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230905-H: MECHANICAL SYSTEMS CONTROLS (15975-H)

Related Sections

Basis Guideline: N/A
230030-H – "Supplemental Laboratory Ventilation Design"
230930 – "Refrigerant Monitoring System"
5.11 – "Fire Command Center"
5.13 – "UMHHC - Healthcare Procedure Room Infection Control Types and Requirements"
5.14 – "UMHHC - Patient Care and Support Spaces Room Type Requirements"
For an explanation of the use of these guidelines, see "Design Guidelines for UMHHC Facilities"

Included as part of this UMHHC guideline section are the details described within the following UM Master Specification sections:
MS230905 – "Mechanical Systems Controls (Hospital Projects)"
MS230910 – "Lab Air Flow Controls-DDC"
MS230920 – "Lab Terminal Air Flow Units & Controls"

The UM Master Specifications may be used as a reference and/or basis, but the A/E is completely responsible for contract specifications (meeting the intent of the UMHHC Guidelines and Preferred Manufacturers List) that are used in UMHHC projects.

UMH Standard Details:
D230905H-2 – "Typical VAV Unit W/ Reheat Coil & Tracking Return Control Diagram - UH"
D230905H-3 – "Typical VAV Unit W/ Reheat Coil Control Diagram - UH"
D230905H-4 – "Typical VAV Unit W/ Reheat Coil Control Diagram - THC & MCHC"
D230905H-5 – "Typical VAV Unit W/ Reheat Coil & Tracking Return Control Diagram - Cancer Center"
D230905H-6 – "Typical Dual Duct CAV Unit Control Diagram - Mott"
D230905H-7 – "Typical DDC VAV Unit W/ Reheat Coil Control Diagram – Retrofit in Existing UMH Facility"
D230905H-8 – "Typical VAV Unit W/ Reheat Coil & Tracking Return Control Diagram - Retrofit in Existing UH Facility"
D230905H-9 – "Typical VAV Unit W/ Reheat Coil & Tracking Return Control Diagram - Retrofit in Existing C&W Facility"
D230905H-10 – "Fan Coil Unit Control Diagram"
D230905H-11 – "Typical DDC Panel Assembly"
D230905H-12a – "Building Management System Network Architecture"
D230905H-12b – "Building Management System Network Architecture for Bldg #5173 Only"
D 15635 001 – "Refrigerant Monitor Control Diagram"
D 15975 001 – "DP Sensor Detail"

General

UMHHC maintains significant differences in the specification and installation of mechanical system controls, compared to projects in UM Campus buildings. UMHHC does not maintain a dedicated mechanical controls shop and hence does not participate in the installation of mechanical control system hardware via in-house trades.

UMHHC owns and maintains a unified Mechanical Control System (MCS) frontend called Siemens Desigo CC. This frontend is the single and only frontend used to monitor, control, alarm and trend DDC points reporting from a variety of DDC systems used in UMHHC facilities, including Johnson Controls, Siemens, Honeywell & ASI.

- The design A/E shall utilize UMHHC's masterspec MS230905 "Mechanical Systems Controls (Hospital Projects)" for all work on hospital funded projects that are to be maintained and monitored by the UMHHC BMS. AE shall be responsible for editing this masterspec so that it is job specific.

- All UMHHC DDC systems, regardless of manufacturer or type, shall report all points back to the Desigo CC frontend. Proprietary, or vendor specific frontends, are not allowed.
- The complete control system work shall be split between the Mechanical Systems Controls Contractor (MSCC), the Systems Integrator (SI) and UMH's Medical Center Information Technology (MCIT) department. See Masterspec 230905 Mechanical Systems Controls (Hospital Projects), Part 1 section for a detailed description on the division of work.
- The MSCC shall provide a fully integrated BACnet MCS incorporating electric, pneumatic, and direct digital control (DDC) components for the control and monitoring of heating, ventilating and air conditioning (HVAC) equipment and other related systems. Controllers shall natively use the most current ANSI/ASHRAE Standard 135 for communications and shall be BTL certified with BTL published PIC statements.
- UMHHC's Desigo CC frontend is installed on virtual servers in MCIT's datacenter. All communication/ integration to the Desigo CC frontend shall be via BACnet IP over the MCIT layer 3 network. UMHC's MCIT department shall be responsible for the design and installation of this primary network. The AE shall coordinate and clearly show on the contract documents all MCIT data drops to all IP based DDC controllers.
- UMHHC wishes to maximize the use of its MCIT network for a) communication to the Desigo CC frontend and b) communication between DDC building controllers. Communication to/ between lower level controllers shall be via a MS/TP secondary field level network (FLN), provided & installed by the Mechanical Systems Controls Contractor (MSCC).
- The SI shall be responsible for BACnet device and object discovery, point instantiation, alarm & trend definitions and creating of all front end graphics. The role of Systems Integrator shall be performed by UMH Systems Monitoring staff, or an integration contractor hired by Systems Monitoring. All contracts for Systems Integration, if needed, shall be at the discretion of UMH Systems Monitoring staff and shall be direct contracts with UMH, external to the construction contract.
- All products to be used as an integral part of the proposed MCS must be contained on the vendor's pre-approved parts list (including BTL PIC statements) on file with the UMHHC Facility Planning and Development (FPD) office.
- The AE shall discuss with the FPD mechanical engineer the approved control manufacturers to list in the project specifications. The desire it to competitively bid all control projects to the approved control manufacturers listed in specification 230905. In general, all terminal unit controls (VAV/ CAV boxes, mixing boxes, FCU's, etc) as well as all brand new stand-alone facility installations shall be competitively bid. However, UMH wishes to standardize controller manufacturers (and programming, sequence of operation, setpoints, alarming, etc) on critical equipment within a given facility. Examples of equipment that UMH may wish to sole source includes modifications to chiller plants, heating plants, AHU plants and Operating Room/ Procedure Room terminal controls.

