SECTION 23 09 23
DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

P A R T 1 - G E N E R A L

SCOPE

The existing building utilizes a Niagara direct digital control (DDC) system with Distech field devices. This scope of this project will include the following:

- First Floor
  - Add (15) new air terminal units and (11) sections of steam convector with DDC control that will be integrated into the existing building Niagara DDC system.
  - Add (2) new transfer air fan with DDC control that will be integrated into the existing building Niagara DDC system.
  - Add (1) new ductless split heat pump system with DDC control that will be integrated into the existing building Niagara DDC system.
- Fifth Floor
  - No work.

Additionally, this project shall provide:

- New Distech ECB-VAV controllers required to integrate all new VAV air terminals and associated steam convectors into the existing building automation system.
  - VAV controllers to be mounted within air terminal unit control enclosure.
- New Distech controllers required to integrate all other devices into the existing building automation system.
- Any required module expansion devices for integration of new outside air dampers with integral AFMS into existing DDC control systems.
- New hot water reheat DDC temperature control valves for new VAV air terminals.
- New steam DDC temperature control valves for existing steam convectors.
- New Distech space temperature sensors associated with each VAV air terminal.
- New Distech space temperature sensors associated with new transfer fans.
- New Distech space temperature sensors associated with each new ductless heat pump system.
- New CO2 sensors associated with select VAV air terminals / zones.
- All control wiring (low and line voltage) for a complete operating system.
- Update of the existing 1st floor City County Building automation graphics to include new air terminals, sensors, convectors, outside air dampers, AFMS, etc. associated with this project.
- Additional Information - 1st Floor
  - New controllers shall be integrated directly into the N4 supervisor via MSTP to IP BACnet router.
  - Provide all required MSTP to IP BACnet routers.
  - Provide cabling from new router to County Network IT closed in the Register of Deeds Area.
- New Niagara N4 supervisor(s) as required to integrate new DDC controls on 1st floor into the existing Niagara DDC system.

All new air terminals and air terminal controls shall be integrated into the Niagara DDC system.

All new controllers, control wiring and temperature control valves shall follow new City County Building Basis of Design protocols to provide building continuity in regards to controllers, wiring and equipment.

Work in this section includes Direct Digital Control (DDC) panels, main communication trunk, software programming, and other equipment and accessories necessary to constitute a complete Direct Digital Control (DDC) system.

VAV Controllers (Application Specific Controllers)
Control Valves
Thermostats
Carbon Dioxide Sensors and Transmitters

PART 3 - EXECUTION
General
Installation
Control Dampers with Integral Airflow Monitoring
Commissioning, Verification and Closeout
Sequence of Operation
Owner Training
Points List

RELATED WORK
Applicable provisions of Division 1 govern work under this Section.

REFERENCE
Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS
FCC Part 15, Subpart J, Class A - Digital Electronic Equipment to Radio Communication Interference

COMMISSIONING
The systems will be commissioned by an independent third party in accordance with USGBC LEED Energy and Atmosphere Credit C3 – Enhanced Commissioning. Refer to Sections 01 91 02 – Commissioning Process, for additional requirements.

LEED CERTIFICATION
The project will be LEED Certified thru the United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) program. Refer to Section 01 81 13 – Sustainable Design Requirements for additional requirements.

QUALITY ASSURANCE

Add 01

APPROVED MANUFACTURER:
Distech / Niagara

APPROVED INSTALLERS:

Masters Building Solutions
930 Stewert St.
Madison, WI 53713

JF Ahern Co
855 Morris St
Fond du Lac, WI 54935

CBRE|ESI
3410 Gateway Rd
Brookfield, WI 53045

The installer shall be specialized and experienced in Niagara/Distech DDC control systems and installation for not less than 5 years. All engineering work shall be done by qualified employees of Niagara, or qualified employees of an Niagara/Distech Authorized Representative that provides engineering and commissioning of Alerton control equipment. Where installing contractor is an authorized representative of Niagara/Distech, submit written confirmation of such authorization. Indicate in letter of authorization that the installing contractor has successfully completed all necessary training required for the engineering, installation, and commissioning of equipment and systems to be provided for the project and that such authorization has been in effect for a period of not less than three years. The letter of authorization should also indicate that the installing contractor is authorized to install Niagara/Distech DDC equipment at the project location at the time the project is bid. Installation of the equipment

shall be done by qualified mechanics and/or electricians in the direct employ or be directly subcontracted and under the supervision of Niagra/Distech or Authorized Niagra/Distech Representative. The contractor providing and installing the equipment under this specification section shall be the same contractor providing and installing equipment under the 23 09 14 specification section.

