UNIVERSITY OF MICHIGAN
ARCHITECTURE, ENGINEERING AND CONSTRUCTION

ARCHITECTURE & ENGINEERING
326 East Hoover, Mail Stop B
Ann Arbor, MI 48109-1002
Phone: 734-764-3414
Fax: 734-936-3334

BuildingName
The Description of the Project
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SPECIFICATION DIVISION 23

END OF CONTENTS TABLE

NEW SECTION: OCTOBER 2011.

JULY 2013: REVISED TO INDICATE THAT ALL PHOENIX CONTROLS SHALL BE LONWORKS® BASED AND THAT BACNET PROTOCOL IS NOT ACCEPTABLE, TO ASSURE PHOENIX CONTROL POINTS CAN BE MONITORED BY BAS. D. KARLE FOR HVAC MTT.

DECEMBER 2013: ADDED (ALL IN PART 3): DO NOT "CLIP" VALVES. LTAU VOLUME FOR VALVES SERVING HOODS WITH HORIZONTAL SASHES TO BE SET TO MAINTAIN THE REQUIRED FACE VELOCITY WITH THE SASHES IN THE POSITION THAT CREATES THE MAXIMUM FREE AREA OPENING. ALSO: ALARM SETTINGS FOR FLOOR MOUNTED HOODS. D. KARLE FOR HVAC MTT.

JUNE 2015: REVISED TO REQUIRE REHEAT COIL BE PROVIDED BY LCC, ADDED REHEAT COIL SPEC. ADDED REQUIREMENT FOR VALVE CALIBRATION CERTIFICATE UNDER SUBMITTALS, ADDED POST SUBMITTALS ARTICLE. IMPROVED DESCRIPTION OF VALVE OPERATION UNDER 2.3.A TO REQUIRE THAT CHARACTERIZED VALVE POSITION BE THE PRIMARY MEANS OF ACHIEVING AIR VOLUME SETPOINT, ADDED THAT ADDITIONAL OR FEWER AIR VALVES ARE THE RESPONSIBILITY OF THE CONTRACTOR TO PROVIDE IF A MANUFACTURER OTHER THAN THE DESIGN BASIS IS SUPPLIED SINCE FLOW RANGE V. VALVE DIAMETER VARIES BETWEEN MFR.S, REQUIRED THAT +/-5% VALVE ACCURACY BE OVER THE ENTIRE CATALOGED VOLUMETRIC OPERATING RANGE OF THE LTAU, REQUIRED FUME HOOD MONITORS BE PROVIDED WITH A COMMON ALARM SILENCE BUTTON SINCE SOME MFR.S WERE PROVIDING MULTIPLE SILENCE BUTTONS. REVISED BUILDING AUTOMATION INTERFACE REQUIREMENTS TO REQUIRE PHOENIX MACRO SERVER AND SIEMENS PXC. STRENGTHENED REQUIREMENT THAT LTAU INDICATED AIR VOLUME NOT TO BE ADJUSTED BASED UPON FIELD MEASUREMENTS (ART. 3.2). D. KARLE PER HVAC MTT.

JUNE 2016: DO NOT USE THIS SPECIFICATION WITHOUT DISCUSSION WITH THE HVAC AND CONTROLS MECH TECH TEAM. SPECIFICATION REVISED FOR APPLICABILITY TO HVAC LAB CONTROLS, BUT ONLY IN LABS WITH VARIABLE AIR VOLUME FUME HOODS, INCLUDING COMBINATION SASH HOODS. ALL OTHER LABS ARE INCLUDED IN SCOPE OF MS230900. REFER TO DESIGN GUIDELINE 230030 FOR ADDITIONAL GUIDANCE. D. APPEL

SEPT 2016: IMPROVED WORDING IN "SUMMARY", IMPROVED WORDING IN "DIVISION OF WORK" REGARDING WHERE THIS SPEC APPLIES, I.E. ALL LABS CONTAINING VAV OR COMBO SASH HOODS. PER HVAC MTT. D. KARLE

SECTION 230910 - VAV/COMBINATION SASH FUME HOOD LABORATORY CONTROLS-DDC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

INCLUDE PARAGRAPH 1.1.A AND B IN EVERY SPECIFICATION SECTION. EDIT RELATED SECTIONS 1.1.B TO MAKE IT PROJECT SPECIFIC.

A. Drawings and general provisions of the Contract, Standard General and Supplementary General Conditions, Division 01 Specification Sections, and other applicable Specification Sections, in particular the Related Sections listed below, apply to this Section.

CAREFULLY VERIFY, EDIT AND COORDINATE RELATED SECTIONS.

B. Related Sections:

1. Section 115313: Laboratory Chemical Fume Hoods
2. Section 233300: Air Duct Accessories and RGDs
3. Section 230900: Mechanical Systems Controls
4. Section 230593: Testing, Adjusting, and Balancing (TAB)
5. Division 26: Electrical

1.2 SUMMARY

A. Section Includes:

1. Controls and terminal airflow units for laboratories that contain variable air volume (VAV) and combination sash fume hoods, including controls for Laboratory Terminal Airflow Units (LTAUs), fume hoods, reheat coils, chilled beams, fin tube, and other devices to control laboratory (or other specialized spaces) pressurization, temperature, and other functions as indicated.
2. Reheat coils and sound attenuators for LTAUs.
3. Laboratory Control system interface with Owner's Building Automation System.

