

PART 1 GENERAL REQUIREMENTS

- .1 Comply with the requirements of Section 21 05 01, Mechanical General Provisions.
- .2 Comply with the requirements of Section 21 05 05, Basic Materials and Methods.
- .3 Comply with the requirements of Sections 22 06 01 and 23 06 01, Approved Substitute Schedules.

1.1 RELATED WORK

- | | | |
|----|-----------------------|------------------|
| .1 | Plumbing | Section 22 05 05 |
| .2 | Air Distribution | Section 23 31 00 |
| .3 | Balancing and Testing | Section 23 05 93 |
| .4 | Electrical | Division 26 |

1.2 WORK BY OTHER SECTIONS

- .1 Section 22 05 05 (Plumbing Trade) to distribute and mount all pipe connected equipment including valves, immersion controllers, thermometers, flow switches etc. in their respective locations, as supervised by this Section.
- .2 Section 23 31 00 (Air Distribution) to distribute and mount all motorized dampers in their respective locations, as supervised by this Section.
- .3 Electrical wiring performed by Division 26:
 - .1 Electrical to supply and install all conduits, wire, & connections from the distribution panels to line side of magnetic starters and thermal overload switches. Including from load side of starters and switches to motors.
 - .2 Electrical to supply and install conduit, wire and connections for line voltage control devices on single phase equipment such as:
 - .1 Electrical thermostats for unit heaters and force flow-heating units.
 - .2 Float switches, pressure switches, alternators for sump pumps, sewage pumps, etc. and other mechanical wiring required but not specified in this section of the specifications.
 - .3 All safety controls must be wired in series with both "HAND" and "AUTO" starter switch positions to ensure against damage to equipment and/or system.
 - .4 Normal and/or emergency power source wiring to Controls Systems panels and other devices or groups of devices requiring 120 volt normal and/or emergency power source.

1.3 ELECTRICAL WIRING PERFORMED BY THIS SECTION

- .1 Supply and installation of all conduit, wire, electric relays, connections and other devices required for control conduit wiring for systems as specified in this Section, whether line or low voltage, shall be responsibility of the Controls Trade, except as noted above.

- .2 The Controls Trade shall either use its own electricians, retain and pay for services of successful Division 26, or use an electrical sub-trade acceptable to the Contract Administrator to supply and install all conduit and wiring for systems as specified in this section.
- .3 Factory trained servicemen in employ of manufacturer, shall make final wiring connections on all components, mount and electrically connect all controls.
- .4 Electrical wiring shall be installed in conformance with CSA & ULC including latest adopted versions of the Manitoba Building Code, National Building Code of Canada, and standards set in Division 26 of this specification.
- .5 Ensure that adequate conduit is installed during initial phases of construction, to accommodate total systems requirements.
- .6 Wire all safety controls in series with both "HAND" and "AUTO" starter positions to ensure that systems are properly protected.
- .7 The Controls Contractor shall provide all other conduit and wiring required for Control systems operation, including tie-ins from relays supplied by the Controls Contractor to motor starting circuits.
- .8 As a minimum, provide separate, dedicated conduit system for each of the following. Conduit to be minimum 19mm EMT.
- .9 Sensor and control wiring for stand-alone electric control systems.
- .10 If approved by system manufacturer, cable up to 30 volts may be installed in extra low voltage communication cable tray.
- .11 Refer to Division 26 for conduit and cable identification requirements.
- .12 The Controls Contractor shall provide detailed wiring diagrams for remote supervisory panels supplied with outdoor equipment, connections between Section 15900 supplied equipment and DX cooling equipment.

1.4 SCOPE OF WORK

- .1 In general terms, the scope of work shall comprise of the provision of new DDC controls, integrated with the City of Winnipeg's existing Building Automation System and allowing for automatic functioning, manual override, etc of all new equipment and devices. Equipment requiring connection and control include, but is not limited, to the following:
 - .1 Gas-fired Furnaces and Condensing Units.
 - .2 Heat Recovery Ventilator HRV-1 c/w supply and exhaust sections (motorized air dampers by controls Contractor), energy recovery cores, electric heating coils, and air filters, alarms.
 - .3 Unit Heater control.
 - .4 Sump pit high level alarms.
 - .5 Miscellaneous exhaust fans control.
 - .6 Domestic Hot Water Re-circulation Pump Status and Alarm.
 - .7 Monitoring of miscellaneous points.
- .2 Controls shall be a central Direct Digital Control (DDC) system c/w with graphical operator station for scheduling, status and alarms. Provide all miscellaneous devices

such as relays, positioners, time-clocks, transformers, etc. as required to interface with and make a complete and operable system.