RESPONSE TIME:
During warrantee period, three (3) hours or less, 24-hours/day, 7 days/week.

Add 01

ELECTRICAL STANDARDS:
Provide electrical products, which have been tested, listed and labeled by Underwriters' Laboratories (UL) and comply with NEMA standards.

DDC Standards: DDC manufacturer shall provide written proof with shop drawings that the equipment being provided is in compliance with F.C.C. rules governing the control of interference caused by Digital Electronic Equipment to Radio Communications (Part 15, Subpart J, Class A).

SUBMITTALS
Provide submittals on all DDC control work.

Details of construction, layout, and location of each temperature control panel within the building, including instruments location in panel and labeling. Indicate which piece of mechanical equipment is associated with each controller and what area within the building is being served by that equipment. For terminal unit control, provide a room schedule that would list mechanical equipment tag, room number of space served, address of DDC controller, and any other pertinent information required for service.

A complete description of each control sequence for equipment that is not controlled by direct digital controls. Direct digital controlled equipment control sequences will be provided by the DDC control contractor.

PRODUCT DATA
Submit manufacturer's specifications for each control device furnished, including installation instructions and start-up instructions. General catalog sheets showing a series of the same device is not acceptable unless the specific model is clearly marked. Annotated software program documentation shall be submitted for system sequences, along with descriptive narratives of the sequence of operation of the entire system involved. Submit wiring diagram for each electrical control device along with other details required to demonstrate that the system has been coordinated and will function as a system.

MAINTENANCE DATA
Submit maintenance data and spare parts lists for each control device. Include this data in maintenance manual.

RECORD DRAWINGS
Provide as-built record control drawings, including sequences, for the installation of all DDC controls.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under Section 23 05 00 and Division 1, General Requirements, Closeout Procedures.

MATERIAL DELIVERY AND STORAGE
Provide factory shipping cartons for each piece of equipment and control device. This contractor is responsible for storage of equipment and materials inside and protected from the weather.

P A R T 2 - P R O D U C T S

GENERAL
Provide DDC control and actuation to accomplish Sequence of Operation (indicated below) and DDC Points list. Provide all controllers, temperature control panels, wiring, etc. for a complete installation.

Controls installed as part of this project shall be fully compatible with existing DDC controls located within the facility.

Provide updated DDC/BAS graphics reflecting new work and sequences of control.

Provide all required installation, termination, wiring, power, graphics and programming for a complete operating system.

VAV CONTROLLERS (APPLICATION SPECIFIC CONTROLLERS)

VAV controllers (ECB-VAV) shall be by Distech. No others will be allowed.

Provide minimum of 12-point VAV controller.

Each supervisory controller shall be able to extend its monitoring and control through the use of stand-alone application specific controllers (ASC's).

Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor based, multi-tasking, real-time digital control processor.

Each ASC shall have sufficient memory to support its own operating system and databases including: Control Processes, Energy Management Applications and Operator I/O (Portable Service Terminal).

The operator interface to any ASC point or program shall be through the supervisory controller connection to any ASC on the network.

ASC's shall directly support the temporary use of a portable service terminal that can be connected to the ASC via zone temperature or directly at the controller. The capabilities of the portable service terminal shall include, but not be limited to, the following information for the:

- Display temperatures
- Display status
- Display setpoints
- Display control parameters
- Override binary output control
- Override analog output control
- Override analog setpoints
- Modification of gain and offset constants

All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the ASC.

ASC's shall support, but not be limited to, the following configurations of systems to address current requirements as described in Sections 23 09 14 and 23 09 93 portions of this specification, and for future expansion of air handling units:

- Variable Air Volume Terminals
- Reheat Terminals

For butterfly type Variable Air Volume (VAV) Terminals, provide differential pressure transducers and damper actuators for flow measurement and actuation of the VAV terminal damper. Pressure transducers for VAV box flow applications do not need to have adjustable pressure ranges or integral display. Provide filter on high side of flow pickups if flow measurement device requires airflow through the device. All differential pressure transducer inputs for airflow measurement shall have a method to compensate for sensor drift to calibrate the zero point of the input. The differential pressure transducers and damper actuators can be integrated into the terminal unit controller or be discrete devices.