1.3 REFERENCES

A. Abbreviations, Acronyms, Definitions (partial list)

1. BAS: Owner's Siemens Apogee brand Building Automation System.
2. Owner: The University of Michigan.
3. Laboratory: For the purposes of this specification, a broad designation for any space served by laboratory controls.

1.4 DIVISION OF WORK

IMPORTANT: DESIGNER SHALL CLEARLY DELINEATE ON THE PROJECT DRAWINGS WHICH SPACES ARE TO BE SERVED BY 230910 "VAV/COMBINATION SASH FUME HOOD LABORATORY CONTROLS-DDC" (I.E. THIS SPECIFICATION) VERSUS 230900 "MECHANICAL SYSTEMS CONTROLS". MAKE A CLEAR DELINEATION ON THE CONTROL DRAWINGS. NORMALLY, LAB

MECHANICAL CONTROL OF ANY SPACE NOT UTILIZING VAV FUME HOODS ARE INCLUDED IN THE SCOPE OF 230900, INCLUDING ANIMAL ROOMS.

A. The VAV fume hood Laboratory Controls Contractor (LCC) shall provide a complete lab control system as described in this specification.

1. Any space containing VAV or combination sash fume hoods shall be provided with the laboratory controls and terminal devices specified in this specification section.
2. All items specified shall be provided by the LCC, including items specified in Related Sections, except where explicitly indicated otherwise.
3. The LCC shall be an installer authorized by the laboratory controls manufacturer.
4. Provide supervision and instruction to insure proper installation of all furnished laboratory control components.

B. The LCC shall furnish LTAUs, LTAU sound attenuators, and LTAU reheat coils to the mechanical contractor. The mechanical contractor shall install in the duct work.

C. The mechanical contractor shall provide duct transitions to connect to LTAUs/LTAU reheat coils, and all other components not specified in this specification section.

1.5 COORDINATION

A. Provide controls and control wiring compatible with equipment provided by others and with existing equipment and controls.

B. Coordinate the installation of controls with the installation of other project equipment.

C. Ensure all control components are located and installed correctly so that the specified and intended performance and the sequence of operation is achieved, including components supplied and/or installed by others.

D. Coordinate with laboratory equipment suppliers (fume hoods, etc.) regarding cut-out dimensions for alarm monitors and to assure proper accommodation is made for the installation of sash sensors and other devices related to laboratory airflow controls.

1.6 ITEMIZED QUOTATION

A. The Laboratory Controls Contractor shall submit with bid, an itemized cost breakdown listing all major components, labor cost (including subcontractor labor and material cost), and engineering costs, for base bid and for each alternate, for the entire work scope of the Laboratory Controls. When requested, provide the itemized breakdown to the Owner post bid, for review and approval.

1.7 SUBMITTALS

A. Submit the following for approval:

1. A separate schematic drawing and wiring diagram for each laboratory room or zone, with sequence of operation. Indicate all set points and alarm settings.

2. Equipment schedule for each room or zone, with the following information:
   a. Equipment tag, room served, occupied/unoccupied min., max., and offset CFM; lab subnet description, name, and network address; network and power trunk identifier.
   b. Model number of each LTAU and control component.
   c. Function of each LTAU and control component.
3. Equipment data sheets indicating performance, wiring diagram, dimensions, weights, required clearances, component locations, and location and size of each field connection.
   a. Data sheets shall be organized behind sheet tabs. Each sheet tab shall indicate the category or component name (i.e. LTAUs, control valves, sensors, etc.)
4. Accuracy certificate, certified by an officer of the company, indicating that LTAU control error will not exceed +/- 5% of flow set point, over the manufacturer’s cataloged volumetric operating range of the LTAU.
5. Ductwork connection types and sizes.
6. Network diagram indicating routers, servers, and peripheral devices, including location of each device (room number) and indicating network connection points to Owner's BAS system.
7. Wiring diagrams for each network device.
8. Wiring diagrams and locations of power supplies.
9. Conduit and wire/cable data sheets.
10. Octave band and A-weighted sound power data for each LTAU, with and without sound attenuators.
11. Installation, operation, and maintenance instructions for each component. Include calibration method, calibration tolerance, inspection period, and cleaning method.

1.8 CLOSE-OUT SUBMITTALS

A. Submit the following as a condition of final payment:

1. As-built schematic drawings and wiring diagrams. Indicate set points, settings and adjustments of all components.
2. Calibration certificate, signed by an officer of the company, indicating that each LTAU was factory calibrated at a minimum of 48 points and that the factory determined calibration data was loaded into the LTAU’s respective controller. Indicate if calibration data was loaded into the LTAU controller at the factory or in the field.

1.9 DELIVERY, STORAGE AND HANDLING

A. Mark each LTAU before factory shipment with a unique identifier corresponding to the LTAU drawing schedule.

B. Shipping and storage protection shall be provided by manufacturer to insure that the interior and exterior of components are completely protected from damage, dirt or weather. Components shall be continuously covered with plastic or other durable means, until just prior to installation. Maintain protection after installation to protect against on-going construction activities.

1.10 QUALITY ASSURANCE

A. Manufacturers and Products: The products and manufacturers specified in this Section establish the standard of quality for the Work. Subject to compliance with all requirements, provide specified products from the manufacturers named in Part 2.

B. Reference Standards: Products in this section shall be built, tested, and installed in compliance with the specified quality assurance standards; latest editions unless noted otherwise.

