module to include cut, paste, search and compare utilities to permit easy CDL modification and verification.
.3 Provide full library of symbols used by manufacturer for system product installed accessible to operators for systems using graphical environment for creation of CDLs Module to include graphic tools required to generate and create new object code for downloading to building controllers.
.4 Module to permit testing of code before downloading to building controllers.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Do complete installation in accordance with requirements of:
.1 Division 26, this specification.
.2 CSA 22.1 Canadian Electrical Code.
.3 ANSI/NFPA 70.
.4 ANSI C2.

.2 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

.3 Communication wiring shall be installed in conduit. Provide complete conduit system to link MCS components. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities. Maximum conduit fill no to exceed 40%. Design drawings do not show conduit layout.

.4 Firestopping: provide fire stopping in accordance with Section 07 84 00 - Firestopping.

.5 Install controllers in secure locking enclosures as indicated or as directed by Departmental Representative. Provide necessary

3.1 INSTALLATION (Cont'd)

.5 (Cont'd) power from 120V branch circuit panel for equipment. Install tamper locks on breakers of circuit breaker panel.

3.2 COMMISSIONING

.1 MCS to be commissioned in accordance with Section 01 91 13 - Commissioning (Cx) Requirements.

.2 MCS to be commissioned in accordance with manufacturer's written procedures and recommended practices.

.3 VRF technician shall be present during commissioning. Technician shall be suitably trained and certified by the manufacturer for all MCS components.

3.3 TRAINING

.1 Provide training as described herein and in accordance with Section 01 91 41 - Commissioning: Training.

3.4 WARRANTY AND MAINTENANCE

.1 Perform one minor and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Departmental Representative.

.2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.

.3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:
.1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.
.2 Check and Calibrate each field input/output device.
.3 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.

3.4 WARRANTY AND MAINTENANCE (Cont'd)

.4 Minor inspections to include, but not limited to:
.1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.
.2 Check equipment cooling fans as required.
.3 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.
.4 Review system performance with Departmental Representative to discuss suggested or required changes.

.5 Major inspections to include, but not limited to:
.1 Minor inspection.
.2 Clean equipment and devices.
.3 Check signal, voltage and system isolation of controllers.
.4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.
.5 Provide mechanical adjustments, and necessary maintenance on printers.
.6 Run system software diagnostics as required.
.7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.
.1 Perform network analysis and provide report as described in Submittal article.

.6 Rectify deficiencies revealed by maintenance inspections and environmental checks.

.7 Continue system debugging and optimization.

.8 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.
.1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

3.5 SYSTEMS SEQUENCES OF OPERATION

.1 This Contractor shall provide a complete I/O summary schedule similar to the one included within these specifications, listing and describing all I/O's in detail. Contractor's standard schedule may be used provided all relevant information is presented.

.2 Whether included in the attached I/O summary schdule or not, it is the responsibility of this Contractor to provide all control points as required to provide a complete and functional control system, as outlined on the drawings and desrcibed in the control narrative sequences of operation.

.3 This Contractor is responsible to review all contact documents, including all drawings and specification, to determine the full scope of work and extent of the hardware and software required for the MCS.

.4 Control Narrative Sequences of Operation:
.1 Miscellaneous: sequences not narrated herein shall be as shown diagrammatically, as inferred from the drawings and specifications, or as required by the equipment and systems supplied.

.5 Sequence of Operation
.1 Fans:
.1 Fan F2 - Electrical Room 123 (MCTC Building):
.1 Fan F1 shall provide ventilation and cooling for Electrical Room 123 as indicated.
.2 When the fan is OFF the motorized outdoor air damper and exhaust air damper shall be closed. On a start command from the VRF system controller the fan shall be energized via the "auto" position of the H/O/A switch within the starter and the two dampers will open.
.3 The VRF system controller shall control the operation of F2 so as to run the fan whenever the temperature of the Electrical Room is above a programmable limit (initially set at 18°C, but user adjustable).

3.5 SYSTEMS SEQUENCES OF OPERATION (Cont'd)

.5 (Cont'd)

.1 Fans: (Cont'd)

.1 (Cont'd)

.4 The VRF system controller shall monitor the temperature of the Electrical Room via its room thermostat. The thermostat set point shall be communicated to the system controller, and although this setpoint may be overridden, it is constrained within preset limits of the control system. As room temperature rises above set point, the normally closed (NC) outdoor air damper shall open, and the normally closed (NC) exhaust air damper shall also open.