- .3 The Base Bid Contractor has a relatively new DDC System already installed with the City.
 - .1 The Base Bid Contractor will be connecting to the Existing System.
 - .2 All Alternate Contractors will be required to provide a completely new Computer, Keyboard, Monitor, Printer, Software and all associated paraphernalia, equal to the existing system, such that the City is left with one system for the entire campus. The cost of upgrading the existing buildings, devices, shall be included in the alternate Contractors' price.
- .4 Johnson (Metasys) will be the Base Bid Contractor.
 - .1 If other Contractors wish to bid this Project, they must provide pricing to the Mechanical Contractor who will list them as an Alternate.
- .5 Space Thermostats/Sensors:
 - .1 Adjustable set-point with maximum operating range from 16 deg. C. to 32 deg. C. Set-point and temperature display.
 - .2 Range shall be adjustable by the DDC system and the Facility Manager.
- .6 Other Thermostats:
 - .1 Direct or reverse acting or remote sensing to suit system. Set-point and temperature indication.
 - .2 Private offices to have set-point adjustment and temperature display.
 - .3 Heavy-duty plastic guards on thermostats in public areas such as entrance-ways, washrooms, corridors, other unsupervised areas, and as otherwise noted.
- .7 Commissioning:
 - .1 Successful equipment operation and control system shall be the responsibility of the mechanical (controls) Contractor. As part of the certification process, the equipment operation and control system shall be tested and verified, until completely successful by an independent third party commissioning agent.
- .8 Provide labour, materials, equipment and services necessary for, and incidental to the supply and installation of the controls systems shown on the drawings and described in this specification, so as to leave the City with a complete and functioning system.
 - .1 The Contract Documents are performance based, diagrammatic and approximately to scale, intended to convey the scope of work and indicate the general arrangement and approximate location of equipment and components. Not all accessories and components have been shown or specified. Include any wiring not indicated or specified but required for automatic control system.
 - .2 Control system installed to be fail-safe.
 - .3 Even though the Work is not completely shown, or is shown schematically, and all details are not shown or specified, it is expected that the Contractor be familiar enough with his field of work to complete the project to the standards generally adhered to by the local industry, including good workmanship and common sense.
 - .4 Provide both office and field engineering to develop a complete and comprehensive control system, based on the outline specifications and system schematics.

- .5 It shall be the responsibility of the Controls Contractor to provide the detailed sequence of operation and the appropriate equipment and accessories, subject to acceptance by the Contract Administrator.
- .6 Provide equipment, personnel and materials necessary to assist with air balancing.

1.5 GENERIC INPUT/OUTPUT FOR METASYS CONTROL

- .1 Controls must be able to interface to MSEA technology on the field device network using either the N2Open or BACnet Protocols.
- .2 No LON protocols are to be accepted.
- .3 Controls Contractor to provide commissioning sheets for all points on field devices as well as head end equipment.
- .4 Controls Contractor to communicate with equipment provider to ensure proper field point integration as well as controllability of the equipment, if not package controls.
- .5 If a Metasys product is not installed, the controls contractor must show seamless integration into the existing Metasys Extended Architecture Operator Interface that is acceptable to the City Staff prior to the award of Contract.
- .6 Controls Contractor to supply all drawings/graphics/sequence of operations in both a hard and soft copy. Drawings and graphics to be able to be read and modified by City of Winnipeg Staff. User interface graphics to be completed using Graphic Generation Tool software. Graphics must use City of Winnipeg graphic templates. Contractor to supply As-Built drawings in an editable format, able to be easily edited by City of Winnipeg Staff.
- .7 The use of either N2Open or BACnet to be determined based on type of building being performed. If the construction is a brand new facility, then BACnet can be used. The term BACnet should then be defined properly in its use, see note 1 below. If the Work is an addition to and the new Work is to be tied into the existing controls, then the Contractor should contact City of Winnipeg technical staff to determine the best protocol to use based on existing equipment.
- .8 If other vendor (non-JCI) controls are to be used, then seamless integration must be proven before approval is given.
- .9 Rooftop Units / Make-Up Air / Air Handling Unit / HRV:
 - .1 Where possible, the manufacturer of the equipment should be contacted to see if an N2Open or BACnet protocol equipped package controller is available from the factory.
 - .2 If no interface from the factory is available then the minimum points expected would be the following:
 - .1 Start/Stop
 - .2 Fan Status
 - .3 Economizer Status
 - .4 Cooling Mode
 - .5 Heating Mode
 - .6 Supply Air Temperature
 - .7 Room Temperature