UMHHC utilizes this same Desigo CC frontend to monitor, alarm & trend electrical equipment, including generators, substations, UPS, meters, etc. The work required for this Electrical Monitoring Systems (EMS) is detailed under electrical design guideline 260913 "Electrical Power Monitoring".

See Design Guideline 230030-H and masterspec 230910 - LABORATORY AIRFLOW CONTROLS-DDC for variable volume laboratory and fume hood air flow controls. Constant volume laboratory designs shall utilize standard VAV terminal boxes for airflow control and hence are covered under masterspec 230905 MECHANICAL SYSTEMS CONTROLS. In general, UMH prefers all DDC controls, including controllers used for lab airflow/ temperature control, to be provided by the MSCC. Furthermore, UMH requires that the integration of these lab systems be <u>native BACnet</u> at the individual field controller level (not via LON or utilize macro/ microservers). Edit masterspec 230910 accordingly. All lab & fume hood controls should be integrated into the Desigo CC frontend.

Direct digital controls (DDC) are the standard for control in new facilities and new renovation work at UMHHC. Renovation work within many existing UMHHC facilities is a mix of pneumatic and DDC controls. In general, all renovation work should look to utilize DDC controls, regardless if the existing control strategy is pneumatic. In special, rare instances, where renovation work does not look to significantly modify the existing VAV box pneumatic controllers, the A/E shall provide a control system that matches existing (i.e. pneumatic controls within the University Hospital). See standard terminal box control details available on the UMHHC FPD website for these instances. The A/E shall discuss the continued use of pneumatic controls with the UMHHC Mechanical Engineer.

Using U-M Master Specification 230905

The A/E shall use U-M Master Specification 230905 as the basis for the control specification and edit it to make it project specific.

When editing this spec, ensure hidden text is turned “on” and carefully review all spec editor’s notes.

Special attention should be paid to the following articles:

- Article 1.6: Edit the list of acceptable controls contractors in consultation with and as approved by the UMHHC Mechanical Engineer.
- Article 2.6: For steam condensate meters used for utility billing, obtain approval for the type of steam condensate meter to be used with UM Plant, and then edit the spec accordingly.
- Article 2.9: If electrical actuators are used, power for these actuators must be accounted for on drawings. Read the spec editor’s note in this article for further direction.
- Article 3.8: MSCC is responsible for data connection raceways between all DDC panels and the MCIT network. MCIT is responsible for data cabling & activation. In order to coordinate MCIT’s scope, the AE shall clearly show all required DDC data connections on the design drawings.

The U-M master specification includes specifications for most types of control components. In some cases the A/E will need to add supplemental specifications for atypical components.

Control or automatic dampers (actuated dampers) are specified in Master Specification 230900. The A/E’s specification should include no other control damper specifications, and specification sections requiring factory provided control dampers, e.g. air handler specifications, shall reference Master Specification 230905 for the control damper spec.

Control Drawings

The required scope of a project’s controls shall be indicated by the use of control drawings. All equipment/ systems that are controlled, monitored or alarmed by the BMS shall be identified with a control diagram and sequence of operation.

Control drawings and sequences shall appear on the mechanical drawings; they shall not appear in project specifications. Include all project specific set points and alarm values.

Control drawings shall utilize U-M’s standard control symbols. Normally, U-M will provide sample control drawings in electronic format for A/E use, which will include sequences of operation. Revise these drawings to make them project specific. Revise sequences of operation to include strategies specific to the project (example: change-over to free cooling). Include all project specific set points and alarm values. Provide similar control drawings for systems not available from U-M’s samples.

Wiring diagrams shall be provided on the control drawings that indicate the method of starting fans, pumps, and other equipment, safety interlocks, interface to manufacturer’s provided controls, etc. These diagrams may be schematic in nature but shall indicate fundamentally how electrical control is accomplished.

All DDC systems shall outline all means of energy conservation including start/ stop optimization, electric demand limiting and day/ night set back, where applicable. For systems with occupied/ unoccupied control, drawings should indicate anticipated operation time schedules of relevant HVAC equipment.

"Point Lists" are not required and shall not be used, however all necessary points for monitoring and control shall be represented on the control drawings.

Typical UMHHC DDC Monitoring/ Alarm Points

General
Provide an automatic restart for all equipment on power failure. Provide a manual override switch for each piece of equipment.

All set points shall be made adjustable for UMH Systems Monitoring from the BMS front end graphical interface.

Packaged Equipment controllers should be specified with a common alarm contact for DDC monitoring, not separate alarm contacts for each alarm condition, except as noted.

See **Table 1- "Typical DDC Monitoring Points- Equipment"** at the end of this document for standardized point reporting/ alarming off typical equipment in UMHHC facilities.

See **Table 2- "Typical DDC Monitoring Points- Room Types"** at the end of this document for standardized point reporting/ alarming off typical room types in UMHHC facilities.