1. AMCA 610 Laboratory Method of Testing Airflow Measurement Stations for Performance Ratings.
2. AHRI Standard 410 "Forced-Circulation Air-Cooling and Air-Heating Coils.
3. AHRI 880 Performance Rating of Air Terminals.
4. NFPA 70 National Electric Code.
5. NFPA 90A Installation of Air-Conditioning and Ventilating Systems.
6. ASTM C916 Standard Specification for Adhesives for Duct Thermal Insulation.
7. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
8. UL 916 Energy Management Equipment
9. Components shall be Underwriters Laboratories (UL) or Intertek (ETL) listed.

1.11 WARRANTY

A. Provide a complete parts and labor warranty for a minimum of 3 years from the date of Substantial Completion.

B. Provide 24 hour per day service during the warranty period, with a maximum response time from when service is requested of 24 hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Laboratory Controls Manufacturers:

1. Phoenix Controls
2. Siemens (Direct Digital Control venturi valve solution)

2.2 GENERAL

A. Provide a complete laboratory control system for any space containing VAV or combination sash fume hoods. This shall include all devices specified in this section and programming, controllers, software; temperature, pressure, and other sensors/transmitters; control valves; control, network, and power wiring; routers, servers, and all other devices required for a complete system.

1. Laboratory control system shall be Direct Digital Control (DDC) type.
2. Laboratory control system shall function to achieve the sequences of operation detailed on the drawings.

3. Each laboratory shall have a dedicated laboratory control system. Laboratory control systems shall be independent and stand-alone from the Owner's BAS. Failures of the BAS system or network communications between the BAS and the Laboratory control system (cut communication cables, router or server failures, etc.) shall have no impact on individual laboratory control.
4. The laboratory control system shall perform the following control functions:
    a. Lab Pressurization Control: Control supply and auxiliary exhaust LTAUs at a volumetric offset to maintain lab pressurization positive, negative, or neutral. Controller shall maintain a constant offset (adjustable) between the sum of the room's total exhaust and the make-up/supply air volumes. This offset shall represent the volume of air that will transfer to or from the corridor or other adjacent rooms. Pressurization control shall consider networked devices, non-networked devices, and any number of constant volume devices.
    b. Lab Temperature Control: Regulate lab space temperature through a combination of supply air volumetric control and control of reheat coils and other auxiliary temperature control devices, in response to temperature sensor(s).
    c. Occupancy Control: Reset LTAU minimum volume settings and/or temperature control set points, based upon external signals from occupancy detectors, local over-ride buttons, and similar devices.
    d. Constant Volume Control: The LTAU shall maintain a constant airflow set point.
    e. Fume Hood Control: Control the face velocity of fume hoods indicated to be variable air volume (VAV) type.
    f. Fume Hood Monitoring: Alarm various conditions at each fume hood.
    g. Other lab control functions as indicated on the drawings.
    h. Interface with the Owner’s Siemens Apogee PPCL Building Automation System.
5. Input power requirements for laboratory control devices shall not exceed 120 VAC.
6. Each lab room shall include a labeled Room Differential Pressure Indicating Gauge to indicate room pressurization relative to the adjacent room or corridor. Provide an engraved POS/NEG label (with 3/8” high lettering) adjacent to the gauge labeled “Correct Room Pressure Offset: X, where X = “POS” (positive) or “NEG” (negative) as indicated by the room volumetric offset indicated on the design documents.

2.3 LABORATORY TERMINAL AIRFLOW UNITS

A. The laboratory terminal airflow unit shall be of venturi control type utilizing a cone shaped element. The position of the valve cone assembly shall be factory characterized to determine a position versus air flow volume relationship. Air flow control shall be achieved by moving the valve cone assembly to the factory characterized position that provides the required air volume. Air flow control shall not be achieved by air flow measurement. However, air flow measurement shall be permitted at inlet velocities 350 fpm and greater, for fine tuning valve cone assembly position after movement to the factory characterized position. Control shall be pressure independent, accomplished by the cone/spring element continuously adjusting position relative to the venturi orifice to compensate for duct pressure fluctuations.

B. Provide LTAUs of the diameter and volumetric range indicated on the drawings. Provide larger, smaller, fewer, or additional valves versus that indicated when necessary to match the volumetric range specified on the drawings (this may be necessary when providing valves from a mfr. other than the design basis).

 1. Include all required costs to adjust duct layout and provide any required transition fittings or additional duct necessary to accommodate the particular valves provided.

C. LTAUs shall have an equal percentage flow characteristic to provide stable control at low flow values. Butterfly, opposed blade, or parallel blade style dampers or VAV boxes are not acceptable

D. LTAUs shall provide pressure independent air flow control and the scheduled air flows over a pressure range of 0.3" WG to 3.0" WG static pressure drop across the valve. LTAU shall respond within 1 second of a change in duct static pressure/flow change under all conditions.

E. Total LTAU control error (including the combined effects of nonlinearity, hysteresis, repeatability, temperature and drift over a one year period) shall not exceed +/- 5% of flow set point. Example: If the LTAU's current flow set point is 1000 CFM, the volume of air delivered by the LTAU shall be within +/- 50 CFM of that set point. This error shall not be exceeded regardless of duct inlet or exit configurations, over the entire manufacturer’s cataloged volumetric operating range of the LTAU, and at any pressure drop across the LTAU from 0.3" WG to 3.0" WG static pressure.

