This Addendum is issued pursuant to the Instructions to Bidders and/or Conditions of the Contract. This Addendum serves to clarify, revise, and supersede information in the Project Manual, Drawings, and previously issued Addenda. Portions of the Addendum affecting the Contract Documents will be incorporated into the Contract by enumeration of the Addendum in the Owner/Contractor Agreement. The Bidder shall acknowledge receipt of this Addendum in the appropriate space on the Bid Form.

PART 1 - NEW DOCUMENTS ISSUED WITH THIS DOCUMENT

1.1 NEW PROJECT MANUAL DOCUMENTS AND SPECIFICATIONS

   A. 28 10 00 – Access Control Systems
      1. Section added

1.2 NEW DRAWING SHEETS

   A. None

1.3 NEW SKETCHES

   A. None

PART 2 - DOCUMENTS DELETED BY THIS DOCUMENT

2.1 DELETE THE FOLLOWING FROM THE PROJECT MANUAL

   A. None

2.2 DELETE THE FOLLOWING DRAWING SHEETS

   A. None
PART 3 - REVISED DOCUMENTS ISSUED WITH THIS DOCUMENT

3.1 REVISED PROJECT MANUAL DOCUMENTS AND SPECIFICATIONS
A. 00 02 Table of Contents GPC
B. 00 02 Table of Contents MEP
C. 12 35 53 - General Requirements for Laboratory Casework
   1. Updated approved manufacturers.
   2. Added additional information on tables used in the project.
D. 12 35 53.19 – Wood Laboratory Casework
E. 23 09 14 – Pneumatic and Electric Instrumentation and Control Devices for HVAC
   1. Added the following in part 2 – products: freezestats, low voltage electronic
      thermostats, humidistats, humidity sensors, temperature control panels and
      power supplies.
   2. Added the following in part 3 – execution: low limit thermostats (freezestats) and
      temperature control panels.
F. 23 09 15 - DDC Input / Output Summary Table
   1. Add DDC input / output summary table for existing air handling unit “AC-2”.
G. 23 09 93 - Sequence of Operation for HVAC Controls
   1. Add sequence of operation for existing air handling unit “AC-2”.

3.2 REVISED DRAWING SHEETS
A. G1.1 – Added dumpster location discussed at pre-bid walk through. Added
   clarification on number of parking permits to be determined based on availability.
B. AD2.1.1 – Added sheet note AD19 to existing WARM ROOM 4415 – “REMOVE
   FABRICATED WARM ROOM AND ALL COMPONENTS, INCLUDING WALL,
   FLOOR, CEILING PANELS AND ANY MOUNTED DEVICES.  PREP WALLS AND
   FLOOR FOR NEW CONSTRUCTION”
C. Q0.0.2: Added general casework note for finishes
D. Q1.1.0: Added a separate Owner Furnished / Contractor Installed schedule for the
   flammable storage cabinet.
E. Q1.1.1: Removed the flammable storage cabinet and placed it in the OFCI schedule
   on sheet Q1.1.0. Updated the room numbers for a number of equipment.
F. Q4.3.0: Undated the room number on the 3D view.
G. P2.4 – Removed CO2 piping scope.
H. P6.1 – Removed details 1 and 3.
I. MD2.1.1, M2.1.1
   1. Add scope of work for upgrading existing air handling unit “AC-2” from
      pneumatic to DDC controls.
J. E0.1
   1. Revised surface raceway from aluminum to steel.
K. E2.1.1
   1. Add scope of work for power connection to new DDC controls for existing air
      handling unit “AC-2”.
   2. Added keynote E214.
3. Revised keynote E203 for additional information for source feed estimating for new panelboard.

L. E5.1.1
   1. Added verbiage to provide new circuit breaker to match existing manufacturer and type in MDS2.
   2. Revised room number of MDS2 to match existing documentation.

M. T0.0 – Added access control symbols and notes.

N. T2.1.1 – Added access control card readers to 5 doors and access control equipment. Revised sheet reference in keynote 2. Added keynote 5. Added redundant fiber for microscope.

O. T5.1 – Added access control equipment and card readers to equipment schedule. Added access control riser, schedule and rough-in detail. Revised connectivity diagram to clarify fiber needs for microscope.

PART 4 - PROPOSED CHANGES IN THE WORK

4.1 None

PART 5 - CLARIFICATIONS

5.1 Working Hours, Access, Building Requirements

   A. GC will have access during building hours, access/work after hours will need to be coordinated with PM and UWPD. Will be confirmed at pre-construction meeting

   B. No special gowning or containment requirements. Will be confirmed at pre-construction meeting

   C. Access to rooms adjacent to project area (Cold Lab 4409 and Toilet 4401) will not be required during construction.

   D. Access to Exit Stairs located within project do not need to be maintained accept in emergency.

   E. Parking Permits require A90 permit at ~$15/day. Contractor to contact Transportation Services for availability. PM to work with contractor to obtain permits if available.

   F. Level 3 under project area is anticipated to be occupied and will require coordination with PM.

   G. Elevator immediately outside project area will be available for access by the contractor. This will also be in use by the building occupants. Contractor will need to protect elevator when in use and restore it to its original condition.

5.2 Owner Furnished – Owner Installed Equipment
A. OF-OI Lab Casework on Q1.1.1 will occur after substantial completion except for the flammable storage cabinet (on the revised sheet Q1.1.1 from above)

5.3 Substantial Completion

A. Provided March 2023 completion date will be deferred to the contract language “by the date set forth in Notice to Proceed”

1. With longer unexpected lead times we have had to modify our original schedules and would expect to discuss this with the chosen bidder.

   a. UW and Design team understands this constraint and will be a topic of discussion with the selected bidders, And are willing to negotiate mobilization as necessary.

5.4 Overhead MEP Support Framework

A. Overhead MEP Support Framework shown as AC3 on A8.1.1 is provided and installed by the GC as part of the architectural scope.

5.5 Bid Questions:

A. “Please provide cut section and additional information on the Lab Casework table schedule as shown on Q1.1.0 with a list description as “Movable table on glides, Adjustable Height.”

   1. Lab casework manufacturer will provide more details on the tables during the submittal process. Reference updated spec section 12 35 53.

   2. Question on the height adjustments for the tables: typically, they are adjustable from 31” to 37” and this is a manual adjustment via screws in the legs. These tables come with “glides” and these are typical for all tables labeled as “movable”. Tables that are labeled as “mobile” will include casters for moving the tables more easily. The weight capacity of a typical table is from 400-600 lbs.

B. Note E211 on E2.1.1 - overhead ceiling service panels are provided by casework manufacturer– Refer to 12 35 53

5.6 Electrical Clarifications

A. All modified and new panelboards should be evaluated in the power system study per specification 26 05 73.

B. Electrical contractor is not responsible for procuring task lighting.

C. Remote mounting the integral surge protective device on new panel L4NPH1 is acceptable if integration into the panelboard is not feasible per manufacturer.

5.7 Fire Alarm Clarifications
A. The local fire alarm NAC, AMP, and amplifier panels are from Notifier by Honeywell. The main building's fire alarm control panel in the fire command center is from Metasys by Johnson Controls.

5.8 Pollution Insurance Coverage

A. UW requires the GPC purchase a Contractors Pollution Liability (CPL) policy that has 10 years of coverage after project completion (i.e. one project specific CPL policy). We agree with the provision that pollution liability is claims-made and not occurrence coverage.
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UW-Madison Project No. **0204-2201** / UWSA Project No. **A-21-012**

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- **A201 General Conditions as modified by UWSA** GC-112
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*(Rev 12/2020)*

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PART 1 - GENERAL

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Section includes laboratory casework with supplementary items necessary to complete their installation.

Manufacturers.
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Under-counter Corrosive Storage Cabinets.
Tables.
Finishes.
Work surfaces.
Sinks.
Umbilicals / Service Drops.
Ceiling Service Panels.
Sleeves in Countertops.

Related Requirements
Section 09.22.16 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring laboratory casework and fume hood.
Section 09.65.13 "Resilient Base and Accessories" for resilient base applied to floor mounted laboratory casework and fume hood base cabinets.
Section 115.313 "Laboratory Fume Hoods."
Section 1235.53.03 "Adaptable Laboratory Casework Systems."
Section 1235.53.13 "Metal Laboratory Casework."
Section 22.10.30 "Plumbing Piping."
Section 26.05.13 "Wire and Cable."
Section 26.51.00 "Lighting."

REFERENCES
Americans with Disabilities Act (ADA).
American National Standards Institute (ANSI)
ANSI A117.1 – Accessible and Useable Buildings and Facilities
ASTM A1008 - Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
ASTM C1036 – Specification for Flat Glass.
D543 – Practice for Evaluating the Resistance of Plastics to Chemical Reagents
ASTM D570 - Water Absorption of Plastics.
ASTM D635 - Rate of Burning and/or Extent and Time of Burning of Plastics in Horizontal Position.
ASTM D638 - Tensile Properties of Plastic.
American Hardboard Association (AHA)
A135.4 – Basic Hardboard.
Business and Institutional Furniture Manufacturers Association (BIFMA).
Environmental Protection Agency (EPA).
(Environmental Protection Agency (EPA).)
Factory Mutual (FM).
PREINSTALLATION CONFERENCE

Before Work begins, conduct conference at Project site to comply with requirements of applicable Division 01 Sections.

Required Attendees:
- Owner.
- Architect.
- Contractor, including superintendent.
- Installer, including project manager and supervisor.
- Manufacturer/fabricator’s qualified technical representative.
- Installers of other construction interfaced with Work.