Factory Provided (Packaged) Controls

In general, UMHHC requires that all controls be provided by a single temperature controls contractor rather than with factory packaged controls. Packaged controls are acceptable on equipment where installing third party controls is not feasible, such as chillers, boilers, storm/sanitary pumps, booster pumps, RO/DI systems, vacuum pumps, air compressors, pollution control (air and water treatment) systems, refrigerant leak detection, fuel oil systems, small unitary DX systems, rooftop units and condensate pumps. For all other equipment, packaged controls are NOT acceptable. Contact UMHHC Mechanical Engineer for use of packaged controls on any equipment not listed. See the respective design guideline for these systems on any specific requirements for packaged controls.

Chillers and boilers shall be equipped with manufacturer provided controls, which shall serve to provide complete control, monitoring and alarming of that respective piece of equipment. Control of the chiller or boiler plant (chiller/ boiler sequencing, etc.) shall be by UMHHC's DDC system. Boiler sequencing panels should not normally be specified.

Packaged controls shall not be specified for air handlers, unless specific permission is given by the UMHHC Mechanical Engineer.

Where packaged controls are specified to be BMS integrated, they shall be specified with an open protocol communication interface. UMHHC's preference is for BACnet interfaces, but other protocols are allowed and could be utilized where appropriate. The A/E shall coordinate with the UMHHC Mechanical Engineer.

Where an open protocol communication interface is available on packaged equipment, the A/E shall specify that the BMS integrate with the packaged equipment controls to provide enhanced monitoring and control capabilities (as opposed to hardwire I/O). The A/E shall discuss the benefits of this with the UMHHC Mechanical Engineer.

Control Air

For facilities on the main hospital campus, 90 PSIG (at the tunnel entrance) compressed air is available from the campus steam tunnel system. This air shall be utilized for temperature control air use; dryers for control air are not required.

In addition to campus compressed air, the A/E shall specify a control air compressor(s) and dryers as a redundant source of compressed air for each facility. Critical facilities NOT connected to the campus compressed air system (ie offsite Ambulatory Surgery Centers, Data Centers, etc.) shall utilize (2) fully redundant air compressors & dryers with an automatic alternating means- see specification.

Pneumatic control air work within existing facilities shall utilize existing pneumatic air sources where feasible. The A/E shall be responsible for analyzing the existing pneumatic control air system in its applicable use in renovation work. U-M Master Specification 230900 specifies control air compressors and accessories (PRV stations, refrigerated air dryers, etc.). The A/E drawings shall indicate the source of control air.

Electric vs. Pneumatic Actuators

Historically UMH has required that large damper actuators and large control valves shall be pneumatically actuated. Small dampers and valves used outside of infrastructure spaces in the distribution of piping & ductwork (i.e. smoke dampers, FCU valves and VAV reheat valves) have utilized electric actuators, as indicated in UM Master Specification 230905.

Improvements in the reliability and functionality of modern electric actuators have caused them to become the standard in the industry. For these reasons, the AE shall specify and coordinate the exclusive use of electric actuators in all new facilities, on all valves and dampers, large or small. Power to these devices shall be closely coordinated. In all cases, the priority of power (ie generator power- equipment branch vs critical branch vs normal power) shall match the power source of the equipment being served.

For existing facilities, the AE shall discuss the use of pneumatics vs electric actuators. In general, the desire is to not intermix actuator types on a given system (ie chiller plant, AHU, etc).

Terminal Boxes

Room thermostats /sensor shall be DDC type for all new construction and pneumatic where interfacing with existing pneumatic controls.

Typically, all thermostats shall be occupant adjustable (limited range, set thru BMS) and shall utilize a visible digital LED temperature readout. Systems that operate with an occupied/ unoccupied mode should utilize thermostats with an integrated override button.

Transient, public areas (i.e. waiting rooms, corridors, cafeteria, etc.) shall control space temperature via a wall mounted temperature sensor that does not include local temperature setpoint adjustment. These sensors and connected temperature control devices shall be set thru the BMS to maintain a 70°F to 74°F temperature range with dead band.

Larger staff or clinical areas which require multiple VAV boxes serving a common area shall be controlled to prevent simultaneous heating & cooling. Typical applications include:

- Where user setpoint adjustment is not required (i.e. public spaces), provide each VAV zone with a space temperature sensor set to control to the same temperature setpoint range (common 4°F range).
- Where user setpoint adjustment is required, provide a thermostat in one of the VAV zones and temperature sensors in the remainder. Program to have the thermostat set the temperature control point of all the VAVs in that space.

All thermostats mounted on cold surfaces (i.e. uninsulated walls) shall be provided with an insulated base plate.

Thermostats/sensor shall be installed in the most frequently occupied area of zone, best representing the load seen in the respective HVAC zone.

The Architect/Engineer shall coordinate their work with project Interior Designer for coordination with equipment, shelving, PC locations, etc. within the space. A/E shall utilize notes on the drawings or in the specifications, as necessary, to prevent the placement of thermostats in non-functional areas of the occupied spaces, such as in or behind bookcases, casework, file cabinets, binder bins, coat hooks, etc. The preferred location for thermostats is adjacent to a door, next to the room's light switch.

Each room provided with radiant heat (baseboard/ ceiling panel) shall be individually controlled to prevent simultaneous heating & cooling. UMHHC's preference is to interlock the radiant heat control valve with the room's respective terminal box. Alternately, large open public spaces on a common exposure can be controlled via a DDC temperature space sensor.

Location of all thermostats shall be shown on the contract documents and on the as-built drawings.

The design of terminal equipment (i.e. VAV boxes) serving pressurized spaces (i.e. Type 1 thru 3 Infection Control Rooms, Protective Environment Rooms, Airborne Infection Isolation Rooms, Pharmacy, Sterile Processing, etc.) shall ensure that the daily calibration cycle does not disrupt the required room pressurization. Typically this requires the use of an "auto-zero" module that calibrates airflow without closing the box damper. See Masterspec 230905.