- .8 Supply Air Low Limit Status (Freeze Stat)
- .10 Exhaust Fans:
 - .1 Exhaust fans will have start/stop/status points.
- .11 Pumps:
 - .1 Pumps will have a start/stop/status as a minimum.
- .12 Lighting Controls:
 - .1 No LON lighting controls are to be accepted. No exceptions.
- .13 Sump Pits:
 - .1 Sump pits to have high alarm status installed.
- .14 Generic Inputs from the Facility:
 - .1 Room temperatures in corner office/rooms on each floor, especially if there are windows present.
- .15 Notes:
 - .1 The term BACnet refers to an industry standard protocol that basically states that all devices using the BACnet technology will be able to communicate to each other. This is not necessarily the case. The BACnet protocol is comprised of several layers interoperability and intercommunications. The controls Contractor performing the supervisory controller installation should confirm that all devices specified are able to communicate to the proposed devices using the BACnet PIC statement and then supply documentation such that all devices supplied will communicate to each other as required for proper operation of the system.
 - .2 If Metasys Network Automation Engines (NAE/NIE/NCE) are to be installed on the project then the version of these devices and their software must be such that the City of Winnipeg does not be required to update/upgrade the existing ADX server in order for all user views, alarms, and point monitoring to occur. The contractor must co-ordinate with City staff to determine the correct version to be installed. All user views and graphics must not be installed in the local supervisory controller (NAE/NIE/NCE). All such items must be programmed into the existing ADX server. User views and graphics must be approved for use by City staff before implementation of such items.
 - .3 All monitored points that have alarms must have operating instructions and alarm messages. These will be co-ordinated with the tech shop and operations supervisor.

1.6 START-UP AND COMMISSIONING

- .1 Start-up and Commissioning shall be undertaken prior to the Occupancy Stage of each Construction Phase.
- .2 Provide equipment, personnel and materials necessary to put the Control Systems into operation.
- .3 Coordinate and cooperate with all the other Contractors to place the Mechanical Systems into operation to the satisfaction of the City.
- .4 Provide equipment, personnel, material, and information necessary to assist the Mechanical Contractor in completing the Commissioning Process.

- .5 Keep field records of what is done. Mark record prints to facilitate accurate and complete as-build information.
- .6 Finalize commissioning and manuals the following cooling season, if not verified previously due to weather.
- .7 Provide City instruction on site.

1.7 QUALITY ASSURANCE AND CONTRACTOR QUALIFICATIONS

- .1 Execute Work of this Section only by skilled tradesmen regularly employed in the manufacture and installation of controls systems.
- .2 All equipment and materials shall be new and C.S.A. approved, unless specifically noted otherwise.
- .3 All similar equipment and/or materials shall be by the same manufacturer.
- .4 All aspects of the installation must comply with the most stringent of the applicable building codes, local regulations, and by-laws.
- .5 Provide office and field personnel who are factory trained and authorized to design and install these systems.

1.8 SHOP DRAWINGS

- .1 Submit Shop Drawings prior to installation, consisting of product and sizing data for all equipment and components, including, but not limited, to:
 - .1 Dampers
 - .2 Actuators
 - .3 Valves
 - .4 Thermostats
- .2 Submit drawings showing piping/tubing layouts and wiring diagrams, with written sequences of operation, and component descriptions.

PART 2 PRODUCTS AND MATERIALS

2.1 GENERAL

- .1 All equipment and materials shall be new and C.S.A. approved, unless specifically noted otherwise.
- .2 Components shall be of the latest available model. Replacement parts shall be readily available from local dealers.
- .3 All similar equipment and or materials shall be by the same manufacturer.
- .4 Components shall be electric/electronic. No pneumatic components will be allowed.