Minimum Agenda: Installer shall demonstrate understanding of the Work required by describing detailed procedures for preparing, installing, and cleaning the Work. Demonstration shall include, but not be limited to, following topics:
- Review Work requirements (Drawings, Specifications, and other Contract Documents).
- Review required submittals, both completed and yet to be completed.
- Review and finalize construction schedule related to Work and verify availability of materials.
- installer’s personnel, equipment, and facilities needed to make progress and avoid delays.
- Review required inspection, testing, certifying, and material usage accounting procedures.
- Review environmental conditions and procedures for coping with unfavorable conditions.
- Resolve deviations or differences between Contract Documents and the manufacturer/fabricator’s specifications.

Record discussions of conference, including decisions and agreements reached, and furnish copy of record to each party attending. If substantial disagreements exist at conclusion of conference, determine how disagreements will be resolved and set date for reconvening conference.

COORDINATION

Coordinate layout and installation of framing and reinforcements for lateral support of fume hoods, wall and tall cabinets.

Coordinate installation of fume hoods with laboratory casework and other laboratory equipment.

ACTION SUBMITTALS

Product Data: Submit manufacturer’s data for each item of laboratory furnishings and equipment. Include component dimensions, configurations, construction details, joint details, and attachments. Indicate location, size, and service requirement for each utility connection.

Shop Drawings: Include the following:
- Location of assemblies in each room to include plans, elevations, sections, and attachment details. Include roughing-in information for mechanical, plumbing, and electrical connections.
- Details of construction.
- Details of connections between units and to adjacent work.
- Indicate details for anchoring laboratory casework and fume hoods to permanent building construction including locations of blocking and other supports. Include calculations demonstrating that anchorages comply with seismic performance requirements.
- Show adjacent walls, doors, windows, other building components, laboratory casework, and other laboratory equipment. Indicate clearances from the above items.
Location and size of holes and cutouts.
Dimensional locations for rough-in of mechanical and electrical services.
Molded epoxy resin tops jointing pattern.
Include coordinated dimensions for laboratory equipment specified in other Sections.

Samples:
Submit Samples which conform to specified requirements, including construction and finishes. Samples will be retained for comparison with Work fabricated and will be returned upon completion of the Contract.
Submit the following Samples for approval:
- Casework: Metal finish, service fixture finish, and work tops.
- One full size combination drawer and cupboard base cabinet with all hardware.

Keying Schedule: Include schematic keying diagram, and index each key set to unique designations that are coordinated with the Contract Documents.

Delegated-Design Submittal: Refer to Section 013573 "Delegated Design Requirements and Procedures" for delegated design submittal procedures and requirements.
Provide delegated-design submittals for seismic restraints for laboratory casework and fume hoods.

INFORMATIONAL SUBMITTALS
Manufacturer’s Project Acceptance Document: Certification by the manufacturer that its product(s) are approved, acceptable, suitable for use in specific locations, for specific details, and for applications indicated, specified, or required, and that a warranty will be issued.
Qualification Data: For manufacturer/fabricator, installer and professional engineer.
   - For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Architects and Owners, and other information specified.
   - Architect may waive submittal of qualification data for available manufacturers listed in this Section.
Test Reports: Submit test reports verifying conformance to specified performance tests.
Field Quality Control Reports: Written report of testing and inspection required by "Field Quality Control".

CLOSEOUT SUBMITTALS
Furnish maintenance instructions and complete touchup kit for each type and color of laboratory paint finish provided.
Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged casework and fume hood finishes.
Operation & Maintenance Manuals: Provide complete written instruction manuals outlining safe operating procedures, safety guidelines, and proper maintenance procedures for equipment and fume hoods.
Warranty: Provide manufacturer's written warranty covering materials and installation (labor) stating obligations, remedies, limitations and exclusions.
Receipts: Furnish receipts for keys and other loose items.

QUALITY ASSURANCE
Single Source Responsibility: Provide casework, work surfaces, laboratory furnishings, and accessories, all furnished by a single laboratory furniture company.
Manufacturer/Fabricator Qualifications: Manufacturer/fabricator with not less than 10 years experience with successful production of products and systems similar to scope of this Project, with a record of successful in-service performance and completion of projects for a period of not less than 10 years, and with sufficient production capability, facilities, and personnel to produce required Work.
   - Modern plant with proper tools, dies, fixtures, and skilled production staff to produce high quality laboratory
casework and equipment, and shall meet the following minimum requirements:

1. 10 years or more experience in manufacture of laboratory casework and equipment of type specified.
2. 10 installations of equal or larger size and requirements.

Installer Qualifications:

Experience: Installer with not less than 10 years experience in performing specified Work similar to scope of this Project, with a record of successful in-service performance and completion of projects for a period of not less than 10 years, and with sufficient production capability, facilities, and personnel to produce required Work.

Supervision: Installer shall maintain a competent supervisor who is at Project during times specified Work is in progress, and, who is experienced in installing systems similar to type and scope required for Project.

Manufacturer/Fabricator Acceptance: Installer shall be certified, approved, licensed, or acceptable to manufacturer/fabricator to install products.

Manufacturer’s Technical Representative Qualifications: Direct employee of technical services department of manufacturer with minimum of 10 years experience in providing recommendations, observations, evaluations, and problem diagnostics. Sales representatives are not acceptable.

Mock-ups: Prior to fabrication and installation, provide a laboratory mock-up where indicated on drawings. Location may be changed to meet construction phasing with approval of Architect. Components utilized meet the requirements of the Drawings and Specifications. The purpose of the mock-up is to verify designs and confirm or modify the sequence of installation between the various trades. Approved mock-up serves as the standard of quality against which the remaining laboratory work is measured. Build mock-up to comply with the following requirements, using materials indicated for the completed Work:

Build mock-up in the location and of the size indicated or, if not indicated, as directed by Architect. Contractor shall provide structural support framework.

Provide laboratory casework and furnishings. Furnishings, such as the fume hood, must be installed, complete with fixtures and accessories, but does not need to be operational.

Provide plumbing pipe, valves, fittings, and accessories required to make connections to complete the laboratory mock-up. Fixtures and furnishings are not required to be operational, but must be installed to review and ensure proper coordination.

Provide electrical systems in conjunction with the laboratory mock-up. Power receptacles, raceway, data back boxes and conduit must be installed, but do not need to be operational. Lighting to be fully operational.

Connections to the laboratory furnishings are required, but the systems do not need to be operational.

Clean exposed faces of mock-up.

Notify Architect fourteen days in advance of the dates and times when mock-up will be installed and ready for review.

Make such changes and alterations to mock-up as may be discussed, agreed upon, and documented in writing resulting from the review. Modifications to the mock-up that are agreed upon in writing will be incorporated into the overall design of the project without change in contract sum. Obtain Architect’s acceptance of mock-up before starting fabrication.

Maintain mock-up during construction in an undisturbed condition as a standard for review of the completed Work.
Acceptance of mock-up does not constitute acceptance of deviations from the Contract Documents contained in mock-up unless such deviations are specifically noted by Contractor, submitted to Architect in writing, and accepted by Architect in writing.

Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

DELIVERY, STORAGE, AND HANDLING
Schedule delivery of casework and equipment so that spaces are sufficiently complete that material can be installed immediately following delivery.

Protect finished surfaces from soiling or damage during handling and installation. Keep covered with polyethylene film or other protective coating. Protect all work surfaces from damage throughout construction period. Do not allow standing on work surfaces during the construction period. Provide signage marked in large lettering that reads: ‘NO STANDING’.

FIELD CONDITIONS
Do not deliver or install equipment until the following conditions have been met:
Building areas requiring the installation of laboratory casework: Dry and unexposed to adverse weather conditions which may damage finished materials.
The air conditioning or heating system: On and functioning in areas of casework installation to maintain the temperature between 60 and 85 degrees Fahrenheit (16 and 30 degrees Celsius) with the relative humidity between 45 percent and 65 percent.

Field Measurements: Where products and systems are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

SEQUENCING AND SCHEDULING
All overhead mechanical, electrical and plumbing rough-in work: Complete prior to laboratory casework deliveries.

All mechanical, electrical and plumbing rough-in work required along walls and service islands, where lab furnishings are to be installed: Complete prior to delivery of materials.

Walls and partitions must be in place and finished with at least the primer coat of paint. If finish painting is to take place after lab casework and furnishings installation, protect the casework and furnishings by covering and masking prior to commencement.

All necessary wood or metal blocking must be installed within partitions prior to delivery of casework and furnishings.

Overhead soffits and ceiling grid must be in place prior to casework installation.

Overhead lighting must be installed and connected prior to casework installation.

All flooring required to be placed under lab casework and furnishings must be installed prior to material delivery.

Concrete floors must be level within 1/8 inch (3 mm) of level per 10 foot (3 m) run, nonaccumulative, when tested with a straight edge in any one direction.

Wet operations to be performed must be complete prior to material deliveries.

WARRANTY
Manufacturer’s Warranty: Furnish manufacturer’s written material and labor warranty signed by an authorized representative using manufacturer’s standard form agreeing to furnish materials and labor required to repair or replace work which exhibits material defects caused by manufacture or design and installation of product. “Defects” is defined to include but not limited to deterioration or failure to perform as required.
Warranty Period: Manufacturer shall warrant the products to be free from material and labor defects for a period of 1 year from date of operational acceptance by the Using Agency.

Date of operational acceptance shall be after factory check, test and start-up services is complete, the unit is operating in a satisfactory manner, and the equipment has been satisfactorily commissioned by the Using Agency.