Valves

In general, UMHHC prefers the use of two-way modulating control valves in conjunction with variable flow pumping systems. In addition, each floor shall utilize a small branch with a balancing valve between supply & return piping at the end of the loop to maintain water circulation.

Fume Hood Controls

A/E to specify a fume hood control system that maintains a constant average face velocity over the entire hood opening area regardless of sash position. Multiple hoods on a common exhaust system shall utilize quick-response Air Control Valves (ACV). See guideline 230030-H for more detailed information on fume hood and laboratory airflow control.

Outside Air Control

All air handling units, rooftop units, etc. including recirculated return air shall include a mixed air economizer. The economizer shall be overridden, with mixed air dampers commanded to minimum outside air positions if the outside air enthalpy is greater than the return air enthalpy.

In cases where high outside air volumes are required by code for densely occupied areas, consider the use of carbon dioxide sensors and associated controls to automatically reduce ventilation during low occupancy periods. The system shall control to maintain a maximum hi-limit carbon dioxide level (PPM) setpoint.

At a minimum, air handling systems serving I-2 areas shall include airflow measuring stations that monitor the active quantity (CFM) of outside air in the system. This may be accomplished by directly measuring the outside airflow into the air handling system, or by measuring the total supply airflow and the return airflow being recirculated back into the supply airstream (i.e. after any relief air discharge) and subtracting the two (just measuring the total airflow returned from the space is not acceptable for this calculation). Please be aware of any other LEED project requirements or other applicable codes which may require direct measurement of the outside airstream into the air handling system. Mixed air damper controls shall be set to automatically maintain the design minimum outside air quantity (CFM) or greater at all times.

Occupied/Unoccupied Control

During design, every effort should be made to group spaces with common anticipated occupancy periods into common central HVAC system zones in order to allow central air handling units and HVAC systems to be scheduled off during typical unoccupied periods. Design drawings should indicate anticipated operation time schedules of relevant HVAC equipment.

Additionally, regardless of location in a scheduled HVAC zone or not, occupancy sensors should be installed and tied into the local VAV or other terminal equipment controller, in order to automatically enable unoccupied mode operation and reduce HVAC system requirements during unoccupied periods in feasible spaces. It is common to use a ceiling or wall mounted (not light switch mounted) occupancy sensor with auxiliary contacts to control both lighting and HVAC in a space. Coordinate with electrical lighting design as applicable. If a terminal HVAC control device serves multiple areas, occupancy sensors in all served areas must simultaneously detect unoccupied conditions prior to enabling unoccupied mode operation. During unoccupied mode, the controller shall reduce minimum airflow setpoint to 0 CFM, but shall maintain an unoccupied space temperature range (typically 68°F to 76°F) and shall increase airflow if necessary to maintain this range. This method of control shall be applied to most space types such as, offices, meeting rooms, exam rooms, waiting rooms, lounges, classrooms, etc. This method of control shall not be applied to corridors, rooms with continuous exhaust airflow requirements, and rooms with air pressure relationship requirements that do not include supply and return airflow control equipment, or areas that are otherwise prohibited by code requirements.

Occupancy control of ventilation shall be included in operating rooms, procedure rooms, or other areas with air pressure control requirements if those spaces include both terminal supply and return airflow control devices. Systems shall reduce airflow but shall maintain required room pressurization setpoints at all times. See SBA-K-H for further details on occupancy control in various procedure rooms.

Room Pressurization Controls/ Monitors

Healthcare code requires certain critical healthcare environments to maintain a minimum room pressure differential of 0.01”wg. In order to validate compliance, room pressure monitors and/or room pressure transmitters shall be provided for all rooms required by code to hold a minimum 0.01”wg. All devices shall be integrated back to the BMS. AE shall design the room envelope (walls, floor, ceiling) and mechanical system for a minimum of 0.02”wg (positive or negative depending on requirement) in order to provide a buffer. Certain spaces, like OR’s, Procedure Rooms, clean rooms, etc, may require a minimum room pressure in excess of 0.02”wg (see SBA-5.13).

See Special Building Area (SBA) section of the design guidelines for a more detailed description of procedure rooms and clinical spaces requiring this type of control and the associated BMS interface.

Room differential pressure monitors, integrated back to the BMS, shall be provided for the following rooms types:

- Operating Rooms/ Procedure Rooms (see SBA- 5.13)
- Sterile Supply (OR Clean Core)
- Protective Environment (PE) Rooms
- Airborne Infection Isolation (AII) Rooms
- Pharmacy (including individual clean room monitoring, if applicable)
- Decontamination (Central Sterile)
- Sterile Processing (Central Sterile)

DDC Panel Locations and Clearances

The control drawings shall include system architecture diagrams specific to the project. These diagrams indicate the location and quantity of DDC and auxiliary panels. UMHHC will normally provide this information to the A/E, for inclusion on the project drawings.

Each DDC panel will have one or more auxiliary panels. See D230905H-11 – “Typical DDC Panel Assembly” detail. The A/E shall indicate the location of these panels on the plan views. For a typical assembly allow 7’of wall space; note that some panel assemblies require more space. Locate panels to provide a minimum of 36” clearance in front of each panel, and designate this clearance on the drawings.

Power for Controls

Power to controllers and associated controlled devices shall be 24 VAC, provided by the MSCC. Power source (i.e. normal vs. emergency power & emergency power priority) shall match that of the equipment being controlled.