Provide a method to view and print a summary of current K-factors for flow correction for each VAV terminal through the DDC system. The summary shall have a minimum of 50 K-factors per group of VAV terminals.

All system setpoints, proportional bands, control algorithms, calibration constants, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the ASC.

All application specific controllers shall be fully programmable. Question and answer or template programming is not acceptable unless this is used to generate the initial application program and the result is able to be freely modified without restriction. Control sequences for terminal unit control that utilize devices wired directly to the terminal unit application controller shall be programmed in the application specific controller and shall be stand-alone in function, i.e. occupancy sensing, temperature setpoint setback, etc. Supervisory controllers shall not be involved in the control sequence logic unless it involves sharing data between or from individual terminal unit controllers to be utilized in a global sequence, i.e. trim and respond strategies, terminal unit grouping, etc.

SUPERVISORY CONTROLLERS

The existing JACE8 controller located on the 5th floor of the City County Building shall be used as the supervisory controller for this project.

SOFTWARE LICENSE AGREEMENT

For Niagara based systems, it is the express goal of this specification to implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. The user Agency shall be the named license holder of all software associated with any and all incremental work on the project(s). All Niagara software licenses shall have the "accept.station.in=*"; "accept.station.out=*" and "accept.wb.in=*" and "accept.wb.out=*" section of the software licenses. The intent is to ensure that the installed Niagara products may be completely open for integrations. The user Agency shall be free to direct the modification of the any software license, regardless of supplier. In addition, the user Agency shall receive ownership of all job specific software configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and /or configured for use within Niagara Framework (Niagara) based controllers and/or servers and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required Ids and passwords for access to any component or software program shall be provided to the user Agency. Provide all software necessary for developing software algorithms in all supervisory, programmable, and application specific direct digital controllers which is licensed to the owner.

Programming tools for programmable and application specific controllers that utilize the Niagara Framework shall not be restricted to any specific brand of Jace. Tools and controllers shall be able to connect to any brand of Jace that are provided under this specification Section.

OPERATOR INTERFACE REQUIREMENTS

The existing web-based browser interface and graphic-based display shall be used, expanded and modified to reflect the floor plan and direct digital control modifications and expansions as required as part of this project.

CONTROL VALVES

Manufacturer: Belimo (Valve and Actuator) only.

Provide all control valves as shown on the plans/details and as required to perform functions specified. Spring ranges must be selected to prevent overlap of operation and simultaneous heating and cooling.

Size operators to allow smooth and positive operation of devices served and to provide sufficient torque capacity for tight shutoff against system temperatures and pressure encountered. Use fully proportional actuators with 0-10VDC inputs and zero and span adjustments unless specified otherwise. If TriState with feedback is specified, valve position shall be fed back to the controller and controller shall position valve based on this feedback. Electric actuators, for applications other than terminal units, shall be provided with a manual override capability. All electric actuators shall be provided with a visible position indicator.

All power required for electric actuation shall be provided by this contractor if it is not able to be directly provided from the DDC controller.

Provide operators that are full proportioning or two-position, as required for specified sequence of operation.

Provide operators with linkages and brackets for mounting on device served.

All valves unless specifically noted on the plans or indicated below shall be ball style valves.

VALVE SERVING	TYPE	SIGNAL	SPRING RETURN	FAIL POSITION
Reheat Coil	Ball	0-10 VDC	No	Last Position
Perimeter Radiation	Valve - Belimo – B215HT186 (1/2", Cv=1.86) Actuator – Belimo – TR24-SR US			

Use equal percentage valves for two-way control valves; size for a pressure drop not less than 4 psi or more than 6 psi. Note: For low flows, the required minimum Cv size will result in lower pressure drop than 4 psi.

Globe valves 2" and smaller: Cast bronze or forged brass body, brass plug and brass or stainless steel seat, stainless steel stem, screwed ends, suitable for use on water systems at 150 psig and 240° F. Seat leakage with actuator supplied will meet ANSI class IV leakage (0.01%). For globe valves that are specified to fail in place, valves shall be open when the stem is up. Only the following globe valve body styles will be acceptable for terminal unit control. Valves and actuators shall be by Belimo.