The Using Agency will perform routine maintenance as described in the Manufacturers Standard Operation and Maintenance manuals during the warranty period. Using Agency performance shall in no way invalidate said warranties.

Installer’s Warranty: Furnish installer’s written workmanship warranty signed by an authorized representative using installer’s standard form agreeing to provide labor required to repair or replace work which exhibits workmanship defects. “Defects” is defined to include but not limited to deterioration or failure to perform as required.

Warranty Period: Installer shall warrant the installation to be free from workmanship Defects for a period of 1 year from date of operational acceptance by the Using Agency.

**PART 2 – PRODUCTS**

**MANUFACTURERS AND PRODUCTS**

Acceptable Manufacturers/Fabricators and Products: Subject to compliance with requirements of Contract Documents as judged by the Architect, provide product by one of manufacturers/fabricators listed. If not listed, submit as substitution according to the Conditions of the Contract and Division 01 Section “Substitution Procedures”.

- Air Master Systems Corporation.
- Kewaunee Scientific Corporation
- Bedcolab, Ltd.
- Mott Manufacturing Limited; Altus.
- Institutional Casework, Inc.

Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

Furnish and install casework, fume hoods, furnishings and equipment specified in the following sections by the same supplier.

- 123553.13 - Metal Laboratory Casework.
- 115313 – Laboratory Fume Hoods
- 123553 – General Requirements for Laboratory Casework and Fume Hoods

**PERFORMANCE REQUIREMENTS**

Contract Documents Design Intent: Drawings and Specifications indicate design intent for products and systems and do not necessarily indicate or specify total Work required and shall not be construed as an engineered design. Furnish and install all Work required for a complete installation.

Coordination of Contract Documents and Work:

- Product Variations: In the event of minor differences between products and systems of acceptable or available manufacturer/fabricators, Contractor shall notify Architect of such differences and resolve conflicts in a timely manner. Failure of Contractor to provide notification shall be construed as acceptance of conditions indicated, and changes caused by minor differences between products and Contract Documents shall be included in the Work at no additional cost to Owner.

- Allowable Adjustments: Minor dimension and profile adjustments may be made in interest of fabrication or erection methods or techniques or ability to satisfy design intent, provided design intent is maintained as determined by Architect. Proposed deviations shall include a detailed analysis of impact to adjacent
substrates or other building systems, including related design or construction cost impacts. If accepted by
Architect, deviations causing changes in materials, constructability, substrates, or conditions shall be
included in the Work at no additional cost to Owner.

Material properties indicated in this Section shall be considered as minimum properties.

CASEWORK, GENERAL
Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing
agency, and marked for intended location and application.

MATERIALS
Sheet Steel: ASTM A1008 /1008M mild steel, cold-rolled, pickled, double annealed, and free from rust, scales, deep
scratches, buckles, ragged edges, and other defects. Provide metallic furniture stock sheets.

Stainless Steel:
Type: Unless otherwise noted on Drawings or elsewhere in this Section, provide Type 304; ASTM
Specification Number A240/240M; stainless steel for tops, sinks, umbilical collar, shelves, and casework;
gage as indicated on Drawings.

Finish: Exposed surfaces ground and polished to a Number 4 satin finish. Provide Type 304 with a tumbled
finish approximating a Number 4 finish for nuts, screws, bolts, and rivets. Provide the grain finish direction as
follows:
Vertical on door and drawer fronts
Vertical on tall storage cabinets door fronts and end panels.
Horizontal on all other exterior surfaces.

Welding: Provide all stainless steel welding material of type similar to sheet material. Provide welds made
without discoloration; ground, polished, and passivated to blend harmoniously with a Number 4 satin finish.

Metal Gages for Sheet Steel and Stainless Steel:
Construct metal cabinets of sheet steel with minimum thickness in U.S. standard gage (mm) as follows:

<table>
<thead>
<tr>
<th>Corner gussets for leveling bolts</th>
<th>Apron corner braces, wall rail systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 gage (3.2 mm)</td>
<td>12 gage (2.7 mm)</td>
</tr>
<tr>
<td>Drawer support, hinge reinforcement, reinforcing gussets</td>
<td>Horizontal rails and top rails, aprons, support struts, adjustable</td>
</tr>
<tr>
<td>14 gage (1.9 mm)</td>
<td>wall and island shelving, shelving hat channels</td>
</tr>
<tr>
<td>Cabinet tops, end panels, bottoms, backs, toespace rails, security panels, vertical posts, vertical dividers, glazed doors, scribe strips, filler panels</td>
<td>18 gage (1.2 mm)</td>
</tr>
<tr>
<td>Door Panels</td>
<td></td>
</tr>
<tr>
<td>18 gage (1.2 mm) exterior</td>
<td>20 gage (0.9 mm) interior</td>
</tr>
<tr>
<td>Enclosures, drawer fronts and bodies, pull-out tablet fronts and bodies, cabinet shelving, closure panels, overhead service carriers</td>
<td>20 gage (0.9 mm)</td>
</tr>
</tbody>
</table>

Epoxy Resin Sheets:
Molded from modified epoxy resin that has been compounded and cured to provide optimum physical and
chemical resistance required of a heavy duty laboratory working surface. Uniform mixture throughout, not
dependent on a surface coating.

Physical Properties:
Compressive Strength (ASTM D695): 30,600 psi (211,000 kPa).
Flexural Strength (ASTM D790): 12,800 psi (88,200 kPa).
Tensile Strength (ASTM D638): 10,100 psi (69,600 kPa).
Water Absorption (ASTM D570): 0.018 percent.
Nonporous surface and edges.
Microbial Characteristics: Will not support micro-organic growth.

Glass:
- Laminated safety glass: Two outer plies of glass with a vinyl interlayer, nominal 1/4 inch (6 mm) thick.
- Tempered safety glass: Heat treated glass, nominal 1/8 inch (3 mm) thick with a minimum of 88 percent clarity.

Sealant:
- Epoxy sealant: two-component epoxy compound.
- Silicone sealant: one-part water base silicone sealing compound, in custom color matching color of surface to be sealed, Dow Corning 732 RTV or General Electric SCS 1200.

HARDWARE

Drawer and Hinged Door Pulls: 3/8 inch (10 mm) diameter stainless steel wire pull, 4-3/4 to 5-1/16 inches (120 mm to 128 mm) center to center with radius corners and a projection of 1 inch to 1-1/2 inches (25 mm to 40 mm). Model 115.61.602 as manufactured by Hafele America, Lamp Model SST-30L as manufactured by Sugatsune America, Inc., Model 1.381.128 as manufactured by Ironmonger Inc., or Model DP57C as manufactured by Mockett.

Drawer and Hinged Door Pulls: 3/8 inch (10 mm) diameter stainless steel bow wire pull, 4-3/4 to 5 inches (120 mm to 128 mm) center to center with radius corners and a projection of 1 inch to 1-1/2 inches (25 mm to 40 mm). Model DP33B as manufactured by Mockett, or Model SS Bow 128 as manufactured by Schaub & Company.

Provide with a clear abrasion and acid resistant coated finish.
Provide with an abrasion and acid resistant powder coated finish with color selection by Owner’s Representative.
Mount door pulls vertically and drawer pulls horizontally.
Provide drawers 28 inches (710 mm) wide and smaller with one pull per drawer face at centerline of cabinet.

Drawer and Pullout Shelving Slides:
- Description: Full extension, ball bearing, rail mounted, multimembered slides fabricated of minimum 16 gage (1.6 mm) steel with an electro-zinc finish.
- Acceptable Manufacturers:
  - Accuride International Incorporated, Santa Fe Springs, California
  - CompX Precision Slides, Waterloo, Ontario Canada
  - Knape and Vogt, Grand Rapids, Michigan

Drawer and Pullout Shelving Slide Ratings:
- Drawer Width: 0-24 inches (0-610 mm) Maximum dynamic load rating 100 pounds (45 kg)
- Drawer Width: Over 24 inches (610 mm) Maximum dynamic load rating 200 pounds (90 kg)

Slides shall have progressive movement with a positive stop at full extension or at a minimum 1 inch (25 mm) over travel and permit removal of drawer without use of tools. Drawers shall not lift out or otherwise be removable without the release of a locking device on each slide.

Dynamic Load Rating: Slides meet BIFMA “Business Institutional Furniture Manufacturers Association” Standards. 0.017 pounds per cubic inch at full travel plus or minus 1/4 inch for 50,000 cycles.

Pull-out Shelf Bumper: Provide on hinged side of pull-out shelf.

Hinges:
- Description: Institutional type, 5-knuckle, projecting barrel, minimum 2-1/2 inches (60 mm) long. Hinges for wood cabinets to have a wraparound design and slotted screw holes for adjustability.
- Material: Type 304 stainless steel, minimum 0.095 inches (2.4 mm) thick.
- Provide minimum of 2 hinges for doors under 48 inches (1200 mm) high; minimum of 3 hinges for doors 48
inches (1200 mm) to 84 inches (2130 mm) high; and minimum of 4 hinges for doors over 84 inches (2130 mm) in height.

Mounting: Drill each leaf for screw attachment to door and frame. Use stainless steel flathead screws.

Door Catches: Roller or magnetic type, adjustable, roller type operating with a built-in tension spring. Provide all parts of cadmium plated steel except roller. Attach to top of base cabinet doors, the bottom of wall cabinet doors, and at the top and bottom of tall cabinet right-hand doors. Provide a vertical sliding bolt assembly, astragal strip and dummy pull for the left-hand door of tall cabinets. Vertical sliding bolts; concealed in the stiles of glazed doors and between pans of solid doors to engage stainless steel keepers.