.5 The status of the fan shall be monitored by a current sensor supplied by the MCS contractor and located in the motor starter. An alarm condition shall be annunciated by the control system if the status of the fan does not match its commanded operating condition.

.6 If the room temperature falls below the low alarm limit, or above the high alarm limit (initially set at 8°C and 28°C respectively, but user adjustable), the control system shall annunciate an alarm condition.

.2 Fan F1 - Serving Fume Extraction Arm - Soldering Station (MCTC Building) - Note: not connected to the VRF system controller:

.1 This fan will have local On/Off control via a manual motor starter which is located at the soldering station bench. The motorized exhaust air damper shall be normally closed. When soldering is being performed, the operator shall switch the fan On and the motorized damper will be commanded open. The fan will continue to run until the switch is turned Off. The motorized damper will then return to the closed position.

3.5 SYSTEMS SEQUENCES OF OPERATION (Cont'd)

.5 (Cont'd)

.1 Fans: (Cont'd)

.3 Fan F4 - Rangehood Exhaust - Kitchen 212 (MCTC Building) - Note: not connected to the VRF system controller:

.1 This rangehood will be controlled by a manual On/Off switch on the hood. The rangehood will have four speed settings and also a switch for the light. The fan will run until the switch is turned to the Off position. The exhaust air discharges to the outside through a wall cap and gravity backdraft damper.

.4 Fan F3 - Janitor Room 205 (similar for fan F5) - (MCTC Building):

.1 Fan F3 shall provide exhaust from Janitor Room 205 as indicated. The fan shall be set to operate at all times but can be commanded off through the VRF system controller. The fan could also be setup on a time schedule for working hours but with possible fumes being stored in the Janitor's room it is recommended to run the fan at all times.

.2 The status of the fan shall be monitored by a current sensor supplied by the MCS contractor and located in the motor starter. An alarm condition shall be annunciated by the control system if the status of the fan does not match its commanded operating condition.

.2 Room Temperature Control:

.1 Fan Coil Units (heating/cooling) with space heat (baseboards - secondary heat).

.1 In rooms served by the VRF system, the FC unit will remain OFF if the room set point temperature is satisfied.

.2 On a call for cooling as sensed by the room temperature controller, the FC unit shall operate in cooling mode until the room set point temperature is achieved. Once the desired room

3.5 SYSTEMS SEQUENCES OF OPERATION (Cont'd)

.5 (Cont'd)

.2 Room Temperature Control:(Cont'd)

.1 (Cont'd)

.2 (Cont'd)

temperature set point is satisfied, the unit will shut down.

.3 On a call for heating, the FC unit shall operate in heating mode until the room setpoint temperature is achieved. If the space temperature remains more than a set amount below setpoint for a set amount of time (initially set a 5°C and 10 minutes, respectively, but user adjustable), the temperature controller shall energize the electric baseboard heater(s) to satisfy the heat demand. As the space temperature rises, the electric heater(s) will be de-energized first. As the temperature continues to rise, the fan coil will be shut off.

.4 For the OPS room, to help provide a level of individual control to occupants (even though there are no divisions between the consoles), each console shall be equipped with a temperature controller to control the temperature from the associated ceiling mounted FC. To avoid the individual FC's from `battling' (ie. some in heating mode and some in cooling mode) the heating/cooling mode changeover is evaluated based on total heating demand versus total cooling demand across the four (4) controllers. If the total cooling demand is greater than the total heating demand, then the MCU (Intelligent Touch Manager, or iTM) changes the indoor units to cooling mode. When the changeover group is in cooling mode, the total cooling demand will be decreased and at some point the total heating demand may exceed the cooling demand and the group will change to heating mode (a guard timer applies so the units do

3.5 SYSTEMS SEQUENCES OF OPERATION (Cont'd)

.5 (Cont'd)

.2 Room Temperature Control:(Cont'd)

.1 (Cont'd)

.4 (Cont'd)

not continuously cycle between heating and cooling). The set points can be different in each of the FC's in the changeover group and demand calculated based on the unit set points versus the room temperature. If the demand is within the Primary Changeover Deadband (PCd) then no heating or cooling is required as this is considered a `no demand' condition. Weighting can be added to each of indoor units' demand in the changeover group which would allow some units to have more `influence' over the group. The default weighting is 1 but can be changed if desired.

.5 For areas not occupied 24 hours per day (or do not require heating/cooling 24 hours per day), space temperatures shall be set back during unoccupied periods by the VRF system controller. The normal work day schedule shall be initially 8am-5pm, but shall be user adjustable if desired. The night set back can be overridden by adjusting the temperature controller in the room should someone enter the space after working hours and want to change the room temperature.