UPS's should be provided for all controllers, to protect against damage due to power quality and to minimize disruption. The exceptions are controllers serving non-critical infrastructure in offsite/ outpatient facilities. Provide UPS with an integral automatic bypass feature (in case of UPS failure) and network integration to the Building Management System (BMS). See Masterspec 230905 for UPS specification. Discuss with FPD engineer.**DDC Panel Assemblies:** Each assembly (not each panel in an assembly) shall be provided with (2) 20 amp dedicated circuits (separate circuit breakers). Indicate these circuits on the electrical drawings, home-runned to the panel assembly location.

- **Terminal Equipment Controllers (TEC) Power (DDC VAV box controllers, etc.):** Designate circuits in receptacle panels on each floor for TEC transformers. In general, provide one 20 amp circuit for every (50) Terminal Equipment Controllers- confirm with temperature control manufacturer requirements.
- **Actuator Power:** See UM AEC Master Specification 230905, article 2.8.
- **Power for meters and other control accessories that are provided by the controls contractor:** Provided through a fused disconnect located in the DDC auxiliary panel and is part of the controls contractor's scope of work. The A/E does not need to typically indicate power for such items on the design drawings. See UM Master Specification 230905, article 2.5.

Status Indication Methods

Pump, fume hood, biosafety cabinets, etc., status indicator should provide a positive indication of proper operation - i.e. status for a fume hood should be connected to a differential pressure switch, NOT an auxiliary starter contact; proof of flow for chillers shall be via a local differential pressure transducer, not via an auxiliary pump starter contact. Status for fans/ pumps should be via a current sensing relay (adjustable to detect belt loss) on the motor.

UMHHC's preference is that the fume hood/ biosafety cabinet be provided with the required local proof/ alarm of central exhaust airflow. Coordinate with Medical Equipment Planner/ Architect.

Life Safety Control

The BMS shall not be used for initiating or alarming life safety applications; however all life safety systems shall report general alarms and status to the BMS front-end. Three common examples are as follows:

- **Stair Pressurization Control:** The building fire alarm system will initiate operation of the stair pressurization fans. Any controls required for stair pressurization shall be stand-alone from (and independent of) the DDC system.
- **Atrium Smoke Purge:** The building fire alarm system will initiate atrium smoke purge. Any controls required for smoke purge shall be stand-alone from (and independent of) the DDC system.
- **Smoke Control:** The building fire alarm system will initiate the smoke control system. Any controls required for smoke control shall be stand-alone from (and independent of) the DDC system.

The controls contractor will provide the stand alone components (dampers, end-switches, pressure transmitters, etc.) and therefore these components shall be indicated on the control drawings and include complete sequences of operation.

Fire Command Centers

The building code requires status indicators and controls for air distribution systems in Fire Command Centers (FCC). These devices shall be provided as a separate DDC control panel in the FCC. The DDC system (as opposed to the fire alarm control system) shall output status to the panel and provide air distribution system control from the panel. Refer to Design Guideline SBA 5.11 Fire Command Center for additional information

Miscellaneous

DDC controlled heating hot water heat exchangers shall include back-up pneumatic control.

DDC controlled cooling towers shall include a pneumatic controller to provide back-up control of the tower condenser water bypass valve arrangement.

Exterior lighting associated with new buildings shall be controlled by DDC. DDC shall turn the lights on and off, and status the lighting contactor (via a current sensing relay). The contract drawings shall indicate a contactor for exterior lighting control by DDC. Consider utilizing the BMS for lighting control in lieu of dedicated lighting control systems.

Existing UMHHC facilities with DDC controls typically utilize numerous weather stations that transmit outside temperature and humidity conditions across the BMS network. Local outside temperature and humidity transmitters should normally not be needed, except on off-site facilities. The A/E shall coordinate this requirement with the UMHHC Mechanical Engineer.

Fan systems capable of developing static pressures in excess of the duct system's (air handler casing, plenums, ducts) static pressure rating (positive or negative) shall be equipped with static pressure safeties to turn off the fans prior to damage occurring from excessive pressure. The A/E should not indiscriminately specify these devices but shall include them based on an evaluation of the maximum pressure the fan can develop, the pressure class of the duct system, damper pressure ratings, and the degree of risk. Static pressure safeties utilized on air handling systems with downstream smoke dampers shall act to reduce fan discharge pressure upon a rise in pressure above normal levels, prior to reaching the static pressure high limit. This function helps maintain continuous AHU service during regular smoke damper testing.

In general for air handlers, heating coil control valves shall be designated as fail open, and cooling coil control valves shall be designated as fail closed.

For all air and liquid flow measuring devices, the A/E shall indicate their location on the plan views as well as on the control drawings. Design the duct or piping at the meter location to provide the manufacturer's required up and downstream straight and unobstructed lengths and indicate these requirements on the drawings. When in doubt as to specific manufacturer's requirements, provide 10 straight diameters upstream and 5 straight diameters downstream. Where flow varies, A/E shall ensure that the turndown ratio for the transmitter will allow accurate measurement at low flow conditions.

All installed devices and sensors shall be calibrated, either factory or in the field. Coordinate field calibration of air and fluid flow sensors with the Test and Balance contractor.

The A/E shall specify that all existing control panels, devices, wiring, and tubing that are to be abandoned as part of new work shall be demolished completely by the TCC. All demolished controllers that are still in working condition shall be handed over to UMHHC's Maintenance group. The A/E shall also specify that all existing control points and system graphics that are no longer going to be utilized as the result of new work shall be demolished or deleted from the BMS software.