Shelf clips: Die formed steel, zinc plated or polycarbonate clip with grooved plug and spring clip. Provide shelf clips adjustable on 1-1/4 inch (32 mm) centers and meet seismic requirements. For metal cabinets shelf adjustment holes are on nominal 1/2 inch (12 mm) centers.

Locks:
- Provide with all base.
- Provide with all chemical storage cabinets.
- Unless otherwise directed, key locks differently within a room, differently between rooms. Provide Master key per Department with a Grandmaster for the building.
- Description: 5-pin tumbler, heavy duty cylinder cam lock type.

Acceptable Manufacturers:
- CompX National, Greenville, South Carolina
- Corbin, Berlin, Connecticut
- Best Lock Corporation, Indianapolis, Indiana
- Illinois Lock Company, Wheeling, Illinois

Finish: Exposed surfaces of locks shall match other casework hardware.

Keying: Capacity for 2000 primary key changes. Master key 1 level with built-in flexibility to accommodate, if required, 3 levels; 1 Grandmaster, 59 Master groups and 70 Submaster groups with 13 primary changes under each.

Keys: Stamped brass available from manufacturer or local locksmith, and supplied in the following quantities unless otherwise specified:
- 2 for each keyed different lock.
- 3 for each group keyed alike locks.
- 2 for master keys for each system.
- Provide controlled key blanks and registered key plan.

Label Holders: Formed steel with satin chrome finish, 3-1/2 inch wide by 1-1/2 inch high (90 mm wide by 36 mm high), to accept card size of 2-3/4 inch wide by 1-1/4 inch high (70 mm wide by 32 mm high), screw installed.

Leveling Glides: 2 inch (48 mm) diameter, two-piece pivot construction, steel housing, non-marring, phenolic or translucent plastic insert, 1/2 inch (12 mm) diameter, minimum 1-1/2 inch (36 mm) long zinc plated stems.

Casters - Swivel Type: 4 inch (100 mm) overall height, with wheel lock. Provide minimum load rating of 300 pounds (136 kg) per caster.
- Basis of Design: Payson Model 050-3UM WK.

Table Leg Shoes: 2-1/2 inch (63 mm) high vinyl with bottom coved, color to match base selected by the Architect for the room finish.

Anti-Tip Interlock: Provide in all mobile cabinets with drawers and adjustable pullout shelves. Provide with snapper actuator, lockbar, adjustable locking pins, drawer wedges, lockbar retainers, and wedge lock.
- Basis of Design: CompX Timberline, System 350.

Drawer Protection and Identification Plate: Plate, Type 304 stainless steel, 16 gage with a number 4 finish. Attach plate to drawer with flathead stainless steel screws countersunk at each corner. Engrave each plate with 1/2 inch high numbering. Numbering selected by the Owner's Representative. Padlock eyes, Type 304 stainless steel, 12 gage with a number 4 finish. Padlock provided by Owner.
FINISHES

Metal Finishes:

Finish casework, casework support structure, fume hood super-structure and other laboratory furnishings.

Preparation: Spray clean metal with a heated cleaner / phosphate solution, pretreat with iron phosphate spray, water rinse, and neutral final seal. Immediately dry in heated ovens, gradually cooled, prior to application of finish.

Application: Electrostatically applied epoxy or urethane powder coat painting process that coats all hidden and exposed surfaces with an acid and abrasion resistant coating. Bake in a controlled high temperature oven to ensure a smooth, hard satin finish. Surfaces shall have a chemical resistant, high grade laboratory furniture quality finish of the following thicknesses:

- Exterior and interior surfaces exposed to view: 1.5 mil average and 1.2 mil minimum.
- Backs of cabinets and other surfaces not exposed to view: 1.0 mil average.
- Finish drawer bodies in matching or harmonizing color and apply corrosion resistant treatment to selected, concealed interior parts.

Color: Select from standard colors.

Metal Finish Performance Requirements:

- Abrasion Resistance: Maximum weight loss of 5.5 mg per 100 cycle when tested on a Taber Abrasion Tester Number E40101 with 1000 gm wheel pressure and Calibrase Number CS10 wheel.
- Hardness: Surface hardness equivalent to 4H or 5H pencil.
- Humidity Resistance: Withstand 1,000 hour exposure in saturated humidity at 100 degrees Fahrenheit (38 degrees Celsius).
- Moisture Resistance: No visible effect to surface finish after boiling water trickled over test panel inclined at 45 degrees Fahrenheit for 5 minutes. No visible effect to surface finish following 100 hour continuous application of a water soaked cellulose sponge, maintained in a wet condition throughout the test period.
- Adhesion: Score finish surface of test panel with razor blade into 100 squares, 1/16 inch by 1/16 inch (1.6 mm by 1.6 mm), cutting completely through the finish but with minimum penetration of the substrate, and brush away particles with soft brush. Minimum 95 squares shall maintain their finish.

WORK SURFACES

Epoxy Resin:

Available Manufacturers:

- American Epoxy Scientific, LLC.
- Durcon, a Wilsonart Company
- Kewaunee Scientific Corporation

Thickness: 1 inch (25 mm) thick unless otherwise noted on Drawings. Check thickness before fabrication. Each corner of top shall not deviate more than plus or minus 1/32 inch (1.5 mm) from nominal.

Warpage: Check top for warpage before fabrication. Place slab on a true plane formed by a surface plate of Tool Room Grade B or better. Measure in unrestrained condition. Top will be accepted for use if there is no gap exceeding 1/16 inch (1.5 mm) in a 36 inch (0.9 m) span or 3/32 inch (2.5 mm) in a 96 inch (2.4 m) span.

Fabrication:

- Provide in longest practical lengths. Bond all joints with a highly chemical and corrosion resistant cement having similar properties as the base material. Provide a 1/8 inch (3 mm) wide drip groove on underside of all exposed edges set back 1/2 inch (12 mm) from edge of top. Finish exposed edges.
- Size Tolerances: Length, plus or minus 1/8 inch (3 mm). Width, plus or minus 1/16 inch (1.5 mm).
- Squareness: Plus or minus 1/64 inch (0.4 mm) for each 12 inches (300 mm). A top spanning 48 inches (1.2 m); held to plus or minus 1/16 inch (1.5 mm).
- Location Of Cutouts And Drillings: Plus or minus 1/8 inch (3 mm).
- Sizes Of Cutouts And Drillings: Plus 1/8 inch (3 mm), minus 0.

Curbs: Supply loose for field application. Provide curbs 4 inches (100 mm) high by 3/4 inches (19 mm) thick unless otherwise indicated on Drawings. Where tops abut wall, casework, or fume hood, supply an end curb. Caulk joints between curb and walls, fume hoods, and cabinets with acid-resistant silicone caulk.

Color: Manufacturer's standard black color.
SINKS

Epoxy Resin Sink:

Available Manufacturers:
- American Epoxy Scientific, LLC.
- Durcon, a Wilsonart Company.
- Or equal, (no known equal).

Description: Integrally molded from modified thermosetting black epoxy resin, and oven cured. Minimum wall thickness of 1/2 inch (12 mm) with all interior corners coved to 1-1/2 inch (36 mm) radius and bottoms pitched to end outlet opening.

Sink mounting methods:
- Drop-in: Supported by an upper flange from the work surface. Top edge of sink positioned 1/8 inch (3 mm) below the work surface with a 30 degree bevel from the top of the work surface to the top of the sink lip. Joint between sink and work surface shall not exceed 1/8 inch (3 mm) plus or minus 1/16 inch (1.5 mm). Seal joint between sink and top with epoxy sealant.
- Under Mount: Support sink at bottom using an upper direction compression support system. Seal joint between top and sink with silicone sealant.

Provide sink with the following accessories:
- Outlet: 1-1/2 inch (36 mm) NPS.
- Overflow: Open end overflow standpipe. Overflow to be 2 inches (50 mm) shorter than depth of sink.
- Strainer: Removable disc strainer.
- Tailpiece: Town & Country Plastics Model PP-18, R&G Sloane Part Number 7218; or Scientific Plastics Company, Inc., Part Number W81595-158.

Epoxy Resin Rectangular Cupsink:

Manufacturers:
- American Epoxy Scientific, LLC.
- Durcon, a Wilsonart Company.
- Or equal, (no known equal).

Description: 4-3/8 inches by 13-3/4 inches by 5-7/16 inches (105 mm by 350 mm by 140 mm) ID with a minimum wall thickness of 3/8 inch (9 mm). Integrally molded from modified thermosetting black epoxy resin, oven cured. Cove corners and pitch bottom to outlet opening.

Provide sink with the following accessories:
- Removable Splash Guard: Type 316 stainless steel, 1/8 inch (3 mm) diameter rod perimeter frame with 0.028 wire diameter 8 by 8 mesh per square inch (645 mm) screen. Spot weld screen to frame. Provide 1-1/2 inch (38 mm) opening at each end for hose/tube pass through.
- Strainer: Removable disc strainer.
- Tailpiece: Town & Country Plastics Model PP-18; R&G Sloane Part Number 7218; or Scientific Plastics Company, Inc., Part Number W81595-158.

LABORATORY SERVICE FIXTURES

General:
Installation: Provide and install at point of use all service fixtures. Connect to the service piping systems specified in Division 22. Provide the product of one manufacturer for all laboratory service fixtures, including fixtures supplied with fume hoods and emergency shower and eyewash units. Provide all fixtures designed for laboratory use and comply with SEFA 7.

Refer to Laboratory Fixture Schedule for fixture types and descriptions.