- .5 The controls system shall be designed, and components selected, so as to be fail-safe, operating to protect the building, the occupants and vulnerable equipment from harm or damage in the event of a failure of the controls system or the power system.

2.2 NAMEPLATES, LABELS AND TAGS

- .1 Nameplates, labels and tags shall include function, setpoint and equipment names and ID numbers.
- .2 Nameplates shall be engraved plastic laminate, minimum 3" x 1" with minimum 1/4" high white letters on black background, mechanically fastened to equipment with screws or rivets.
- .3 Labels shall be self adhesive white tape with black embossed lettering, similar to Brother P-touch. 'Dymo' labels will not be acceptable.
- .4 Tags shall be engraved, all metal, attached with metal key chains.

2.3 VANDAL PROOF COVERS

- .1 Provide vandal proof covers (guards) on all wall mounted thermostats, temperature sensors, humidistats and humidity sensors in public areas.

2.4 PIPING/TUBING AND POWER AND CONTROL WIRING AND ACCESSORIES

- .1 Control wiring and conduit shall meet or exceed the requirements of C.S.A., U.L.C., the current edition of the Canadian Electrical Code, and all local Code requirements as well as the requirements as specified in Division 16.
- .2 The Controls Contractor shall provide piping/tubing and power and control wiring required by the control systems.
- .3 The Controls Contractor shall provide power transformers required by the controls systems.
- .4 The Controls Contractor shall provide all interlock piping/tubing and wiring required by the control systems, including pneumatic/electric switches, piping/tubing and wiring between control system components such as low limit protection, thermostats, alarms, motor starters and motor interlocks, etc., as required to achieve the control function specified in the schematic drawings and sequences of operation.
- .5 All control wiring, regardless of voltage, shall be installed in a continuous, dedicated system of rigid metal tubing (EMT). Maximum lengths of 7 feet of flexible metal conduit will be accepted for final connections to devices and equipment.
 - .1 Plenum-rated cable will be acceptable in the crawlspace, if it is allowed by code, installed neatly (without dips and sags), and securely fastened to the structure.

2.5 AIR SYSTEM CONTROL DAMPERS AND DAMPER OPERATORS

- .1 Control dampers shall be all metal construction as follows:
 - .1 Blades maximum 6" wide and 48" long.
 - .2 Modules to be maximum of 48" wide and 48" long.

- .3 Multiple sections to have stiffening mullions and jack shafts.
 - .4 Sealed bearings.
 - .5 Linear flow vs. position characteristics.
 - .6 Low leakage design with edge seals and blade seals.
- .2 Materials:
- .1 Frame: 2.5mm thick galvanized sheet steel.
 - .2 Blades: two (2) sheets 0.8mm thick or 1.6mm galvanized sheet steel.
 - .3 Bearings: oil impregnated sintered bronze. Provide additional thrust bearings for vertical blades.
 - .4 Linkage: zinc plated steel.
 - .5 Seals: replaceable neoprene seals or SS spring on side, top and bottom of frame and along all blade edges and blade ends.
- .3 Mixing dampers shall be of parallel blade or opposed blade design to eliminate stratification of air streams.
 - .4 Damper operators shall be spring return, fail safe models. Power return operators will not be accepted.
 - .5 Damper operators shall be sized to provide adequate power for opening, closing and modulating the dampers as required. They may be 24V or 120V at the Contractor's option.
 - .6 Outdoor dampers/operators shall be suitable for proper operation down to -50 deg. F and be weatherproof.
 - .7 Provide operators for the air handling unit mixing dampers supplied by the equipment manufacturer as part of the air handling units.
 - .8 Provide each operator with a bracket for attaching to ductwork, building structure or equipment.
 - .9 Mixing dampers: dampers mixing cold and warm air shall be parallel blade mounted at right angles to each other with blades opening to mix the air streams.
 - .10 50 l/s m² maximum allowable leakage against 1.0 kPa static pressure.
 - .11 Damper operators to be electric proportional or two (2) position type as required, with adjustable forward and return stops, aluminum housing and spring return.
 - .12 Operators mounted outside shall be complete with internal heater.
 - .13 Valve operators shall be of type to withstand temperatures likely to be encountered in application.
 - .14 Size operators to guarantee component operation under maximum load. No operator shall be required to drive more than 2.5 sq.m. (27sq.ft.) of damper.