.2 Backup AC System for E&I Electronic Equipment Room:

.1 The E&I Electronics Equipment Room contains many pieces of electronic and server equipment and the room must be maintained at a cooler temperature to ensure the equipment does not shutdown due to overheating. Should the main VRF system for the building shutdown or be taken out of service for maintenance, etc., this backup, low-ambient `cooling only' system shall be energized. The two outdoor condensing units shall start up and

3.5 SYSTEMS SEQUENCES OF OPERATION (Cont'd)

.5 (Cont'd)

.2 Room Temperature Control:(Cont'd)

.2 (Cont'd)

.1 (Cont'd)

the two indoor wall mounted units shall provide cooling as required to maintain space temperatures below critical levels. Once the VRF system returns to service, these units shall de-energize.

.2 The backup AC system shall be totally independent of the main system, such that failure of any component of the main system cannot prevent or compromise start-up and operation of the backup system.

.3 The backup system shall start automatically whenever the space temperature reaches the backup system's temperature setpoint. The wall temperature controllers for the backup system shall always be set higher than that of the main system to prevent simultaneous operation.

.4 Communications wiring shall be provided between the main system outdoor units (CU-1 and the backup system outdoor untis (CU-2 and CU-3). The MCS shall continuously monitor the status of CU-2 and CU-3, and shall annunciate an alarm condition whenever either backup unit is running.

.3 Heat Recovery Ventilator (HRV) and baseboard heaters (No Air Conditioning):

.1 In rooms that do not require cooling, fresh outdoor air is provided and heat is provided by baseboard heaters. The ventilation air is delivered at a constant volume and supply air is heated to setpoint (initially set at 20°C but user adjustable) via duct heaters when required. The reheat coil S.A.T setpoint (as sent to the RHC by the MHU) shall be capable of varying as the outdoor air temperature varies, by means of an OAT reset algorithm. For these spaces, on a call for heat from the temperature controller, the

3.5 SYSTEMS SEQUENCES OF OPERATION (Cont'd)

.5 (Cont'd)

.2 Room Temperature Control: (Cont'd)

.3 (Cont'd)

.1 (Cont'd)

baseboard heater(s) in the space will energize and provide heating until the room set point temperature is achieved.

.2 For the spaces not on a 24 hour schedule, space heating shall be setup for night set back (initially 18°C but user adjustable).

.3 For spaces not on a 24 hour schedule, each HRV shall be equipped with a scheduling mechanism and a manual override for after-hours operation.

.1 For HRV-2, scheduling shall be provided by the MCU. Override shall be via a wall-mounted device. The device shall feature a light which is illuminated whenever the HRV is running, as well as a momentary-contact pushbutton which shall send a signal to the MCU to run the HRV for a set length of time (initially 4 hours, but user adjustable).

.4 Unit Heater Control Sequence:

.1 On a call for heating as sensed by the room temperature controller, the unit heater shall switch to On and the fan shall start. Once the temperature is satisfied, the heater shall de-energize.

.2 In areas where there is an overhead door to the outside, the unit heaters must de-energize when the door is open. Once the door is closed, the heater shall be re-enabled to be energized as required to raise room temperature to the desired set point.

.3 Fan speed may be manually adjustable from within the cabinet enclosure where indicated. See

3.5 SYSTEMS SEQUENCES OF OPERATION (Cont'd)

.5 (Cont'd)

.2 Room Temperature Control: (Cont'd)

.4 (Cont'd)

.3 (Cont'd)

electrical for more details on unit heaters.

.3 Pumps P1 and P2:

.1 The domestic hot water recirculation pump (P1) shall be equipped with a combination magnetic starter with Hand/Off/Auto (H/O/A) switch. The switch will be set to the `auto' position for normal operation.

.2 DHWR pump (P1) shall operate in one of three control modes as selected by the Owner: no control (ie. pump is turned off), timed control, or demand control. For timed control, the control system will run the pump for a programmed number of cycles per day. The cycle length and number of cycles shall be user adjustable. For demand control, the control system will monitor the DHW return temperature by means of an aquastat installed in the recirculation piping. If the DHWR temperature drops below the pump cut-in set point for a preset length of time (initially set at 49°C for 5 minutes but user adjustable), the pump shall be commanded On. When the DHWR temperature rises above the pump cut-out temperature (initially set at 54°C but user adjustable), the pump shall be commanded Off.