Acceptable Manufacturers:
- WaterSaver Faucet Company
- Broen-LAB A/S
- Chicago Faucet Company

Materials: Provide the bodies of service valves, fixtures and accessories of cast or forged brass with a minimum copper content of 60%...
content of 85 percent. Fabricate assembly components and operating parts such as valve stems, renewable units, packing nuts, outlet nozzles, and straight serrated hose ends from solid brass bar stock. Fabricate replaceable seats, needle cones, valve disc screws, and other accessories from monel metal or stainless steel alloys especially selected for use intended.

Provide water faucets that meet the requirements of the United States Safe Drinking Water Act as lead-free.

Assembled at the factory: Service fixtures, including the mounting of valves and shanks to turrets, flanges, and other mounting accessories.

Furnish and install nipples, locknuts, washers, shanks and other accessories required to properly mount and connect the fixtures.

Testing: Individually factory test fixtures. Valves and fixtures, except water fixtures, shall withstand a test pressure of 100 pounds per square inch (690 kPa). Test water fixtures at 80 pounds per square inch (550 kPa).

Fixtures located on the same plane shall have their handles project the same distance from the plane of reference to present a uniform, related appearance, regardless of valve type.

Identify mechanical services with full view colored index buttons in accordance with U.S. Standard Color Code.

Water Valve:
- Renewable unit containing all working parts which are subject to wear, including stainless steel or monel metal seat, monel metal screw, heavy duty seat disk, Teflon packing, and an integral or external adjustable volume control.
- Provide unit capable of being readily converted from compression to self closing, and vice versa, without disturbing faucet body proper and shall also be capable of being readily converted from water construction to needle valve or steam valve construction without disturbing faucet body.
- Provide unit sealed in valve body with special composition gasket. Metal-to-metal or ground-joint type of sealing not acceptable.

Needle Valves:
- Vacuum, gas, and air needle valves shall have a stainless steel replaceable floating cone that is precision ground and self-centering.
- Action of valve: Slow compression for fine control under pressure up to 150 psi (1050 kPa) and shall have parts subject to wear, easily replaceable.

Fine Needle Valves:
- Fine stem threads with approximately 30 threads per inch (25 mm).
- Renewable stainless steel needle and seat with 1/8 inch (3 mm) orifice.
- Constructed to maintain a constant flow rate of 4 bubbles per 15 seconds as valve is tested out under 50 pounds (350 kPa), 100 pounds (700 kPa), 150 pounds (1050 kPa), 200 pounds (1400 kPa), and 250 pounds (1720 kPa) of nitrogen pressure,

Laboratory Ball Valves: Straight pattern body, valve stem with integral chrome plated ball and TFE-coated O-rings stem seals in valve body, molded TFE valve seals, and tested at 125 psi nitrogen under water. Valves shall have chrome plated forged brass lever-type handle with screw-on type index requiring less than 5 pounds pressure to actuate. Provide with removable 10 serrated hose end.

Steam Valves: Bonnet assembly similar to needle valve fixture. Provide valve stem with flat Teflon valve disc and renewable, stainless steel valve seat.

Goosenecks: Hot water/cold water gooseneck mixers shall swivel. Provide swivel point at turret or at valve level if wall or panel mounted. Provide swing joints with heavy Teflon packings. All goosenecks shall provide full thread for attachment of antisplash outlet fixtures, serrated tips or filter pumps.
Vacuum Breakers: Provide vacuum breakers, integral with the gooseneck where required. Vacuum breakers shall have a forged brass body, renewable seat and a special design valve member for fine flow control. Vacuum breakers shall not spill over at low water volume. At fume hoods provide vacuum breakers externally mounted on face of fume hood superstructure where required as part of the factory pre-piping.

Aerators: Aerators shall have 3/8 inch (10 mm) NPS male inlet. Provide with integral flow control that adjusts between 0.5 GPM (1.29 LPM) and 3.0 GPM (7.77 LPM). Flow control to be set as indicated on Drawings.

Serrated Tips: Serrated tip fixtures shall have 3/8 inch (10 mm) IPS thread with hose end being tapered and shall not have less than 10 serrations. Provide 1/8 inch (3 mm) diameter of orifice in serrated tip, except where otherwise specified. For water units provide with integral flow control that adjusts between 0.5 GPM (1.29 LPM) and 3.0 GPM (7.77 LPM). Flow control to be set as indicated on Drawings.

Turrets: Round type design, brass drop forging, as indicated on Drawings. One-way or two-way as required with 3/8 inch (10 mm) IPS female inlet thread for connections. Furnish units with brass shanks, brass locknuts, and washers.

Infrared Sensor Operator: Infrared sensor operator shall include the infrared sensor with range between 2 inches (50 mm) and 8 inches (200 mm), thermostatic mixing valve, solenoid valve with strainer filter, battery powered control module, and plug-in adapter for 120 VAC power supply.

Fixture Finish: Fixtures shall be coated with an electrostatically applied epoxy powder coating in the color of silver metallic.

Faucet and Valve Handles: Finished to match fixture finish, 4-arm type or wrist blade type with removable screw-on type colored plastic discs with identification lettering stamped on disc in a contrasting color as scheduled below.

<table>
<thead>
<tr>
<th>Service</th>
<th>Index Color</th>
<th>Letter Color</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>Orange</td>
<td>Black</td>
<td>AIR</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>Pink</td>
<td>Black</td>
<td>CO2</td>
</tr>
<tr>
<td>Chilled Water Return</td>
<td>Green</td>
<td>White</td>
<td>CHWR</td>
</tr>
<tr>
<td>Chilled Water Supply</td>
<td>Green</td>
<td>White</td>
<td>CHWS</td>
</tr>
<tr>
<td>Compressed Air</td>
<td>Orange</td>
<td>Black</td>
<td>CA</td>
</tr>
<tr>
<td>Cold Water - Potable</td>
<td>Green</td>
<td>White</td>
<td>CW</td>
</tr>
<tr>
<td>Hot Water - Potable</td>
<td>Red</td>
<td>White</td>
<td>HW</td>
</tr>
<tr>
<td>Gas</td>
<td>Blue</td>
<td>White</td>
<td>GAS</td>
</tr>
<tr>
<td>Industrial Cold Water</td>
<td>Green</td>
<td>White</td>
<td>ICW</td>
</tr>
<tr>
<td>Industrial Hot Water</td>
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<td>White</td>
<td>IHW</td>
</tr>
<tr>
<td>Lab Air</td>
<td>Orange</td>
<td>Black</td>
<td>LA</td>
</tr>
<tr>
<td>Purified Water</td>
<td>White</td>
<td>Black</td>
<td>PW</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>Brown</td>
<td>White</td>
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<tr>
<td>Special Gas</td>
<td>Light Blue</td>
<td>Black</td>
<td>SG</td>
</tr>
<tr>
<td>Steam</td>
<td>Black</td>
<td>White</td>
<td>STM</td>
</tr>
<tr>
<td>Vacuum</td>
<td>Yellow</td>
<td>Black</td>
<td>VAC</td>
</tr>
</tbody>
</table>

Faucet and Valve Handles: Molded plastic or wrist blade type with a colored screw-on type index disc. Provide color coded handle and index disc to match the fixture’s service index color. Provide color code requirements for indexing service fixtures as follows:

<table>
<thead>
<tr>
<th>Service</th>
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<th>Symbol</th>
<th>Handle Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
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<td>Black</td>
<td>AIR</td>
<td>Blue</td>
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<tr>
<td>Carbon Dioxide</td>
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<td>Cold Water O Potable</td>
<td>Blue</td>
<td>White</td>
<td>CW</td>
<td>Green</td>
</tr>
</tbody>
</table>
Wrist blade Handles: Install handles so blades are perpendicular to the benchtop in the off position and horizontal to the benchtop in the open position.

**UMBILICALS/SERVICE DROPS**
Description: Construct of 18 gage (1.2 mm) sheet metal with collar at top. Provide bottom curb in same material as benchtop, properly cemented to benchtop. Provide top collar of 16 gage (1.6 mm) sheet steel.

Provide 1 inch by 1 inch (25 mm by 25 mm), 18 gage (1.2 mm) angle at curb.

Umbilicals shall have removable sections for easy access to piping and conduit. Exposed fasteners will not be allowed. Removal of sections shall not disturb ceiling or benchtop. Construct hanger clips of 18 gage (1.2 mm) sheet metal and spot welded to removable section.

On freestanding umbilicals provide a pipe support channel, spot welded to the fixed enclosure section. On wall or corner umbilicals, attach pipe support channel to the wall. Basis of Design: Unistrut Finish: Finish as specified for metal finish in this section, with color selected by Owner’s Representative.

**CEILING SERVICE PANELS**
Description: Construct of 18 gage (1.2 mm) sheet metal. Form panel from one sheet with edges formed up 1 inch (24 mm) and returned back. Reinforce with welded hat channels for the full length of the panel. Panels to fit into a 24 inch by 24 inch (609 mm by 609 mm) T-grid acoustical suspended ceiling structure.

Ceiling service panels provide a means to mount and disconnect quick connect service fixtures, electrical and data outlets. Panels accommodate single sided and back-to-back bench configurations.

Provide with cover plates. Coordinate locations of services, service fixtures, electrical and data, junction boxes with other trades.

Finish: Finish as specified for metal finish in this section, with color selected by Owner’s Representative.