2.6 DIRTY FILTER PRESSURE SWITCH/GAUGES

- .1 For all air filters in HRV-1 provide adjustable pressure switch/gauges to permit local readout and remote monitoring of air filter conditions.
- .2 Provide static pressure probes (SPP) and mount the gauges where they can be easily read. Provide lamacoid labels to identify the filter bank and the changeout pressure.
- .3 Differential pressure switch/gauges for local indication and remote monitoring of filter pressure drops shall be equal to:
 - .1 Dywer Series 3000 Photohelic pressure switch/gauge c/w adjustable signal flag, zeroing valves, mounting kit, aluminum connecting tubing, and static pressure probes with compression fittings.

- .4 Differential pressure range shall be suitable for 0 to 1".

2.7 THERMOSTATS

- .1 Room thermostats and/or sensors shall be located where shown on drawings. Mount thermostats and sensors approximately 1370mm (54") above finished floor.
- .2 Calibrate all thermostats and confirm to City that this Work has been done.
- .3 Provide adjustable set-point with operating range from 16 deg. C. to 32 deg. C.
- .4 Thermostats to be direct or reverse acting or remote sensing to suit system. Provide set-point indicator and thermometer to indicate area temperature.
- .5 Thermostats to have blank covers with concealed adjustment and thermometers inside cover. Private offices to have exposed thermometer and adjustment.
- .6 Provide heavy-duty plastic guards on thermostats in public areas such as entranceways, washrooms, corridors, retail areas, other unsupervised areas, and as otherwise noted.
- .7 Standard of Acceptance: For standard rooftop units; Honeywell T7300 with sub-base capable of 2 stages of heat and 2 stages of cooling with economizer. For other rooftop units thermostats shall be capable of 4 stages of heat control where required in section 3.7 – Sequence of Operation below. Other equipment; as otherwise noted or specified.

2.8 REMOTE ELEMENT THERMOSTAT

- .1 Die cast aluminum body with die cast zinc cover. Body finish of erudite and cover sprayed silver. Suitable for surface mounting. 3 mm F.P.T. air connections with an integral 0-207 kPa output gauge. Provide 2.44m averaging element for air flow sensing with 1.2m copper capillary. Element range to be - 34 to 149 deg. C. (-30 to +300 deg. F.). Instrument ambient temperature limits to be - 29 deg. C. to 65.5 deg. C. (-20 to +150 deg. F.). Dials to have dual ranges - one side -18 deg. C. to +51 deg. C. (-1 to +124 deg. F.) and 43.3 deg. C. to 106.6 deg. C. (110 to 224 deg. F.) and be spaced 1 deg. C. (2 deg. F.) apart.

2.9 REMOTE BULB CONTROLLER - ELECTRIC - TWO POSITION

- .1 Cold rolled steel cover with baked enamel finish. Precision snap-acting contacts in dust-tight and tamper-proof enclosure. Ranges shall be available to cover over -34 deg. C. to 54 deg. C. (-30 deg. F. to 130 deg. F.). Companion wells and duct flanges available for mounting sensing bulb. Remote capillary system of 1.8 m, 2.4 m or 3 m depending on range selected and shall be liquid filled. Manual or automatic reset on limit applications shall also be available.

2.10 AIR FLOW SWITCHES

- .1 Where required for airflow indication, provide duct pressure sensors operating on the velocity pressure principal, sensing actual air velocity using an appropriate pitot tube tip as a velocity pressure probe (VPP).
 - .1 Differential pressure sensors piped across fans will not be accepted.
 - .2 Current sensing switches are an acceptable substitute.

2.11 MANUAL TIMERS

- .1 Where required for manual override, provide wall mounted spring return timer for 0-8 (unless otherwise specified) hours in 15 minute increments.

2.12 REMOTE TRANSMITTERS

- .1 Pneumatic feed back type and available with either immersion bulbs or 2400 mm (8 ft.) sensing elements. Available ranges as required by the installation.

2.13 RECEIVER CONTROLLERS

- .1 Provided to match scales of remote transmitters with adjustable set point and throttling ranges, indicating output gauge; reversible.