.3 The Elevator Sump Pump (P2) will energize when the level of liquid in the sump pit lifts the pump float level switch. The pump will continue to operate until the level of liquid drops below the float switch. The MCU shall monitor the operation of pump P2 by means of a current transformer installed in the electrical panel or on the branch circuit wiring. The MCU shall monitor and record such data as time and date of each pump start, duration of each run cycle, and number of runcycles (since the last cycle counter reset to zero). MCU shall be capable of annuciating an alarm or

3.5 SYSTEMS SEQUENCES OF OPERATION (Cont'd)

.5 (Cont'd)

.3 Pumps P1 and P2:(Cont'd)

.3 (Cont'd)

service call, should the run duration or run frequency exceed preset values.

.4 The status of each pump shall be monitored by a current sensor on each pump. An alarm condition shall be annunciated by the VRF system controller if the status of the pump does not match its commanded operating condition.

.4 Heat Recovery Ventilators (HRV):

.1 HRV-1-MCTC Building (24 hour spaces):

.1 The unit shall be supplied as a complete, package unit with all controls prewired except as otherwise indicated or required. Unit controls shall have inputs and outputs indicated and as required to operate under the control of the facility's VRF system controller.

.2 For these 24hr occupied spaces, the unit shall run continuously and the outside air and exhaust dampers shall be normally open (NO). The control system shall direct the duct heater to maintain the supply air temperature (SAT) set point.

.3 The control system shall employ SAT set point reset. Outdoor air reset shall adjust the SAT set point upwards as the OAT decreases. The return air reset shall adjust the SAT set point downwards as the return air temperature increases. Both reset functions shall utilize a weighting factor based on the offset from a base temperature. These weighting factors and base temperatures shall be accessible in the control system and shall be user adjustable.

.2 HRV-2-MCTC Building (regular workday schedule areas):

.1 The unit shall be supplied as a complete, package unit with all controls prewired except as otherwise indicated or required.

3.5 SYSTEMS SEQUENCES OF OPERATION (Cont'd)

.5 (Cont'd)
.4 (Cont'd)
.2 (Cont'd)
.1 (Cont'd)

Unit controls shall have inputs and outputs indicated and as required to operate under the control of the facility's VRF system controller.

.2 The unit shall normally operate on a preset daily schedule. This schedule shall be accessible for viewing and editing by the Owner either locally or remotely. The unit will run continuously during the occupied schedule and will shut down at the end of the schedule. The unit may be manually started after normal hours by means of a wall mounted override timer. This device shall be equipped with a pushbutton: pushing the button will signal the control system to start the unit for a period of 4 hours (but user adjustable). The device will also be equipped with a pilot light which will illuminate whenever the unit is running (whether by scheduled or timer activation).

.3 When the unit is Off, the outside air and exhaust dampers shall be closed and the heating coil de-energized. The temperature transmitters shall continue to monitor but high and low limits shall not alarm.

.4 When the control system commands the unit On, the outside air and exhaust air dampers shall open and the unit shall be energized.

.5 Some areas must be maintained at a slightly negative pressure in relation to adjacent spaces at all times when the HRV is running. This relationship must be coordinated at the time of balancing with the TAB agent.

.6 Whenever the HRV is running, an interlock shall enable the duct

3.5 SYSTEMS SEQUENCES OF OPERATION (Cont'd)

.5 (Cont'd)
.4 (Cont'd)
.2 (Cont'd)
.6 (Cont'd)
heater to maintain the supply air temperature (SAT) set point.
.7 The control system shall employ SAT set point reset. Outdoor air reset shall adjust the SAT set point upwards as the OAT decreases. The return air reset shall adjust the SAT set point downwards as the return air temperature increases. Both reset functions shall utilize a weighting factor based on the offset from a base temperature. These weighting factors and base temperatures shall be accessible in the control system and shall be user adjustable.
.3 HRV-1 and HRV-2 shall each be equipped with an airflow measuring station which shall communicate with the MCS. Each station shall be calibrated to its HRV's normal airflow at the time of commissioning. An alarm condition shall be annunicated by the control system if at any time the airflow of the HRV does not match its commanded operating condition.
.4 Room 211 shall be equipped with a wall mounted CO2 (carbon dioxide) alarm. The unit shall continuously monitor the CO2 level in the room, and initiate a visual and audible alarm if the CO2 level exceed the preset high limit. All alarms shall also be communicated ot the MCS. If the HRV is OFF at the time of a CO2 alarm, then the MCS shall command it ON. The Owner shall have the option of having all CO2 alarms annuinicated to the OWS.