**SLEEVES IN COUNTERTOPS**
Description: 14 gage (2.0 mm), Type 304 stainless steel, with a Number 4 finish.

Extend sleeves 1 inch (25 mm) above the countertop and provide with a flange on the bottom for fastening to the underside of the countertop. Install with clear silicone sealant between the outside of the sleeve and the countertop. Provide top edge of sleeve with a smooth radius to prevent chafing of insulation on hoses.

**OVERHEAD SERVICE CARRIERS (STRUT ASSEMBLY)**
Description: Construct of metal framing system components in dimensions indicated in drawings. Coordinate connection of services, point exhaust, electrical and data raceway with other trades.

Available Manufacturers:
Securely and rigidly fasten the entire assembly, including diagonal braces, to structural slab above or to a structural grid where provided.

Ceiling Trim Plate: Provide ceiling trim plate at each vertical support that penetrates the ceiling system. Finish assembly as specified for metal finish in this section. Paint all exposed piping and conduit servicing the carrier. Color selected by Owner’s Representative.

UTILITY DROPS
Description: Construct of metal framing system components. Unistrut part numbers are referenced.
Available Manufacturers:
Unistrut Corporation.
Elcen.
Grinnell Power-Strut.

Fasten members to overhead structure and to curbed opening in benchtops. Vertical members are not required for wall mounted condition.

Fasten members to overhead structure and to finished floor. Vertical members are not required for wall mounted condition.

Finish assembly as specified for metal finish in this section, with color selected by Owner’s Representative.

TABLE – METAL LEG FRAME, ADJUSTABLE HEIGHT
Perimeter rails: 2 inches by 2 inches by 12 gage (50 mm by 50 mm by 2.7 mm) steel channel with a continuous inner reinforcement U-channel. Spot weld inner reinforcement channel approximately 12 inches (300 mm) on center, staggering weld on each side.

Legs: 1-1/2 inch by 1-1/2 inch (38 mm by 38 mm by 2.7 mm) by 12 gage steel tubing. Height adjustment to be accomplished through inner telescoping leg and spring bolts.
Provide each leg with leveling glides and/or casters as scheduled on the drawings.

Inner leg: 27-1/4 inches long (692 mm by 2.7 mm) by 12 gage inner telescoping leg extension. Provide with six 9/16 inch round holes on inside of table for spring bolts. Provide each leg with a leveling glide unless otherwise noted.

Quick Release Pins: Provide each leg with two 1/2 inch diameter by 2-1/2 inch (13 mm diameter by 64 mm) usable leg stainless steel push-button, quick-release pins, McMaster-Carr model 92384A096, or equal.

Stretcher rails: 2 inches by 1-1/4 inch (51 mm by 32 mm by 1.6 mm) by 16 gage steel tube. Connect by welding between two end legs and between two back legs.

Finish: Finish as specified for Metal Finishes under this section.

Tops: As specified for Work Surfaces under this section. Refer to Table Schedule for type.

SOURCE QUALITY CONTROL TESTING OF METAL FINISH
Metal Finish: Meet or exceed the latest edition of the following Section and Articles of SEFA-8-M Recommended Practices
Testing Requirements: Provide a third party tester that is not a representative of the Manufacturer or Installation Contractor
Test Results: Submit a certified report providing test results and indicating the finish conforms with or exceeds the
above SEFA-8-M Recommended Practices.

**SOURCE OF QUALITY CONTROL TESTING OF EPOXY RESIN WORK SURFACE**

Meet or exceed the latest edition of the following Section and Articles of SEFA-3 Recommended Practices:

2.1 Chemical/Stain Resistance Test
   - Test Method A
   - Test Method B

Testing Requirements: Provide a third party tester that is not a representative of the Manufacturer or Installation Contractor

Test Results: Submit a certified report providing test results and indicating the finish conforms with or exceeds the above SEFA-3 Recommended Practices

**PART 3 – EXECUTION**

**EXAMINATION**

Acceptance of Surfaces and Conditions: Examine substrates to receive products and systems and associated work for compliance with requirements and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance of surface conditions.

**DELIVERY**

Delivery casework systems in two stages:
   - Deliver fixed casework.

**PREPARATION**

General: Comply with manufacturer’s instructions, recommendations, and specifications for cleaning and surface preparation. Surfaces shall have no defects, contaminants, or errors which would result in poor or potentially defective installation or would cause latent defects in Work.

**INSTALLATION**

General:

Installation Quality Standards: In addition to standards listed elsewhere, perform Work according to following, unless otherwise specified.
   - Respective manufacturer/fabricator’s written installation instructions.
   - Approved submittals.
   - Contract Documents.

Control of Corrosion: Prevent galvanic action and other forms of corrosion by isolating metals and other materials from direct contact with incompatible materials.

Install casework, tables, casework support systems, overhead service drops, fume hoods and local point exhaust devices in accordance with manufacturer’s instructions and approved Shop Drawings, and under the supervision of the manufacturer’s trained personnel.
   - Include installation of service fixtures. Final connections to services are specified in Division 22.

Anchor casework and fume hoods securely in place with appropriate seismic tie-down kits, in accordance with delegated design calculations and requirements.

Casework Installation:
   - Install, plumb, level, true and straight with no distortions. Shim as required, using concealed shims. Securely anchor to building structure. Where laboratory furniture abuts other finished work, scribe and apply filler strips for accurate fit with fasteners concealed where practicable.
   - Installation of each individual bench run shall start at the high point of the floor under that bench run with
levelers screwed in as much as possible.
Where required, assemble units into one integral unit with joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16 inch (1.5 mm).
At fixed casework installations provide galvanized backer plates at toe kicks to receive applied base where floor elevation deviations cause gaps over one inch between bottom of cabinet base and floor.
Adjust casework and hardware so that doors and drawers operate smoothly without warp or bind.
Lubricate operating hardware as recommended by Manufacturer.
Securely fasten tall cabinets, fume hood superstructures and tall flammable storage cabinets to solid support material near top of cabinet.
Reinforcement of stud walls to support cabinets, shelving, and other wall mounted laboratory furnishing items: Done during wall erection by trade involved. Laboratory furniture company/supplier is responsibility for indicating on Shop Drawings the accurate location and sizing of reinforcement.

Work Surface Installation:
Field jointing where practicable: Made in same manner as factory jointing using dowels, splines, adhesives, and fasteners recommended by Manufacturer. Locate field joints as shown on accepted Shop Drawings, factory prepared so that there is no job site processing of top and edge surfaces. Abut top and edge surfaces in 1 true plane, with internal supports placed to prevent any deflection. Provide all holes and cutouts as required for built-in equipment and mechanical and electrical service fixtures. Prior to making openings, verify size of opening with actual size of equipment to be used. Form inside corners to a radius of not less than 1/8 inch (3 mm). After sawing, rout and file cutouts to ensure smooth, crack free edges. Seal exposed edges after cutting with a waterproofing material recommended by manufacturer.
Secure tops to support with concealed Z-Type, angle type fastening, “Liquid Nails”, Ply400/Ply 200 adhesive or equivalent. Fastening devices spaced no more than 3 feet (0.9 m) on center. Adhesives shall be liberally applied for solid anchoring of tops.
Epoxy Resin Work Surface Joints: 3/32 inch (2.38 mm) flush and smooth with epoxy sealant.
Caulk joints between curb and walls, fume hoods, and cabinets with acid-resistant silicone caulk.

Sink Installation: Set in chemical resistant sealing compound sinks which were not factory installed and secured and supported per manufacturer's recommendations.
Accessory Installation: Install accessories, fixtures and equipment in accordance with manufacturer's recommendations ready for final connection to services.

FIELD QUALITY CONTROL
Manufacturer/Fabricator’s Field Service: Manufacturer/fabricator’s qualified technical representative shall inspect first day’s Work and periodically inspect Work to ensure installation is proceeding in accordance with manufacturer/fabricator’s designs, recommendations, instructions, and warranty requirements. Representative shall submit written reports of each visit indicating observations, findings, and conclusions of inspection.
Owner’s Testing Agency Field Service: The Owner may employ and pay a qualified independent testing agency to perform field quality control. Materials and installation failing to meet specified requirements shall be replaced at Contractor’s expense. Retesting of materials and installations failing to meet specified requirements shall be done at Contractor’s expense.

ADJUSTING
Repair or remove and replace defective work, as directed by Owner’s Representative upon completion of installation. Adjust doors, drawers, hardware, fixtures and other moving or operating parts to function smoothly.

CLEANING AND PROTECTION
Clean shop finished casework and fume hoods, touch up as required, and remove and refinish damaged or soiled areas.

Cover casework for protection against soiling and deterioration during remainder of construction period.

Clean countertops with diluted dishwashing liquid and water leaving tops free of all grease and streaks. Use no wax or oils.

Protect casework and fume hoods before, during, and after installation. Materials damaged due to improper protection are cause for rejection.

END OF SECTION
SECTION 123553.19 – WOOD LABORATORY CASEWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

Section includes wood laboratory casework (door and drawer fronts only).

Related Requirements:

Refer to Section 123553 General Requirements for Laboratory Casework and Fume Hoods for all References, Approved manufacturers, Materials, Hardware, Finishes, Installation, etc.

1. Section 123553.03 Flexible Laboratory Casework Systems

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

Refer to Section 123553 for approved manufacturers.

2.2 CASEWORK DESIGN

Comply with SEFA 8-W "Laboratory Grade Wood Casework."

A. Minimum standards for work within this Section: Construct in accordance with Premium Grade of the Architectural Woodwork Standards, latest edition unless otherwise specified herein.

B. Full overlay style.

C. Rigid and self-supporting cabinets suitable for use in an assembly or as individual, stand-alone units, with joints securely glued and cabinets clamped under pressure during assembly to ensure secure joints and cabinet squareness.