 1. Systems using air flow sensors (Siemens):
  a. The +/- 5% control error specified above shall be achieved when one straight equivalent duct diameter is provided upstream of the inlet to the LTAU, regardless of LTAU exit conditions.
  b. Provide minimum one straight equivalent duct diameter upstream of the inlet to the LTAU. Transitions connecting to the inlet or outlet of the LTAU and associated reheat coils shall not exceed 30 degrees.
  c. Airflow sensors shall be constructed of corrosion proof material for room supply, return, and general exhaust air. Construct of 316L stainless steel (parts exposed to exhaust air) for all other exhaust applications.

F. Every LTAU shall be factory calibrated across the manufacturer’s cataloged volumetric flow range using NIST traceable air flow stations and instrumentation with a combined accuracy of +/- 1 percent of signal over the entire range of measurement. Air flow shall be verified to be within an accuracy of +/- 5 percent of signal at a minimum of 48 different air flows. LTAU air flow shall be calibrated with 0.6” of static pressure across the LTAU. The resulting factory determined calibration data shall be loaded into the LTAU’s respective controller, at the factory or in the field during installation. Provide factory calibration certificate for each valve, certified by an officer of the manufacturer.

G. LTAUs shall be constructed of minimum 16 gauge aluminum. Shaft and shaft support brackets shall be 316 stainless steel. Pivot arm and internal linkage shall be aluminum or stainless steel. Springs shall be spring-grade stainless steel. Shaft bearing surfaces shall be made of Teflon, polyester, or polyphenylene sulfide composite.

NOTE BELOW PARAGRAPH. IF LTAUS OTHER THAN FUME HOOD LTAUS (EXAMPLE: SNORKELS HANDLING CORROSIVE CHEMICALS) NEED CORROSION PROTECTION, BE SURE TO INDICATE THAT FACT ON THE DRAWINGS. NOTE THAT LTAUS SHOULD NOT BE USED ON THE EXHAUST OF CAGE AND RACK WASH EQUIPMENT BECAUSE EVEN LTAUS WITH ENHANCED COATING SYSTEMS HAVE NOT PROVEN TO HOLD UP TO THE CORROSIVE EFFECTS OF THE EXHAUST FROM THESE DEVICES. RATHER, CAGE OR RACK WASHERS SHOULD BE EXHAUSTED BY DEDICATED EXHAUST FAN(S).

1. Additional construction requirements for LTAUs connected to fume hood exhaust or where indicated on drawings:
   a. Coat LTAU with minimum 5.0 mil dry film thickness Heresite P403 coating material, applied and baked per coating manufacturer's recommendations.
   b. Shaft, pivot arm and linkage, and other internal metal parts (nuts, bolts, rivets, etc.) shall be stainless steel.
   c. Shaft shall be Teflon coated.
   d. Shaft bearing surfaces shall be made of Teflon or polyphenylene sulfide composite.

IF LOW LEAKAGE CONSTRUCTION IS REQUIRED, THE DESIGNER MUST SPECIFY THE MAXIMUM LEAK RATE PERMITTED FOR CASING LEAKAGE AND SHUT-OFF LEAKAGE. CONSULT MFR.'S CATALOGS TO DETERMINE AVAILABLE LEAKAGE PERFORMANCE OPTIONS.

H. Low Leakage Construction

1. Provide where indicated.
2. Provide low leak seal materials compatible with the severity of service indicated by the particular valve coating that has been specified.

I. Supply air LTAUs shall come factory insulated with minimum 3/8" thick flexible closed cell polyethylene insulation with a flame/smoke rating not to exceed 25/50, K value not to exceed 0.270 btu-in/hr-ft^2-°F @ 75°F mean temperature, and a permeability maximum of 0.08 Dry Cup. Perm-In. Rubatex Therma-Cel, AP/Armaflex, or equivalent. Insulation shall be installed per insulation mfr. recommendations using mfr. recommended adhesives and joint vapor barrier sealants.

DESIGNER SHALL PROVIDE PERFORMANCE DATA FOR THE SOUND ATTENUATORS ON THE DRAWINGS. DESIGNER MUST SPECIFICALLY INDICATE WHERE ATTENUATORS ARE REQUIRED. DESIGNER SHALL REVISE SPEC SECTION REFERENCE BELOW, IF REQUIRED.

2.4 LABORATORY TERMINAL AIRFLOW UNIT SOUND ATTENUATOR

A. Furnish sound attenuators only when specifically indicated.

B. Attenuator shall be properly matched to each individual LTAU to meet the sound performance scheduled. Provide stainless steel packless type attenuators for all fume hood and "wet" exhaust applications.

C. Attenuator pressure drop shall not exceed 0.20 in. w.c. at the LTAUs maximum rated flow, unless indicated otherwise on drawings.

D. Refer to Related Section "Sheet Metal Accessories" for additional attenuator specifications.

2.5 LTAU/LAB CONTROL

A. The control devices (controllers) shall be microprocessor-based DDC type and shall linearly regulate airflow based on digital control signals. The device shall generate a digital feedback signal that represents its airflow.

B. Laboratory controls shall be segregated into subnets at a lab room level. Provide commercially available routers to isolate each subnet from BAS communications, when required. All control points including all subnet points (both inputs and outputs) shall be available to the BAS for monitoring and trending. Laboratory control performance shall be unaffected by the quantity of points being monitored, processed, or controlled.