2.14 TEMPERATURE INDICATION

- .1 Provide 75 mm (3") diameter direct reading dial type field calibratable temperature gauges in required ranges suitable for surface mounting on ductwork, or flush mounting on instrument cabinet face, with capillary tube lengths to suit. Accuracy: plus or minus 1% at centre of scale.

2.15 FREEZE PROTECTION

- .1 Provide electric type freeze protection cutouts, with labeled reset buttons mounted on the front of local control panels.
- .2 All air systems introducing outside air shall have low temperature protection. Provide if not part of unit. Electric low limit thermostat in air stream with low point sensitivity element to serpentine entire coil face.
- .3 Thermostat for each coil bank wired in series to activate alarm and shut down fans.
- .4 Two (2)-position manual reset type.

2.16 CARBON MONOXIDE (CO) DETECTION SYSTEM

- .1 The Metasys system shall be responsible for CO detection as required by the Manitoba Building Code.
- .2 Refer to Electrical specifications for CO system requirements.

2.17 PANELS - GENERAL

- .1 Provide all pre-wired control panels, except for those furnished as part of equipment under other sections.
- .2 Fabricate fully enclosed, lockable cabinets using minimum 14 gauge all steel construction with enamel finish:
 - .1 Use hinged locking door.
 - .2 Common key all locks.

- .3 Provide either wall mount or freestanding panels as required by the actual installation.
- .4 Where heat-generating equipment is to be mounted inside of an enclosure, provide vented cabinets.
- .5 Mount all routinely operated, manually adjusted, and indicating devices on the panel door. Enclose all other devices.
- .6 Mount plasticized control schematics inside the panels.

2.18 MISCELLANEOUS DEVICES

- .1 Provide all necessary relays, positioners, clocks, transformers, etc. as required to interface with and make a complete and operable system.

2.19 OPERATING INSTRUCTIONS SERVICE AND GUARANTEE

- .1 Provide operating instructions for the temperature control system in accordance with the General Conditions of the Contract and include a description of the sequence of operation and "as-built" drawings of the system schematics.
- .2 Upon completion of the installation, all control equipment supplied under this Contract shall be adjusted to place the system in complete operating condition subject to Contract Administrator's approval. All adjustments shall be made in coordination with the field Contract Administrator responsible for balancing the air systems. The control system shall be guaranteed against defects in workmanship and material for a period of one (1) year under normal use and service from the date of beneficial occupancy.

PART 3 INSTALLATION AND EXECUTION

3.1 COMPONENTS - GENERAL

- .1 Mount all controllers and relays within control panel cubicles.
- .2 Mount exposed components for easy access and protect from damage.
- .3 Locate all local control panels as shown on the drawings or as directed by the City or Contract Administrator.
- .4 Damper operators: do not install in ducts or fresh air intakes.
- .5 Sensor elements for remote thermometers: where installed to sense a common temperature condition with a controller, strap both elements together.
- .6 Provide brass wells of sizes to suit sensor bulbs, c/w unions and dielectric elements as required.
- .7 Mount gauges and thermometers for easy readability.
- .8 Install the air compressor and after drier convenient to a floor drain and pipe condensate and blow-down lines thereto. Run drain lines on walls. Do not run drain piping across floors in areas required for access.

3.2 NAMEPLATES, LABELS AND TAGS

- .1 Provide nameplates for all panels and major components.
- .2 Provide labels inside of panels and cabinets, and at all remote locations, for adjustment and readout points.
- .3 Provide tags at all valves and equipment not suited for attaching nameplates.
- .4 Identify all equipment mounted on the front of control panels with 50 mm x 75 mm (2" x 3") lamacoid nameplates.
- .5 Identify instruments inside of control panels with labels.

3.3 PIPING/TUBING AND POWER AND CONTROL WIRING AND ACCESSORIES

- .1 Control wiring shall be connected from specific breakers in power panels. Refer to Electrical Drawings.
- .2 Run piping and conduit neatly clipped to walls or structural members, parallel to and at right angle to, building lines.