D. Joints: Doweled and glued or mortised and tenoned secured with glue and countersunk screws.

E. Square edged door and drawer fronts overlapping the openings on all four sides. In elevation, hold the reveal between end panel and door or drawer edge to a maximum of 1/8 inch (3 mm) wide. Hold spaces between abutting doors and drawers to a maximum of 1/8 inch (3 mm) wide, both horizontally and vertically, and shall be accurate and uniform, forming a continuous reveal throughout full length of assembled casework. Hold the reveal between top of cabinet and door or drawer edge to a maximum of 1/4 inch (6 mm) wide. Trim and sand smooth with all edges and corners radiused.

F. Testing of Casework, Tables, and Shelving: Meet or exceed SEFA 8-W.

G. Epoxy-finished maple wood panels for the doors and drawers.

2.3 CASEWORK FABRICATION

General: Include completely enclosed vertical posts. Include the items of cabinet construction listed. Exclude provisions for doors in open shelf cabinets or cubbies.

A. Floor Mounted Base Cabinets:
   End Panels:
   3/4 inch (19 mm) veneer core hardwood plywood.
   a. Exposed edges: 1/8 inch (3 mm), Type 1 hardwood lumber edgebanding.
   b. Provide a minimum of 2 rows of drilled holes in each end panel, 1-1/4 inch (32 mm) on centers, for the attachment of drawer and shelf slides or shelf clips.
   c. Attach to top frame, bottom, intermediate rails, and toespace rail with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.
   d. For sink cabinets containing an under-mount sink, provide support rails secured between end panels with leveling screws to support sink.
   
   Backs:
   Unexposed interiors and exteriors: Minimum 3/16 inch (5 mm) hardboard.
   e. Exposed interiors and unexposed exteriors: 1/4 inch (6 mm) veneer core hardwood plywood.
   f. Exposed exterior backs: 3/4 inch (19 mm) veneer core hardwood plywood.
g. Provide removable vertical split backs on all base cabinets, except units with security panels and sink cabinets, to allow access to service piping from the front of the unit.
h. All sink cabinets to have partial height back panels to allow passage of the drain line and piping to the service chase.

Bottoms:

i. 3/4 inch (19 mm) veneer core hardwood plywood.

j. Exposed edges: 1/8 inch (3 mm), Type 1 hardwood lumber edgebanding.

k. Attach to end panels with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.

Toespace Rail:

l. Install between end panels to provide a minimum toespace of 2-1/4 inches (57 mm) deep by 4 inches (100 mm) high.

m. Type 2 hardwood lumber or fir, 3/4 inch (19 mm) by 4 inch (100 mm).

Top Frames:

n. Full frame consisting of front, rear, and side members. Join frame members with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.

o. Front member: Type 1 hardwood lumber or Type 2 hardwood lumber with 1/8 inch (3 mm), Type 1 hardwood lumber edgebanding. Minimum 1 inch (25 mm) by 2-1/2 inch (64 mm).

p. Rear member: Type 1 or Type 2 hardwood lumber. Minimum 1 inch (25 mm) by 2-1/2 inches (64 mm).

q. Side members: Type 2 hardwood lumber. Minimum 3/4 inch (19 mm) by 1-1/2 inch (38 mm).

r. Attach top frame to end panels with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.

Intermediate Rails:

s. Provide between drawers and doors, and between drawers at all security panels.

t. Type 1 hardwood lumber, minimum 3/4 inch (19 mm) thick.

u. Attach to end panels with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.

Security Panels:

v. 1/4 inch (6 mm) thick medium density fiberboard let into intermediate rails.

w. Provide on all base cabinets with locks, between drawers and door, and between drawers.

Adjustable Pullout Shelves:

x. Shelf: 3/4 inch (19 mm) veneer core hardwood plywood.

y. Retaining lip: Provide all around shelf, 2 inches (50 mm) above shelf surfaces, using 2-3/4 inch (70 mm) by 1/2 inch (12 mm) Type 2 hardwood lumber.

z. Adjustable on 1-1/4 inch (32 mm) centers.

aa. Front edge of shelf to be within 1 inch (25 mm) of inside face of door.

bb. Pullout shelves to fully extend with doors open at minimum of 90 degrees.

Adjustable Shelves:

cc. Provide one shelf per cupboard unit. 1 inch (25 mm) veneer core hardwood plywood.

dd. Exposed edges: 1/8 inch (3 mm), Type 1 hardwood lumber edgebanding.

e. Fit dividers and end panels with stud type shelf brackets for adjustment on 1-1/4 inch (32 mm) centers. Groove shelves at brackets to prevent movement.

f. Front edge of shelf to be within 1 inch (25 mm) of inside face of door. Provide split-depth shelf so that front section can be removed to allow for taller storage.

Hinged Doors:

gg. 3/4 inch (19 mm) hardwood plywood, combination core with 1/8 inch (3 mm).

Drawers:

hh. Drawer box (back, sides, and subfront): Type 2 hardwood. Attach back, subfront and sides with 5/16 inch (8 mm) dowels and glue or multiple dovetail and glue.

ii. Bottom: 1/4 inch (6 mm) hardboard. Dado bottom into back, subfront and sides sealed with hot melt glue around drawer bottom perimeter.

jj. Removable drawer head: 3/4 inch (19 mm) hardwood plywood, combination core with 1/8 inch (3 mm).

Pull-out Tablet:

kk. Pull-out tablet front: 3/4 inch (19 mm) hardwood plywood, combination core with 1/8 inch (3 mm).

ll. Tablet body: 3/4 inch (19 mm) hardwood plywood, particleboard, combination core.

mm. Tablet slides: Accuride Model #2109 keyboard slide with hold-in/hold-out detent and clear zinc finish.
Mobile Base Cabinets:

Provide mobile cabinets as described under Floor Mounted Base Cabinets above, unless modified under this Paragraph.

Omit toespace or bottom base and provide swivel type casters.

dd. End Panels: Attach to top, bottom, and intermediate rails, with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.

ee. Tops: 3/4 inch (19 mm) veneer core hardwood plywood.

1) Exposed edges: 1/8 inch (3 mm), Type 1 hardwood lumber edgebanding.
2) Attach to end panels with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.

Backs: Unexposed interiors and exposed exterior backs: 3/4 inch (19 mm) veneer core hardwood plywood.

Work Surface: Provide all mobile casework units with a 3/4 inch (19 mm) thick epoxy top.

ff. Anti-Tip Interlock: Provide in all cabinets with drawers and adjustable pullout shelves.

gg. Counterweight: Provide in all cabinets.

Tall Cabinets:

End Panels:

3/4 inch (19 mm) veneer core hardwood plywood.

hh. Exposed edges: 1/8 inch (3 mm) Type 1 hardwood lumber edgebanding.

ii. Provide 2 rows of drilled holes in each end panel, 1-1/4 inch (32 mm) on centers, to receive shelf clips.

jj. Attach to top, bottom, and bottom rail with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.

Backs: 1/4 inch (6 mm) veneer core hardwood plywood.

Bottoms:

3/4 inch (19 mm) veneer core hardwood plywood.

kk. Exposed edges: 1/8 inch (3 mm), Type 1 hardwood lumber edgebanding.

ll. Attach to end panels with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.

Bottom Toe Space:

3/4 inch (19 mm) by minimum 4 inch (100 mm), Type 1 hardwood lumber or fir.

mm. Attach to end panels with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.

Tops:

1 inch (25 mm) veneer core hardwood plywood.

nn. Exposed edges: 1/8 inch (3 mm), Type 1 hardwood lumber edgebanding.

oo. Attach to end panels with multiple dowels and glue or mortise and tenon joints secured with glue and countersunk screws.

Fixed and Adjustable Shelves:

1 inch (25 mm) veneer core hardwood plywood.

pp. Exposed edges: 1/8 inch (3 mm), Type 1 hardwood lumber edgebanding.

qq. Provide five full width shelves. Center shelf to be fixed by attaching to end panels with doweled and glue or mortise and tenon joints secured with glue and countersunk screws.

Four shelves to be adjustable.

rr. Adjustable on 1-1/4 inch (32 mm) centers.

ss. Front edge of shelf to be within 1 inch (25 mm) of inside face of door.

Hinged Framed Glass Doors:

Frame: Minimum 3/4 inch (19 mm) by 2-3/4 inch (70 mm), Type 1 hardwood lumber.

tt. Glass: laminated safety glass.

uu. Assemble frame with mortise and tenon joints secured with glue.

vv. Provide extruded vinyl retaining molding designed so glass can be replaced without tools.

Filler Panels:

Provide filler panels or scribe strips at exposed to view areas between back of cabinets and walls, between backs of cabinets at end of island or peninsula benches, and at any other area necessary to enclose gaps. For floor mounted cabinets provide all filler panels with bottom 6 inches (152 mm) fixed and the top portion removable.

2. 3/8 inch (10 mm) veneer core hardwood plywood with 1/8 inch (3 mm), Type 1 hardwood lumber edgebanding.
3. Secure to frame and/or cabinet back and wall with metal angle and oval head screws with finishing washers.

2.4 ADJUSTABLE SHELVING
   For nominal dimensions and general requirements refer to Section 123553.
   A. For Wall Frame Assemblies refer to Section 123553.
   B. For Adjustable Island and Peninsula Bench Shelving Support refer to Section 123553.