For information regarding controls related to refrigerant leakage monitoring, see DG230930 Refrigerant Monitoring Systems and the standard detail D 15635 001 Refrigerant Monitor Control Diagram.

TABLE 1 – Typical DDC Monitoring Points (Equipment)				
System	**Point**	**Point Type**	**Alarm**	**Notes**
Central Plant Equipment				
Air Handling Units	Supply Fan Motor Start/Stop	DO		
	Supply Fan Status	DI	If status does not match start/stop command	Shall be monitored by a current sensing relay or a contact on the fan VFD. Review with project engineer.
	Supply Fan VFD Speed	AO		
	Return Fan Motor Start/Stop	N/A		Return fan to be electrically interlocked with supply fan independent of DDC system.
	Return Fan Status	DI	If status does not match start/stop command	Shall be monitored by a current sensing relay or a contact on the fan VFD. Review with project engineer.
	Return Fan VFD Speed	AO		
	Discharge Air Temperature	AI	If DAT is > +/-5°F of setpoint	Shall be installed downstream of supply fan & humidifier to read actual temperature supplied to terminal equipment.
	Discharge Air Humidity	AI	If humidification is enabled and DAH > 90% relative humidity	*Only on systems including humidifiers.
	EOD Supply Air Static Pressure	AI	If > defined maximum setpoint	Supply duct static pressure sensor mounted 2/3 of the way down the supply duct system. Review need for additional system static pressure sensors with project engineer.
	Discharge Static Pressure	AI	If > defined maximum setpoint	Mounted at the supply discharge of the Air Handling Unit.
	Humidifier Control Valve	AO		*Only on systems including humidifiers.
	Cooling Coil Control Valve	AO		
	Preheat Coil Control Valve	AO		
	Preheat Coil Pump Start/Stop	DO		Preheat coil recirculation pump
	Preheat Coil Pump Status	DI	If status does not match start/stop command	Shall be monitored by a current sensing relay.
	Freezestat Monitor	DI	When freezestat is activated	Freezestat sensor and controller shall be installed upstream of cooling coil. In I-2 and Ambulatory Surgery Center facilities, freezestat alarm shall serve to full open the AHU heating control valve and shall keep supply/ return fans operational. In all other facilities, freezestat alarm shall shut-down supply/ return fans.
	Preheat Air Temperature	AI	If PAT is more than 10°F > MAT when the preheat valve is commanded closed.	Mounted downstream of preheat coil and upstream of freezestat.

TABLE 1 – Typical DDC Monitoring Points (Equipment)				
System	**Point**	**Point Type**	**Alarm**	**Notes**
	Mixed Air Temperature	AI		
	Mixed Air Dampers	AO		
	Return Air Temperature	AI		Mounted upstream of return fan.
	Return Air Humidity	AI	If humidity is > 60% or < than 20%	Mounted upstream of return fan.
	Return Air Enthalpy	AI or Virtual		Preferred method is to calculate enthalpy based on dry bulb temperature and relative humidity sensor inputs.
	Supply Airflow	AI		
	Return Airflow	AI		
	Outside Airflow	AI	If system outside air CFM is > 10% below defined minimum OA CFM or minimum OA percentage	Only applies to specific system types. Can be accomplished via direct outside airflow measurement or calculated between multiple airflow sensors. Consult with project engineer.
Heating Hot Water/ Boiler Plant	Boiler Enable/ Disable	DO		
	Boiler Temperature Setpoint	AO		Hardwired I/O or integrated
	Boiler Alarm	DI	General alarm	General alarm from boiler control panel.
	Boiler Status	DI	Alarm if boiler is enabled and fails to prove status	
	HHW Setpoint	AO		
	Boiler/HX Supply Sensor	AI	If > max setpoint	Include at the output of each boiler or heat exchanger in the system.
	Boiler/HX Isolation Valve	DO		
	Boiler/HX Isolation Valve Position	DI	If position does not match DO command	From valve endswitch.
	Loop Supply Temperature	AI	If > max setpoint	Each primary, secondary, tertiary, etc. loop should have a supply temperature sensor.
	Loop Return Temperature	AI		Each primary, secondary, tertiary, etc. loop should have a return temperature sensor.
	Loop Flow	AI		Each primary, secondary, tertiary, etc. loop should have a GPM flowmeter or a means of calculating loop flow from other system flowmeters.
	Heating Energy Load	Virtual AI		System shall utilize supply and return temperature sensors and flow meters to calculate the system energy load, displayed as MMBtu/hr.
	Differential Pressure	AI	If < or > defined acceptable min/max setpoints	Differential pressure sensor comparing supply & return pressures. Consult with project engineer for quantity and relevant locations.
	HX Steam Control Valve	AO		*Only applies to systems with heat exchangers. Individual outputs to steam control valve serving each heat exchanger.
	Pump Start/Stop	DO		
	Pump Status	DI	If status does not match start/stop command	Shall be monitored by a current sensing relay or a contact on the fan VFD. Review with project engineer.
	Pump VFD Speed	AO		

TABLE 1 – Typical DDC Monitoring Points (Equipment)