3.4 PROJECT COMPLETION

- .1 Prior to the Occupancy Stage of each Construction Phase:
 - .1 Start-up and Commission the Controls Equipment and Systems.
 - .2 Assist the Mechanical Contractor in the Start-up and Commissioning of the Mechanical systems. Refer to Specification Section 15995.
 - .3 Calibrate all thermostats, valves, damper motors, relays, etc, provided under this Contract.
 - .4 Verify and optimize the system.
 - .5 Provide three complete instruction manuals, complete with "as constructed" schematics, for insertion into the Operation and Maintenance Manuals.
 - .6 Provide instructions to City as required. Refer to Specification Section 15010.

3.5 CALIBRATION AND ADJUSTMENT OF CONTROLS SYSTEMS

- .1 All components shall be calibrated before the areas are occupied in order to minimize the disruption to the occupants following the takeover the building.
- .2 Upon completion of the installation phase of the project, calibrate and adjust all controls systems and components installed under this Contract to provide acceptable space conditions and proper functioning of the systems. Keep a written log of the calibration data for each device, including the instrumentation against which the equipment is calibrated. Include this log in the Operation and Maintenance manuals.
- .3 If requested, the Contractor shall be prepared to provide written documentation of recent calibration checks for all instrumentation and sensors.

3.6 VERIFICATION AND OPTIMIZATION OF THE OPERATION OF THE MECHANICAL SYSTEMS

- .1 The installation shall be completely tested, demonstrating that the equipment and systems installed are performing in the manner intended.
- .2 Provide equipment, personnel and materials necessary to produce written records for verification of the operation of all control systems and all equipment.
- .3 Provide equipment, personnel and materials necessary to adjust the controls systems as part of the overall optimization of the mechanical systems.
- .4 Adjust control set points and tune control algorithm performance to optimize the operation of the systems.

3.7 SEQUENCE OF OPERATION

.1 CENTRAL VENTILATION SYSTEM HRV-1

- .1 HRV-1 shall consist of a Supply fan, an Exhaust Fan, Heat Exchange Cores, Electric Pre-heat Coil RHC-1, with external outside air dampers and exhaust air dampers.
- .2 The Controls Contractor shall provide a Remote Control Panel for field installation and wiring by Controls Contractor. Remote Panel will come with:
 - .1 System ON/OFF switch and Status Light.
 - .2 Heat/Cool Switch, Heating and Cooling Status Lights.
 - .3 Discharge temperature Set-point adjustment and Indication.
 - .4 Air Filter Monitoring. Provide dirty filter alarm and light for each bank of filters.
 - .5 System Trouble Shut-down Alarm and Light.
 - .6 Monitor and Indicate: Status, O/A temp, S/A and E/A temperatures.
- .3 The System will be provided with a Remote Thermostat, shipped loose for Field Installation and wiring by Controls Contractor for Cooling Control.
- .4 The System will be provided with a with Remote Discharge Air temperature Sensor, shipped loose for Field Installation and wiring by Controls Contractor for Heating Control.
- .5 Provide start/stop function of HRV-1 based on a time-clock function.
- .6 Provide duct and Air Handler temperature sensors. Note that not all sensors are used as controllers, some are for monitoring only.
- .7 Provide all transformers, relays and power and control wiring as required.
- .8 Sequence of Operation:
 - .1 Occupied Cycle:
 - .1 When the system is energized, the Outside Air and Exhaust Air dampers shall open fully.
 - .2 With the dampers open fully, the Supply and Exhaust fans shall be allowed to operate.
 - .3 The Supply and Exhaust fans shall be reverse interlocked.
 - .4 Several seconds are allowed by a time delay relay to prove air flow through a pressure differential switch. If air flow is not proven, the system shall be de-energized.
 - .5 If Supply air flow is proved, a relay shall energize the Exhaust fan and a time delay relay shall allow several seconds for exhaust air flow to be proved through a pressure