1. Phoenix Controls: All control shall be LONWORKS® based. BACnet protocol is not acceptable.

C. Speed of Response:

1. Labs with VAV fume hoods or where indicated:
   a. Speed of response shall be less than 1 second. High speed electronic actuators shall be provided.
      1) Phoenix Controls Accel II Venturi Valves/Celeris
      2) Siemens venturi style air valves with high speed actuators

D. The control devices shall store control algorithms in non-volatile, re-writeable memory. The device shall be able to stand-alone or be networked with other room-level digital airflow control devices using an industry standard protocol.

E. Room-level control functions shall be embedded in and carried out by the controllers using peer-to-peer distributed control architecture. Critical control functions shall be implemented locally.

F. The control devices shall use industry standard 24 VAC power.

G. It shall be possible to connect a notebook PC commissioning tool at each lab room and every point associated with that room’s control shall be accessible from that connection point.

H. The control devices shall have built-in integral input/output connections ("points") that address all network and non-network sensors switches and control devices indicated on the drawings and as necessary to accomplish the required sequence of operation. Unless explicitly indicated otherwise in the sequence of operation, every device controlled shall be controlled by an output dedicated to that device. For example, multiple actuators **shall not** be controlled by the same 0 to 10 Vdc or 4 to 20 mA output. At a minimum, the airflow controller shall have:

1. Three universal inputs capable of accepting 0 to 10 Vdc, 4 to 20 mA, 0 to 65 K ohms, or Type 2 or Type 3 10 K ohm @ 25 degree C thermistor temperature sensors.
2. One digital input capable of accepting a dry contact or logic level signal input.
3. Two analog outputs capable of developing either a 0 to 10 Vdc or 4 to 20 mA linear control signal.
4. One Form C (SPDT) relay output capable of driving up to 1 A @ 24 VAC/VDC.

I. Provide any other devices necessary to accomplish the intended sequence of operation.

J. Control devices shall meet FCC Part 15 Subpart J Class A and be UL 916 listed.

K. Actuators

HIGH SPEED ELECTRONIC ACTUATORS CAN BE SET FAIL LAST POSITION AS WELL AS FAIL OPEN OR FAIL CLOSED.

1. High Speed Electronic:
   a. UL 916 listed high-speed electronic actuator with an actuator stroke speed of 1 second or less when positioning the valve to respond to a flow change of 5:1. Factory mounted to the valve. Loss of main power shall cause the valve to position itself in a failsafe state. This position shall be maintained constantly without external influence, regardless of external conditions on the valve (within product specifications). Failsafe states shall be as indicated on drawings. Where not indicated, supply LTAUs shall fail normally closed-minimum position, exhaust LTAUs shall fail normally open-maximum position.

2.6 VAV FUME HOOD CONTROL

A. The fume hood controller shall use a sash position sensor to measure sash opening to proportionally control the hood's exhaust airflow. Controller shall maintain an "average" constant face velocity to +/- 5% tolerance, over a minimum range of 20% to 100% of sash travel.

B. The hood exhaust airflow control device shall respond to a change in sash position by reaching 90% of the final commanded position within one (1) second of the sash reaching 90% of its final position, with no more than a 5% overshoot or undershoot, and with no noticeable oscillation. This shall be accomplished at any sash movement rate up to 1-1/2 feet per second.

C. The fume hood monitor shall receive sash position signals from sash sensors. The monitor shall compute the total open sash area and then output an exhaust airflow control command signal to the appropriate exhaust airflow control device (LTAU).

1. A vertical sash position sensor shall be employed to measure the height of each vertically moving fume hood sash. The vertical sash sensor shall consist of a precision 10-turn potentiometer mechanically coupled to a constant tension spring reel. Resolution shall be +/- 1/2 inch or better. A stainless steel, burr and snag-free cable shall be attached to the spring reel. Expected lifetime based on manufacturer's tests shall be over 200,000 full height sash movements. Sash sensor shall be installed in a location on the fume hood easily accessible for service.
2. A horizontal sash position sensor shall be provided for each horizontal sash. The horizontal sash sensor shall consist of magnetic bars or a sensor strip/actuator block. Resolution shall be +/- 1/2 inch or better.
3. Provide both vertical and horizontal sash position sensors for hoods with combination sashes.

2.7 FUME HOOD MONITORS

CONSIDER IF OTHER LABORATORY EQUIPMENT WOULD BENEFIT FROM BEING EQUIPPED WITH A FUME HOOD MONITOR AND INDICATE THAT EQUIPMENT ACCORDINGLY. EXAMPLES: EXISTING FUME HOODS, BIO-SAFETY CABINETS.

A. Provide fume hood monitors for all chemical fume hoods and for other laboratory equipment where indicated.

1. Monitor shall include audible alarm, visual LED alarm, and a common (single) alarm silence button.
2. The fume hood monitor shall provide an alarm indication for the following conditions:
   a. Low fume hood face velocity as detected by:
      1) Insufficient differential static pressure as detected by the exhaust airflow LTAU pressure switch (Phoenix).
      2) Insufficient air volume, as detected by the air flow station (Siemens).
      3) Sash raised above sash stop position.
      4) Signal loss between the exhaust airflow LTAU and the fume hood monitor (VAV hoods only).
   b. When an alarm condition is detected, audible and visual alarm indicators shall activate. Pushing the alarm silence button shall mute the alarm for an adjustable time delay, initially set at 10 minutes. Alarm shall re-sound after the time delay, until alarm condition clears. Visual alarm shall remain lit until alarm conditions clears.
3. Sash position shall be sensed by using a vertical sash position sensor. Vertical sash position sensor shall be as specified under the article "VAV Fume Hood Control".
4. Fume hood monitor shall be suitable for surface mounting on the front of the fume hood.
5. Approved fume hood monitors:
   a. Phoenix FHM430 Controller (Variable volume fume hoods)

b. Siemens

2.8 SENSORS/TRANSMITTERS

A. Except as noted below, sensors and transmitters shall comply with the requirements of Related Section "Mechanical Systems Controls", including approved manufacturers.