THERMOSTATS
Thermostats shall be by Distech.

Thermostats shall match existing thermostat functionality located in adjacent areas of the City County Building.

Terminal unit space sensors shall be provided with digital displays with setpoint adjustments and manual occupancy override and indication of occupancy status. Provide information to the AE on sensor colors offered by the manufacturer and obtain approval on what color should be provided on the project. Provide setpoint adjustment as specified in the DDC Input/Output Summary Table and sequence of operation

CARBON DIOXIDE SENSORS AND TRANSMITTERS
Subject to compliance with requirements, provide products by one of the following: Building Automation Products Inc.; BAPI; Telaire; a brand of Amphenol Thermometrics Inc; Vaisala, Veris Industries or Approved Equal.

Description:
NDIR technology or equivalent technology providing long-term stability and reliability. Two-wire, 4-20 mA output signal, linearized to carbon-dioxide concentration in PPM.

Construction:
House electronics in an ABS plastic enclosure. Provide equivalent of NEMA 250, Type 1 enclosure for wall-mounted space applications and NEMA 250, Type 4 for duct-mounted applications.

Equip with digital display for continuous indication of carbon-dioxide concentration.

Performance:
Measurement Range: Zero to 2000 ppm.
Accuracy within 2 percent of reading, plus or minus 30 ppm.
Repeatability within 1 percent of full scale.
Temperature Dependence within 0.05 percent of full scale over an operating range of 25 to 110 deg F.
Long-Term Stability within 5 percent of full scale after more than five years.
Response Time within 60 seconds.
Warm-up Time within five minutes.
Provide calibration kit. Turn over to Owner at start of warranty period.

P A R T 3 - E X E C U T I O N

GENERAL
All electronic work required as an integral part of the Direct Digital Control system work is the responsibility of this contractor.

This contractor shall provide all labor, materials, engineering, software, permits, tools, checkout and certificates required to install a complete Direct Digital Control system as herein specified.
This Direct Digital Control system as herein specified shall be fully integrated and completely installed by this section. It shall include all required computer CPU software and hardware. Include the engineering, installation, supervision, calibration, software programming, and checkout necessary for a fully operational system.

INSTALLATION
All work and materials are to conform in every detail to the rules and requirements of the National Electrical Code and present manufacturing standards. All material shall be UL approved.

Install system and materials in accordance with manufacturer's instructions, rough-in drawings and details on drawings.

Any line voltage wiring to be by this contractor.

Label all control devices with the exception of dampers, valves, and terminal unit devices with permanent printed labels that correspond to control drawings. Temperature control junction and pullboxes shall be identified utilizing spray painted green covers. Other electrical system identification shall follow the 26 05 53 specification.

All control devices and electrical boxes mounted on insulated ductwork shall be mounted over the insulation. Provide mounting stand-offs where necessary for adequate support. Cutting and removal of insulation to mount devices directly on ductwork is not acceptable. This contractor shall coordinate with the insulation contractor to provide for continuous insulation of ductwork.

Provide all electrical relays and wiring, line and low voltage, for control systems, devices and components. Install all high voltage and low voltage wiring (includes low voltage cable) in rigid metal conduit. All conduit must be installed in accordance with electrical sections (Division 26) of this specification and the National Electrical code.

Conduit shall be a minimum of 1/2 " for low voltage control provided the pipe fill does not exceed 40%.

Minimum low voltage wiring gauge to be 18 AWG for outputs and 20 AWG for inputs. All low voltage wiring to be stranded.

Low voltage wiring can be run without conduit above accessible lay-in tile ceilings. All wiring in mechanical rooms, above inaccessible hard ceilings, exterior locations, and in any exposed areas, and in all other locations should be in conduit. Wire for wall sensors must be run in conduit. Wiring for radiation valves shall be run in conduit where routed through walls.

Where wiring is installed free-air, installation shall consider the following:

- Wiring shall utilize the cable tray wherever possible.
- Wiring shall run at right angles and be kept clear of other trades work.
- Wiring shall be supported utilizing "J" or "Bridal-type" steel mounting rings anchored to ceiling concrete, piping supports, walls above ceiling or structural steel beams. Mounting rings shall be of open design (not a closed loop) to allow additional wire to be strung without being threaded through the ring. For mounting rings that do not completely surround the wire, attach the wire to the mounting ring with a strap.
- Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If wiring "sag" at mid-span exceeds 6-inches; another support shall be used.
- Wiring shall never be laid directly on the ceiling grid or attached in any manner to the ceiling grid wires.
- Wall penetrations shall be sleeved.