- differential switch. If exhaust flow is not proved, the Exhaust fan and Supply fan are de-energized.
- .6 With both air flows proven, the operation of both fans shall continue.
 - .7 If at any time during the operation of the system, exhaust air flow or supply air flow ceases, then the exhaust fan and supply fan shall be de-energized.
 - .8 HRV-1 shall supply ventilation air to the building at approximately 18 deg. C (64 deg. F) (operator adjustable setpoint).
 - .9 A sensor in the outside air stream shall monitor the outside air temperature and shall energize the SCR controlled electric pre-heat coil to ensure that air entering the air-to-air heat exchangers is no less than -25 F (-31C). If the pre-heat coil cannot maintain a temperature of -25F (-31C) then the system shall shut down and indication provided at the control panel.
 - .10 The air-to-air heat exchangers shall then provide the next stage of heat.
 - .11 If further heat is required, electric heating coil RHC-1 shall be energized. An SCR controller shall control the output of the coil only as much as necessary to maintain the supply air temperature.
 - .12 The heating shall be disabled when no airflow is proven.
- .2 Unoccupied Cycle:
 - .1 HRV-1 shall be off.
 - .2 Intake and Exhaust dampers shall close.
 - .3 Crawlspace Ventilation
 - .1 The HRV also provides ventilation to the crawlspace while operating.
 - .2 Provide a humidity sensor in the crawlspace that will override the unoccupied cycle and operate the HRV to maintain the humidity setpoint.
- .9 Provide building freeze protection by shutting the system down and initiating an alarm at the DDC if supply air temperature falls below 45 F (8C) adjustable.
- .2 DOMESTIC HOT WATER SYSTEM INCLUDING PUMP RP-1, AND WATER HEATER DWH-1.
 - .1 The Pump shall operate on an Occupied/Unoccupied schedule as programmed through the DDC system.
 - .2 The Water Heaters have integral operating and safety controls.
 - .3 FURNACE UNIT CONTROL.
 - .1 All Furnaces shall operate on an Occupied/Unoccupied schedule as programmed through the DDC system.
 - .2 Power and control wiring by Division 26.
 - .3 Sequence of operation:
 - .1 Occupied Cycle:
 - .1 Furnace blowers shall operate continuously for space ventilation.

- .2 Furnaces FU-1 and FU-2 serving MPR-1 shall operate together as one unit. Furnace FU-3 shall operate independently to serve MPR-2 and adjoining spaces.
- .3 If at any time during the operation of the system supply air flow ceases, then an alarm shall be indicated through the DDC system.
- .4 On a call for heating or cooling from the respective space sensor, the Furnace heating or cooling shall energize.
- .2 Heating and Cooling:
 - .1 The switch-over from Heating to Cooling and vice versa shall be automatic or manually overridden.
 - .2 When the system is in Heating the Cooling shall be locked out. When in Cooling mode, the Heating shall be locked out.
- .3 Unoccupied Cycle:
 - .1 Furnaces shall cycle on/off as required to maintain night set-back temperatures.
- .4 Provide building freeze protection by shutting the system down and initiating an alarm at the DDC if supply air temperature falls below 45 F (8C) adjustable.
- .4 ELECTRIC BASEBOARD HEATERS:
 - .1 Supply 115 V wall mounted heating only thermostats (with lockbox in common areas).
 - .2 Provide transformers, relays and power and control wiring as required.
- .5 ELECTRIC ENTRANCE HEATERS:
 - .1 Supply 115 V wall mounted heating only thermostats (with guards).
 - .2 On a call for heat from the thermostat, the entrance heater supply fan shall be energized.
- .6 ELECTRIC UNIT HEATERS:
 - .1 Supply 115 V integral unit mounted heating only thermostats.
 - .2 On a call for heat from the thermostat, the corresponding electric unit heater fan shall energize.
 - .3 Provide a heavy-duty metal guard for thermostat.
 - .4 Provide an adjustable ambient lock out which will prevent the unit heater from cycling with the outdoor temperature above 55F. (13C.).
- .7 DUPLEX WEEPING TILE SUMP PUMPS SP-1/SP-2.
 - .1 Duplex pumps shall come with a control panel and an alarm panel shipped loose, for installation and wiring by the Electrical Contractor.
 - .2 Duplex pumps shall come with float switches shipped loose, for installation by the Plumbing Contractor and wiring by the Electrical Contractor.
 - .3 Provide control wiring between floats and control panel.
 - .4 Provide control wiring between control panel and alarm panel.
- .8 MISCELLANEOUS EXHAUST FAN CONTROL:
 - .1 As per Exhaust fan Schedule.

.9 MISCELLANEOUS ALARMS

- .1 Monitor domestic hot water re-circulation pump status.
- .2 Monitor weeping tile sump high level alarm.
- .3 Intrusion Alarm.
- .4 Main fire alarm panel:
 - .1 Trouble signal.
 - .2 Main panel alarm.

END OF SECTION 25 05 05