1. Room temperature sensors (RTS) shall have a digital temperature display, high accuracy temperature set point slide, and a minimum temperature range of 55-95°F. 10K Type 2 thermistor, inaccuracy of ±0.5°F or less between 55-95°F. Provide with integral communications jack.
   a. Approved manufacturers: Phoenix, Siemens
   b. Provide combination room temperature/humidity sensors where indicated.
      1) Features: same as RTS.
      2) Temperature: Thermistor, same as RTS.
      3) Humidity transmitter: 4-20 mA output, inaccuracy ±2% or less between 15%-95% RH at 25°C.
         a) Approved manufacturer: Phoenix.

2.9 CONTROL VALVES

A. Control valves shall comply with the requirements of Related Section "Mechanical Systems Controls", including approved manufacturers.

1. Unless noted otherwise, control valves for reheat coils, cooling coils, chilled beams, fin tube radiation, and other terminal devices shall utilize 3-position floating point electronic actuators as specified for "TECs" in Related Section Mechanical Systems Controls.
   a. Fail-last-position: Reheat and cooling coils; chilled beams.
   b. Fail open (maximum heat): Fin tube.
   c. Fail closed (zero heat): Reheat coils serving animal rooms or ventilated cage racks.

2.10 ROOM DIFFERENTIAL PRESSURE INDICATING GAUGES

A. Dial (4" dia.) in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, scale -0.25" WC to +0.25" WC, suitable for surface or flush mounting. Accuracy +/-2% of full scale. With plastic gauge mounting plate for flush mounting and space pressure sensor consisting of pressure port, barbed tubing connection, and sensor plastic mounting plate suitable for mounting on a standard electrical junction box.

B. Approved Manufacturers:

1. Dwyer “Magnehelic” with A-465 pressure sensor and A-464 flush mounting plate (provide A-368 mounting bracket for surface mount applications)

2.11 MISCELLANEOUS COMPONENTS

A. Except as specified in this section, laboratory controls shall be provided in compliance with the requirements of Related Section "Mechanical Systems Controls", including approved manufacturers.

2.12 POWER SUPPLIES

A. Provide all necessary power supplies/control transformers, power distribution wiring, etc. for a complete operating system. This includes but is not limited to power supplies for lab airflow controls, sensors/transmitters, control valves, and network devices such as routers and servers.

BELOW PARAGRAPH INDICATES THAT POWER SUPPLIES SHOULD BE INSTALLED ABOVE DOORS TO LABS. DESIGNATE THE LOCATION OF THIS EQUIPMENT ON THE DRAWINGS. WORK WITH ELECTRICAL ENGINEER TO DESIGNATE THE RECEPTACLE PANEL CIRCUITS TO FEED LAB CONTROL POWER SUPPLIES. DEPENDING ON LOAD, MULTIPLE POWER SUPPLIES MAY BE FED FROM A SINGLE 120 VAC CIRCUIT.

B. Install power supplies secured to a wall and mounted above the doors to labs, unless indicated otherwise. Utilize receptacle panel circuits designated for powering lab control power supplies.

C. Provide power supplies for lab airflow controls in NEMA 1 metal enclosures, adequately ventilated to prevent overheating of the equipment, with exterior labeled "Laboratory Airflow Controls Power Supply", and listing the room numbers served. Maximum cabinet projection from wall shall be 8 inches. Label each secondary circuit inside the cabinet with the room number(s) served.

1. Control transformers shall be rated NEC Class 2 and shall meet all the requirements and recommendations of the laboratory airflow controls manufacturer.
2. No more than five pressurization zones shall be served from a single control transformer. No control transformer shall exceed 500 VA.
3. Each pressurization zone shall be powered by a dedicated (isolated) secondary circuit. Each secondary circuit shall include a disconnect switch, "power on" indicator, and be current limited with a slow blow fuse or circuit breaker.
4. Provide a disconnect switch, with shielded terminations, for line side power (one per control transformer). Locate inside the power supply enclosure.

D. Provide network power supplies of type and size recommended by lab control manufacturer.

THE UPS SHOULD BE CONNECTED TO A STANDBY POWER CIRCUIT (EMERGENCY GENERATOR) WHEN STANDBY POWER IS AVAILABLE IN THE BUILDING. COORDINATE WITH ELECTRICAL ENGINEER.

E. Provide an uninterruptible power supply (UPS) for any server provided to allow communication to the BAS system.

1. Provide a UPS large enough to operate the server for a minimum of 5 minutes upon a loss of normal power.

2.13 INTERFACE TO BUILDING AUTOMATION SYSTEM

A. The laboratory control system network shall digitally interface with the BAS system. The interface to the BAS shall be BACnet over IP/Ethernet communications protocol.

B. Every room-level point shall be available to the BAS for monitoring, trending and control, both inputs and outputs. The laboratory controls system shall maintain a cache of all points to be monitored by the BAS. The room-level airflow control devices shall update this cache continually.

C. Provide all equipment, including but not limited to routers, servers, software interface drivers, and network interface cards to allow communication between the laboratory airflow controls and the BAS.