Wiring shall not be attached to existing cabling, existing tubing, plumbing or steam piping, ductwork, ceiling supports or electrical or communications conduit.

Mount control panels adjacent to associated equipment on vibration-free walls or free-standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.

Provide as-built control drawings of all systems served by each local panel in a location adjacent to or inside of panel cover. Provide a protective cover or envelope for drawings.

Provide all necessary routers and or repeaters to accomplish connection to the BAN via the panel-mounted port provided.

All tubing, cable and individual wiring is to be permanently tagged, with numbers corresponding with "Record Drawings", spares are to be labelled as "Spare".

Provide technician to work with air balancing contractor and/or provide balancing contractor with necessary hardware to over-ride DDC controllers for air balancing.

Provide documentation to demonstrate that all points, input and output, have been checked out and verified operational, note any points not operating properly with notation of reason.

COMMISSIONING, VERIFICATION AND CLOSEOUT

The controls contractor shall participate in all aspects of building commissioning as required in Sections 01 91 00 – Commissioning and 01 95 01 – Monitoring-Based Commissioning.

SEQUENCE OF OPERATION

VARIABLE AIR VOLUME TERMINALS WITH HOT WATER REHEAT

Systems consist of:

- Variable air volume terminal
- DDC VAV unit controller.
- Discharge air temperature sensor.
- Hot water reheat coil with modulating 2-way or 3-way temperature control valve.
- DDC space sensor.
- DDC CO2 space monitor (select locations)

- Lighting occupancy sensor and relay (provided and installed by Division 26).

Provide all line and low voltage wiring for a complete operating system.

Mount discharge air temperature sensor a minimum of 3 duct diameters downstream of reheat coil.

Provide all control wiring between occupancy sensor and VAV controller.

Provide a DDC space temperature sensor to control, in sequence, a modulating electronic control valve for the hot water reheat coil and actuator for terminal air flow. When space temperature is below setpoint, the air terminal damper shall modulate toward the cooling minimum flow position. After the air terminal damper is at its minimum flow, the hot water valve shall modulate open to maintain space temperature. If the air terminal has a heating airflow, the hot water control valve and air terminal shall open in parallel.

The reverse shall occur when space temperature is below setpoint. The heating coil valve shall be commanded closed whenever the associated AHU is off. Provide a discharge air temperature sensor for monitoring purposes.

Each space temperature sensor shall have a manual override button that shall index the space to the occupied mode for a period of two hours (adj.). If an occupancy sensor is specified, it shall index the terminal unit DDC controller to occupied mode for a minimum of 30 minutes (adj.).

Provide separate adjustable cooling and heating setpoints for both the occupied and unoccupied modes. When the space temperature is between the heating and cooling setpoints, the heating valve shall be closed and the airflow at heating and cooling minimum flow.

Occupancy sensors will be provided by the Division 26 contractor. Provide wiring from all occupancy sensor contacts to building automation system for space occupied/unoccupied control. When the occupancy sensor signals the zone is unoccupied, the minimum flow setpoint shall be zero CFM (adj.) and the heating and cooling temperature setpoints will be maintained at either the occupied or unoccupied heating and cooling setpoints as defined by the weekly schedule (grouped or individually). When the occupancy sensor signals the zone is occupied, the occupied minimum flow setpoint shall be as scheduled and the occupied heating and cooling temperature setpoints shall be maintained regardless of the weekly schedule. All programming for the above sequence shall reside in the terminal unit controller and a supervisory controller shall not be required to reset any flow or temperature setpoints based on the occupancy sensor.

Where there are multiple occupancy sensors associated with a VAV zone that serves multiple spaces, all occupancy sensors must be “unoccupied” for the air terminal to move to zero airflow setpoint.

<u>VARIABLE AIR VOLUME TERMINALS WITH HOT WATER REHEAT AND PERIMETER STEAM RADIATION</u>

Systems consist of:

- Variable air volume terminal
- DDC VAV unit controller.
- Discharge air temperature sensor.
- Hot water reheat coil with 2-way temperature control valve.
- Existing steam convector(s) with new DDC modulating steam control valve and actuator
- DDC discharge air sensor.
- DDC space sensor.
- DDC CO2 space monitor (select locations)

Provide all line and low voltage wiring for a complete operating system.