System	Point	Point Type	Alarm	Notes
Chilled Water Plant	Chiller Enable	DO		
	CHW Setpoint	Integrated AO		
	Chiller Alarm	DI	General alarm	General alarm from chiller control panel.
	Chiller Status	DI	Alarm if chiller is enabled and fails to prove status	
	Chiller Relief Valve Status	DI	If relief valve opens	
	Chiller %RLA	Integrated AI		Integrate from chiller control panel.
	Chiller KW	Integrated AI		Integrate from chiller control panel.
	Primary Pump Status	DI	If chiller is enabled and primary pump is not active	Preferred control is for chiller control panel to command primary pumps on and off. DI point shall report pump status to BMS. Applies to primary CHW and CW pumps.
	Chiller/HX CHW Supply Temperature	AI		Temperature sensor at the chilled water outlet of each chiller or heat exchanger as applicable.
	CHW Loop Supply Temperature	AI	If temperature is > +/-5°F of setpoint	Each primary, secondary, tertiary, etc. loop should have a supply temperature sensor.
	CHW Loop Return Temperature	AI		Each primary, secondary, tertiary, etc. loop should have a Return temperature sensor.
	CHW Loop Flow	AI	If primary loop GPM is < minimum setpoint to maintain chillers.	Each primary, secondary, tertiary, etc. loop and decoupler line should have a GPM flowmeter or a means of calculating loop flow from other system flowmeters.
	Cooling Energy Load	Virtual AI		System shall utilize supply and return temperature sensors and flow meters to calculate the primary loop energy load, displayed as Tons.
	Total Chiller Electrical Load	Virtual AI		System shall sum active chiller KW and display total chiller KW.
	Total Plant KW/Ton	Virtual AI		System shall divide total chiller KW by total primary CHW tons to calculate and display total plant chiller KW/Ton.
	Chiller/HX CW Return Temperature	AI		Temperature sensor at the condenser water outlet of each chiller or heat exchanger as applicable.
	CW Loop Supply Temperature	AI	If temperature is > +/-5°F of setpoint	If the system includes a cooling tower bypass, include a sensor for the chiller side and the tower side of the loop.
	CW Loop Return Temperature	AI		If the system includes a cooling tower bypass, include a sensor for the chiller side and the tower side of the loop.
	Cooling Tower Bypass Valve	AO		*Only applies to systems with cooling tower bypass valves.
	Cooling Tower Isolation Valve	DO		
	Cooling Tower Isolation Valve Position	DI	If position does not match DO command	From valve endswitch.

TABLE 1 – Typical DDC Monitoring Points (Equipment)

System	Point	Point Type	Alarm	Notes
	Cooling Tower Vibration	DI	If vibration switch is activated	
	Cooling Tower Fan Start/Stop	DO		
	Cooling Tower Fan Status	DI	If status does not match start/stop command	Shall be monitored by a current sensing relay or a contact on the fan VFD. Review with project engineer.
	Cooling Tower VFD Speed	AO		
	Cooling Tower Basin Temperature	AI	If temperature falls below 34°F	*Only applies to towers with outdoor basins.
	Cooling Tower Basin Heater	DO/AO		*Only applies to towers with outdoor basins. DO or AO for on/off or modulating heating control. Review with project engineer.
	Secondary CHW Pump Start/Stop	DO		
	Secondary CHW Pump Status	DI	If status does not match start/stop command	Shall be monitored by a current sensing relay or a contact on the fan VFD. Review with project engineer.
	Secondary CHW Pump VFD Speed	AO		
	CHW Differential Pressure	AI	If < or > defined acceptable min/max setpoints	Differential pressure sensor comparing supply & return pressures. Consult with project engineer for quantity and relevant locations.
Misc. Mechanical Equipment				
Exhaust/ Supply Fans	Fan Enable	DO		
	Status	DI	Alarm if fan is enabled and fails to prove status	Shall be monitored by a current sensing relay.
Sanitary & Storm Pumps	Pump Controller Alarm	DI	General alarm	General alarm from control panel
	High Water Alarm	DI	High water alarm	Alarm from control panel
Environmental (Hot/ Cold) Rooms	Alarm	DI	General alarm	General alarm from control panel
Heat Trace	Alarm	DI	General alarm	Alarm from control panel
	OA Temperature Setpoint	AO		Integrated from control panel
RO/ DI Systems	Alarm	DI	General alarm	General alarm from control panel
Glycol Make-up Systems	Low Pressure Alarm	DI		Alarm from control panel
	Low Level Alarm	DI		Alarm from control panel
Refrigerant Leak Detection	(3) Alarms	DI	Detector Fault alarm, Low Level Refrigerant Leak, TLV/ TWA Alarm	From leak detection panel
Booster Pumps	Alarm	DI	General alarm	General alarm from control panel
	Discharge Pressure	AI		Via pressure sensor in downstream piping
Air Compressors	Alarm	DI	General alarm	General alarm from control panel
Hot Water Heaters	Discharge Temperature	AI	Alarm when HW temperature is 130°F or < 105°F	Via temperature sensor in downstream piping
	Campus HW	AI	Alarm when temperature < 105°F	For facilities supplied by campus tunnel HW service

TABLE 1 – Typical DDC Monitoring Points (Equipment)