DESIGNER MUST INDICATE ON THE DRAWINGS, THE QUANTITY OF FIELD LEVEL NETWORKS CONNECTING LAB CONTROLS TO THE U-M BAS, AND THE LOCATIONS WHERE THE NETWORKS CONNECT TO U-M BAS. TYPICALLY THIS WILL BE AT A DATA CLOSET OR AT BUILDING DDC PANELS. CONTACT THE U-M DESIGN MANAGER, WHO WILL OBTAIN A NETWORK RISER DIAGRAM FROM U-M PLANT DEPARTMENT FOR DESIGNER'S USE.

1. The LCC is responsible for providing the entire network up to and including final network connection to Owner's BAS via connection to an Ethernet switch at a building direct digital controller or data closet location(s), as indicated on the drawings.
2. Provide servers and routers specifically designed for the laboratory controls network and recommended by the laboratory control manufacturer.

THE NEXT PARAGRAPH SPECIFIES A "RMI (ROOM INTEGRATOR)" FOR PHOENIX AND A “PXC” SERVER FOR SIEMENS, WHICH ARE REQUIRED TO PROVIDE BACNET OVER IP/ETHERNET COMMUNICATION FOR CONNECTION TO U-M’S BAS SYSTEM. FOR RENOVATIONS, A MACROSERVER OR PXC MAY ALREADY EXIST THAT CAN BE UTILIZED FOR THE PROJECT. CONSULT WITH U-M PLANT ENGINEERING THROUGH THE DESIGN MANAGER TO DETERMINE, THEN EDIT THE NEXT PARAGRAPHS ACCORDINGLY.

a. Phoenix Controls Server: Provide Phoenix Controls RMI Room Integrator.
b. Siemens Server: Siemens model PXC100-E96.A BACnet IP controller with a PXC expansion module.
   1) Mount in a NEMA Type 1 metal control panel enclosure with removable door, right or left hand hinged, locking, with perforated subpanel, keyed to match other U-M control panels. Minimum size 19-1/2” x 16-3/8” x 5-3/4” deep. Provide 120 VAC service box, disconnect, power supply, UPS, and bus connection module. All components shall be in compliance with related articles of this specification.

BELOW PARAGRAPH INDICATES THAT NETWORK DEVICES SHOULD BE INSTALLED ABOVE LAB DOORS AND IN ELECTRICAL CLOSETS. DESIGNATE THE LOCATION OF THIS EQUIPMENT ON THE DRAWINGS. LAB CONTROL NETWORK EQUIPMENT SHOULD NOT BE INSTALLED IN BUILDING DATA CLOSETS DUE TO RESTRICTIONS ON THE PERSONNEL ALLOWED TO ACCESS DATA CLOSETS.

D. Install routers secured to a wall and mounted above the doors to labs, or where indicated.

1. Provide in a wall mounted metal enclosure, adequately ventilated to prevent overheating of the equipment, and separate from lab control power supply cabinets.
   a. Routers may be mounted in lab control power supply cabinets.
   b. Maximum cabinet projection from wall shall be 8 inches.

E. Install servers and server UPS in building electrical closets, or where indicated.

F. Label router and server cabinets "VAV Fume Hood Laboratory Controls Network" and with router/server tag number.

G. Provide communication cable types, connectors, termination devices, and other accessories recommended specifically for the lab control networks by the lab control manufacturer.

H. The Owner shall configure any BAS alarms, trending, or control commands at the BAS; LCC shall assist in trouble shooting the creation of such items for a period of one year after the final acceptance of the lab control system.

2.14 MISCELLANEOUS ELECTRICAL

A. Provide all wiring in conduit and J-hooks per Related Section Mechanical Systems Controls, except as noted below:

1. Wiring between occupancy sensors and lab controls shall be run in conduit at all locations.
2. J-hooks shall be painted bright white color.
3. Conduit fittings and junction box covers shall be painted bright white. Alternative: Allied Tube True Color® EMT, color white, may be used in lieu of painted fittings and junction boxes.

B. Provide 120 VAC wiring from receptacle panels to power supplies and to any other equipment associated with the laboratory airflow controls.

C. All electrical work shall conform to Related Sections Division 26 and Mechanical Systems Controls. Maintain all NEC clearances.

2.15 REHEAT COILS

A. Acceptable Manufacturers:

1. Trane, a business of Ingersoll Rand.
2. York by Johnson Controls.
3. McQuay International.
4. Aerofin.
5. Marlo DRS Technologies, Inc.
6. Coil Replacement Co.
7. Heatcraft Worldwide Refrigeration.
8. USA Coil & Air.

B. Provide coils factory-mounted to the LTAU, with capacities and characteristics as scheduled on the Drawings. Provide slip and drive or flanged connections to allow removal and reversal of coils in field.

C. Coils: Maximum of 10 fins per inch, minimum 2 rows, same side supply and return piping connections, enclosed in a sheet metal casing to match the size of the attached terminal airflow unit.

D. Coil Header and Connection Materials: Seamless copper with extruded tube holes to permit expansion and contraction without creating undue stress or strain. Copper connections.

E. Rated for 200 psi working pressure, 250 deg. F, with 3/8 inch copper tubing, minimum wall thickness of 0.016 inch, and mechanically bonded aluminum fins, 1/2 inch or larger solder connectors, and manual air vent on return. Hydrostatically test coils at 250 psi, or at 250 psi air pressure under water. Maximum pressure drop at design flow shall not exceed 10 feet or as scheduled. Hot water shall be equally distributed through all tubes by means of orifices or a header design.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all components in strict compliance with component manufacturers' recommendations.