Mount discharge air temperature sensor a minimum of 3 duct diameters downstream of reheat coil.

Provide all control wiring between occupancy sensor and VAV controller.

Provide a DDC space temperature sensor to control, in sequence, a modulating electronic control valve for the hot water reheat coil and actuator for terminal air flow. When space temperature is below setpoint, the air terminal damper shall modulate toward the cooling minimum flow position. After the air terminal damper is at its minimum flow, the hot water reheat valve and perimeter steam radiation valve(s) shall modulate open in parallel to maintain space temperature.

Where multiple steam radiation convectors (each with a temperature control valve) are located within the same VAV zone, the convectors shall each have a control valve and be controlled in unison.

The reverse shall occur when space temperature is below setpoint.

The heating coil valves shall be commanded closed whenever the associated AHU is off. Provide a discharge air temperature sensor for monitoring purposes.

Each space temperature sensor shall have a manual override button that shall index the space to the occupied mode for a period of two hours (adj.). If an occupancy sensor is specified, it shall index the terminal unit DDC controller to occupied mode for a minimum of 30 minutes (adj.).

Provide separate adjustable cooling and heating setpoints for both the occupied and unoccupied modes. When the space temperature is between the heating and cooling setpoints, the heating valve shall be closed and the airflow at heating and cooling minimum flow.

When the building is in the unoccupied mode and there is a call for heat in any perimeter zone, the perimeter steam radiation shall be used from setback heating. The VAV terminal heating coil control valve shall remain closed and air handler remain off.

Occupancy sensors will be provided by the Division 26 contractor. Provide wiring from all occupancy sensor contacts to building automation system for space occupied/unoccupied control. When the occupancy sensor signals the zone is unoccupied, the minimum flow setpoint shall be zero CFM (adj.) and the heating and cooling temperature setpoints will be maintained at either the occupied or unoccupied heating and cooling setpoints as defined by the weekly schedule (grouped or individually). When the occupancy sensor signals the zone is occupied, the occupied minimum flow setpoint shall be as scheduled and the occupied heating and cooling temperature setpoints shall be maintained regardless of the weekly schedule. All programming for the above sequence shall reside in the terminal unit controller and a supervisory controller shall not be required to reset any flow or temperature setpoints based on the occupancy sensor.

On a CO2 level of 750 PPM (adjustable) or above with the space occupied, the terminal shall enter CO2 mode. The terminal damper shall modulate open and the reheat coil shall remain in control to maintain space temperature setpoint. The terminal damper shall be allowed to modulate to its maximum position in a timed fashion. Upon a drop in space CO2 level below 750 FPM, the terminal shall leave CO2 mode and return to normal operation. If the space CO2 level does not fall below 750 PPM (adjustable), with the terminal damper in its maximum position, the associated air handler outside air damper shall modulate open. See air handler sequence for additional information.

TRANSFER AIR FAN (TF-2)

Systems consist of:

- Ceiling mounted transfer air fan with ECM motor.
- DDC space sensor.

On a rise in space temperature above setpoint, the fan shall cycle on. On a drop in space temperature below setpoint, the fan shall cycle off.

TRANSFER AIR FANS (TF-3)

Systems consist of:

- Ceiling mounted exhaust fan.

Fan shall operate whenever the air handler is in the occupied mode.

When the air handler is in the unoccupied mode, the exhaust fan shall be off.

DUCTLESS SPLIT AIR CONDITIONER

Systems consist of:

- Ductless split high wall mounted evaporator (indoor unit)
- Ductless split heat pump (outdoor unit).
- Integral ductless split controls
- DDC space sensor.

The ductless split system shall be controlled via its own integral stand-alone control system.

The DDC space temperature sensor shall be for monitoring and alarming thru the BAS.

OWNER TRAINING

Provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 2 hours. Provide two follow-up visits for troubleshooting and instruction, one six months after substantial completion and the other at the end of the warranty period. Length of each visit to be not less than 8 hours or the time necessary to provide required information and complete troubleshooting and inspection activity for all controls.

END OF SECTION