System	Point	Point Type	Alarm	Notes
	Temperature			
	Discharge Pressure	AI		
Medical Vacuum Pumps & Lab Vacuum Pumps	System Malfunction	DI	General alarm	General alarm from control panel
	Low Vacuum Pressure Alarm	DI	Alarm	Alarm from control panel
	High Vacuum Pressure Alarm	DI	Alarm	Alarm from control panel
	Lag Pump Running	DI	Alarm	Alarm from control panel
Medical Air Compressors	System Malfunction	DI	General alarm	General alarm from control panel
	Low Pressure Alarm	DI	Alarm	Alarm from control panel
	High Pressure Alarm	DI	Alarm	Alarm from control panel
Medical Oxygen	Low Oxygen Pressure Alarm	DI	Alarm	Alarm from control panel
	Oxygen Reserve in use Alarm	DI	Alarm	Alarm from control panel
Domestic CW Service	Pressure	AI		
Steam/ Steam Condensate Meters	Flow	AI		
Snow Melt Systems	Alarm	DI	General alarm	General alarm from control panel
	Glycol Temperature	AI	Alarm if below min temperature	
	Glycol Pressure	AI	Alarm if below min pressure	
Lighting Control	Enable/ Disable	DO		
Water Leak Detection	Alarm	DI	General alarm	General alarm from leak detection panel
UPS (DDC Controller)	Alarm	Integrated DI	General alarm	
	Low Battery	Integrated AI	Low battery	
	Power Failure	Integrated DI	Power Failure	
	Load Reset	Integrated DO		
Terminal/ Unitary Mechanical Equipment				
Computer Room AC Units (CRAC)	CRAC Enable/ Disable	DO		
	CRAC Status	DI	Alarm if CRAC is enabled and fails to prove status	
	CRAC Alarm	DI	General alarm	General alarm from CRAC unit
VAV/ CAV Box	Thermostat	(2) AI's		Includes active space temperature and thermostat temperature setpoint
	Airflow	AI		Active VAV box airflow (CFM)
	Reheat Valve	Output		Output to reheat coil control valve (0 to 100% open)
	Damper	Output		Output to airflow control damper (0 to 100% open)
	Active Temperature Setpoints	Virtual		Active control temperature setpoint or setpoints of a control range.
	Min CFM Setpoint	Virtual		
	Max CFM Setpoint	Virtual		
	Discharge Temperature	AI		Via temperature sensor mounted at discharge of RHC

TABLE 1 – Typical DDC Monitoring Points (Equipment)

System	Point	Point Type	Alarm	Notes
	Perimeter Valve	Output		*Only applies to spaces where a perimeter heater is intended for control by the VAV box controller
	Occupancy Status	DI		*Only applies to rooms with connected occupancy sensors
	Humidity	AI		*Only applies to rooms with space humidity sensors
	Carbon Dioxide	AI		*Only applies to rooms with space carbon dioxide sensors
Fan Coil Unit/ Blower Coil Unit (FCU/ BCU)	Thermostat	(2) AI's		Includes active space temperature and thermostat temperature setpoint
	Active Temperature Setpoints	Virtual	For critical spaces, if space temperature is > +/-5°F of setpoint	Active control temperature setpoint or setpoints of a control range.
	Fan Command	DO		On/off signal to fan motor
	Fan Speed	AO		*Variable speed signal only applies to units with ECM motors.
	Coil Control Valve	Output		Output to coil control valve (heating and/or cooling with separate points for each as applicable) (0 to 100% open)
	Drain Pan Leak Status	DI	Alarm if leak is detected	From leak detector at cooling coil drain pan
	Discharge Temperature	AI		Via temperature sensor mounted on discharge of FCU/ BCU
Room Pressure Monitor	Room Pressure	AI		
	Room Pressure Alarm	N/A	Alarm at 0.01"wc (for > 15 mins)	Local alarm only, when monitor alarm is activated
Emergency Shower	Alarm	DI	Alarm	Via flow switch

Notes:

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TABLE 2 – Typical DDC Monitoring Points (Room Types)				
System	**Point**	**Point Type**	**Alarm**	**Notes**
Typical HVAC Zone	Room Temperature	AI		
	Room Humidity	AI		*Only required in rooms served by booster humidifiers
Protective Environment (PE)/ Airborne Infection Isolation (AII) Rooms/ Pharmacy	Room Pressure	AI		
MRI Rooms	Oxygen Monitor	DI	Alarm if oxygen concentration is below limits	Indicative of Helium leak from the magnet
Infection Control Room Types 1- 3 (i.e. Operating Rooms/ Procedure Rooms)	Room Temperature	AI	See SBA-K-H for alarm limits	Via temperature sensor located in return branch serving room. Room adjustable.
	Room Humidity	AI		Via humidity sensor located in return branch serving room. Not user adjustable.
	Airchange Rate	Virtual AI		From airflow off supply VAV box
	Room Pressurization	AI		
Decontamination/ Sterile Processing Rooms	Room Temperature	AI		
	Room Humidity	AI	< 30% RH or > 60%RH for > 15 mins	
	Room Pressurization	AI		
Telecommunication Rooms (see SBA-C-H)	Space Temperature	AI	Space temperature is < 65°F or > 80°F	
	Leak Detection (Floor)	DI	Alarm	Only required when a possible source of water leak exists in room (i.e. water piping, FCU).
Substation Rooms, Elevator Machine Rooms, Electrical Rooms	Space Temperature	AI	Space temperature is < 60°F or > 90°F	
	Leak Detection	DI	Alarm	Only required when a possible source of water leak exists in room (i.e. water piping, FCU).
Generator Room	Space Temperature	AI	Space temperature is < 60°F or > 90°F	
	Intake & Exhaust Dampers	AO	Alarm via endswitch	
Computer Rooms	Room Temperature (several locations)	AI	If temperature is > +/-5°F of setpoint	Typically several locations in the room
	Room Relative Humidity	AI	If humidity is > 60% or < 20%	
	Raised Floor Temperature	AI		
	Raised Floor Static Pressure	AI	If floor SP is +/- 20% of design	

Notes:

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