DESIGNER SHALL LAY OUT SHEET METAL DUCTWORK TO PROVIDE ONE STRAIGHT EQUIVALENT DUCT DIAMETER UPSTREAM OF THE INLET TO ALL LTAUS (REGARDLESS OF BASIS OF DESIGN MFR.).

B. Systems using air flow sensors (Siemens):

1. Provide one straight equivalent duct diameter upstream of the inlet to the LTAU. Transitions connecting to the inlet or outlet of the LTAU and associated reheat coils shall not exceed 30 degrees.

C. Install fume hood monitors surface mounted on the front of the fume hood. Furnish exact cut-out dimensions to the fume hood factory to allow for concealed wiring to the monitor.

D. Install the sash position sensors and sash travel limit brackets in a neat and workmanlike manner. Install cables and wires in a manner which avoids contact by the user during normal fume hood use, and allows horizontal and vertical sashes to be positioned in any combination without binding, twisting or tangling.

E. Terminate wiring at all devices.

F. No material shall be exposed if it is possible to conceal it. Exposed materials shall be installed only with consent of the Owner.

G. Installation shall also comply with Related Sections Mechanical Systems Controls and Division 26.

H. Install components so that they are easily accessible for service and in conformance with NEC clearance requirements.

DESIGNER: NOTE THE PARAGRAPH BELOW AND INCLUDE U-M STANDARD DETAIL "SUPPLY AIR LTAU CLEARANCE" ON THE DESIGN DRAWINGS.

I. Install LTAUs with proper NEC clearances at LTAU mounted controls, including at actuators.

3.2 SYSTEM START-UP

A. Program, start-up, calibrate, and test all laboratory controls.

B. Program, start-up, and test integration to the BAS system.

C. Adjust LTAU air volume to provide hood face velocity to within +/- 5% of required setpoint. Operate the lab controls to assist the TAB Contractor in verifying that correct airflow rates and alarm settings are within +/- 5% tolerance.

1. All adjustments to the LTAUs shall be done by the LCC, not the TAB contractor.
2. TAB contractor shall take flow readings to verify that the air flow volumetric flow rate indicated by the LTAU matches the measured air flow volume, and to assist in setting alarms. Assist the TAB contractor in verifying measured LTAU air flow against that reported by the LTAU controller, at design minimum and maximum CFM.
3. LTAU air flow shall not be adjusted based on field air flow measurements. If LTAU air flow verification indicates calibration is not within +/- 5% tolerance, do not field adjust. Notify Owner and return to factory for recalibration.

D. Unless indicated otherwise, set controls to maintain hood face velocities as follows:

1. VAV Hoods
   a. To maintain 100 fpm (standard hoods) and 70 FPM (Reduced Face Velocity Hoods) for the entire sash travel, for all vertical and horizontal sash positions. Note: The LTAU’s capacity may be insufficient to maintain the required air flow velocity through the entire travel of the sash as it is raised above the sash stop. Do not “clamp” hood LTAU air flow, allow the LTAU to open as far as it can in an attempt to maintain face velocity, except limit travel to the extent necessary so that the room cannot become more negative than indicated; clamp valve if necessary to prevent room from going more negative.
      1) Hoods with Horizontal Sashes: Set controls to maintain the required face velocity with the sashes in the position that creates the maximum free area opening. Example:, If the sash has 4 horizontal sashes, the face velocity must be achieved with 2 sashes in the full open position (with the sash vertical position closed)

E. Set fume hood monitor alarms as follows:

1. Insufficient differential static pressure/air volume:
   a. Face velocity 80 FPM (standard hoods) or 60 FPM (Reduced Face Velocity Hoods.
   b. LTAU valve cone at maximum travel.
2. Sash above the sash stop position.
   a. Time delay to re-alarm after silence button pushed: 10 minutes.
   b. Alarm shall clear when sash returned to sash stop position or lower.

c. Floor mounted hoods: Alarm shall activate when any sash is above its sash stop position; time delay and alarm clear shall be same as above.

F. Set other control parameters/alarms to comply with the laboratory airflow control drawings.

3.3 COMMISSIONING

A. Perform the commissioning activities as outlined in the Division 01 Section Commissioning and other requirements of the Contract Documents.

B. Demonstrate that the laboratory controls perform per the sequence of operation and the design intent.

C. Demonstrate every fume hood monitor alarm set point.

D. Demonstrate that the laboratory control system communicates properly to the BAS system, including:

1. Every point specifically indicated on the drawings as to be monitored, logged, or controlled by the BAS.
2. For each pressure zone, a minimum of 10% of points. Specific points to be designated by the U-M Commissioning Authority (CxA).
3. If more than 20% of the demonstrated points fail to communicate correctly, demonstrate that every point on the system communicates correctly to the BAS

E. Demonstrate that UPS' support connected loads for the specified duration.

F. Perform other demonstrations as may be required by the CxA.

3.4 CLOSEOUT ACTIVITIES

A. Submit as-built documentation per article "Submittals". Obtain approval of as-built documentation prior to Owner training.

B. Provide on-site training to Owner's maintenance personnel. Familiarize personnel with location of LTAUs, controllers, system components, power supplies, and network devices. Review the control concept for each lab and room type.

END OF SECTION 230910