2.5 HARDWARE
   Refer to Section 123553.

2.6 METAL FINISH
   Refer to Section 123553.

PART 3 - EXECUTION

3.1 GENERAL
   Refer to Section 123553.

END OF SECTION
SECTION 23 09 14
PNEUMATIC AND ELECTRIC INSTRUMENTATION AND CONTROL DEVICES FOR HVAC
BASED ON DFD MASTER SPECIFICATION DATED 10/26/2021

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

SCOPE
This section includes control system specifications for all HVAC work as well as related control for systems found in other specification sections. Included are the following topics:

PART 1 - GENERAL
Scope
Point List
Related Work
Reference
Work Not Included
Quality Assurance
Reference Standards
System Description
Submittals
Demolition
Design Criteria
Operation and Maintenance Data
Material Delivery and Storage

PART 2 - PRODUCTS
Control Valves
Control System Instrumentation
Thermostat Guards
Electric/Electronic Thermostats
Humidistats
Temperature Control Panels
Temperature Sensors
Humidity Sensors
Power Supplies

PART 3 - EXECUTION
Installation
Control Valves
Control System Instrumentation
Room Thermostats and Temperature Sensors
Low Limit Thermostats (Freezestats) Temperature Control Panels Preconstruction Review Meeting
Construction Verification
Agency Training

POINT LIST (Section 23 09 15)

RELATED WORK
Section 01 91 01 – Commissioning Process
Section 23 08 00 – Commissioning of HVAC
Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC - Coordination
Section 23 09 15 - Direct Digital Control Input/Output Point Summary Tables
Section 23 09 23 - Direct Digital Control System for HVAC
Section 23 09 93 - Sequence of Operation
Section 23 33 00 - Ductwork Accessories - for control damper installation
Division 23 - HVAC - Equipment provided to be controlled or monitored

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

WORK NOT INCLUDED
Direct digital controls and energy management interface, as specified in Section 23 09 24.
QUALITY ASSURANCE

Installing contractor must be a manufacturer's branch office or an authorized representative of a Direct Digital Control (DDC) equipment manufacturer that provides engineering and commissioning of the DDC equipment. Submit written confirmation of such authorization from the manufacturer. Indicate in letter of authorization that installing contractor has successfully completed all necessary training required for engineering, installation, and commissioning of equipment and systems and that such authorization has been in effect for a period of not less than three years. DDC equipment may or may not be required to be installed by this contractor as part of the project, but the intent of this quality assurance specification is to ensure that the installing contractor has the capabilities to engineer, install, and commission the field devices supplied under this section for temperature control.

REFERENCE STANDARDS

ANSI B16.22  Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings
ANSI/ASTM B32  Specification for Solder Metal
ASTM B75  Seamless Copper Tube
ASTM D1693  Environmental Stress-Cracking of Ethylene Plastics
ASTM D 635  Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
UL 94  Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
AMCA 500-D  Laboratory Method of Testing Dampers for Rating

SYSTEM DESCRIPTION

System is to use direct digital control with electric actuation for room temperature.

SUBMITTALS

Include the following information:

- Manufacturer’s data sheets indicating model number, pressure/temperature ratings, capacity, methods and materials of construction, installation instructions, and recommended maintenance. General catalog sheets showing a series of the same device is not acceptable unless the specific model is clearly marked.
- Schematic flow diagrams of systems showing fans, pumps, coils, dampers, valves, and other control devices. Each control device provided under this Section shall be uniquely labeled. Duplicate labeling may be used within similar mechanical systems. Label each device with setting or adjustable range of control. Indicate all wiring, clearly, differentiating between factory and field installed wiring. Wiring should be shown in schematics that detail contact states, relay references, etc. Diagrammatic representations of devices alone are not acceptable.
- Details of construction, layout, and location of each temperature control panel within the building, including instruments location in panel and labeling. Also include on drawings location of mechanical equipment controlled (room number), horsepower and flow of motorized equipment (when this data is available on plans), locations of all remote sensors and control devices (either by room number or column lines).
- Schedule of control dampers indicating size, leakage rating, arrangement, pressure drop at design airflow, and number and size of operators required.
- Schedule of control valves indicating system in which the device is to be used, rated capacity, flow coefficient, flow required by device served, actual pressure drop at design flow, size of operator required, close-off pressure, and locations where valves are to be installed.
- A complete description of each control sequence for equipment that is not controlled by direct digital controls. Direct digital controlled equipment control sequences will be provided by the DDC control contractor.
- Calculations completed to determine size of control air compressor(s) and dryer(s).

Prior to request for final payment, submit record documents which accurately record actual location of control components including panels, thermostats, wiring, and sensors. Incorporate changes required during installation and start-up.

Provide a complete set of Submittal Drawings to the 23 09 23 DDC Contractor to enable them to coordinate the interfacing of the 23 09 14 controls with the 23 09 23 supplied controls. The 23 09 23 contractor is also required to provide any information regarding their supplied control equipment to the 23 09 14 contractor so that the 23 09 14 contractor can complete his engineered Submittal Drawings.
Provide a complete set of control Record Drawings to the 23 09 23 DDC Contractor to enable them to provide a complete composite set of drawings incorporating DDC and electric/pneumatic controls as specified. Where communication and/or power wiring is specified to be provided under this Section, point to point routing of communication trunks and power wiring between DDC controllers, DDC communication devices, control panels, and Ethernet switches shall be documented in the control Record Drawings.

All submittals are to comply with submission and content requirements specified in specification Section 01 91 01.

DEMOLITION
Where existing control devices, piping, or wiring are discontinued from use, remove, and turn over to owner. If owner does not want them remove from premises. Remove any previously abandoned control devices in a similar manner.

DESIGN CRITERIA
Size all control apparatus to properly supply and/or operate and control the apparatus served.

Provide control devices subject to corrosive environments with corrosion protection or construct them so they are suitable for use in such an environment.

Provide devices exposed to outside ambient conditions with weather protection or construct them so they are suitable for outdoor installation.

Use only UL labeled products that comply with NEMA Standards. Electrical components and installation to meet all requirements of the electrical sections (Division 26) of project specifications.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

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

PART 2 - PRODUCTS

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

Size operators to allow smooth and positive operation of devices served and to provide sufficient torque capacity for tight shutoff against system temperatures and pressure encountered. For pneumatic actuated systems, use rolling diaphragm, spring loaded, and piston type operators. For electric modulating actuation, use fully proportional actuators with 0-10VDC inputs and zero and span adjustments unless specified otherwise in the chart below. If TriState with feedback is specified, valve position shall be fed back to the controller and controller shall position valve based on this feedback. For two-position electric actuation use 24 VAC for DDC controlled actuators, 120 VAC actuators may be used for hardwire interlocking. Electric actuators, for applications other than terminal units, shall be provided with a manual override capability. All electric actuators shall be provided with a visible position indicator.

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

Provide operators that are full proportioning or two-position, as required for specified sequence of operation. Provide spring-return for applications involving fire, freeze protection, moisture protection or specified normally open/closed operation. Valves shall move to their fail positions on loss of electrical power or air pressure to the actuator. For high pressure (> 20 PSI) full proportioning pneumatic actuators, provide with zero bleed pilot positioners that are integral with the actuator. For high pressure two-positioning actuators, provide with electro-pneumatic solenoid air valve and adjustable bleed orifice integral with the actuator.
Provide end switches integral to the valve actuator to prove the valve open, closed, or both to meet the application where specified in the plans or specifications. End switch contact ratings shall be suitable for application.

Two-position shut-off valves used for isolation of mechanical devices shall be sized for a maximum pressure drop of 2 PSI at design flow and shall be a minimum of line size.

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

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

<table>
<thead>
<tr>
<th>VALVE SERVING</th>
<th>TYPE</th>
<th>SIGNAL</th>
<th>SPRING RETURN</th>
<th>FAIL POSITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reheat Coil</td>
<td>Globe or Ball</td>
<td>0-10VDC or TriState w/Feedback</td>
<td>No</td>
<td>Last Position</td>
</tr>
</tbody>
</table>

See plan details, notes, and schedules for where two-way and three-way valves should be used.

1. Equivalent Cv butterfly valves may be used where 3" and larger globe valves would be required.

WATER SYSTEMS:

Use equal percentage valves for two-way control valves; size for a pressure drop not less than 4 psi or more than 6 psi. Where valve sizes are less than line size, Corrected Cv should be used to correct for piping reducers/increasers. Modulating valve size should never be less than half of line size. Consult with AE for acceptable pressure drop if available valve selections do not fall within the desired pressure range. Note: For low flows, the required minimum Cv size will result in lower pressure drop than 4 psi.

Use three-way valves sized for a maximum pressure drop of 5 psi and that have linear characteristics so that the valve pressure drop remains constant regardless of the valve position.

Globe valves 2" and smaller: Cast bronze or forged brass body, brass plug and brass or stainless steel seat, stainless steel stem, screwed ends, suitable for use on water systems at 150 psig and 240° F. Seat leakage with actuator supplied will meet ANSI class IV leakage (0.01%). For globe valves that are specified to fail in place, valves shall be open when the stem is up. Only the following globe valve body styles will be acceptable for terminal unit control: Siemens Powermite 599 VF Series (599 VE Series Zone Valves are not acceptable), Invensys VB7200 Series, Johnson Controls VG7000 Series, Belimo G200 and G300 Series, and Honeywell V5011/V5013 Series. Minimum size for globe valves shall be 0.7 Cv.

Characterized Ball Valves 2" and smaller: The following manufacturers are acceptable: Honeywell, Belimo, Johnson Controls, KMC Controls, Yamatake, Bray, Siemens. Forged brass or bronze body, stainless steel shaft and ball, reinforced Teflon or PTFE ball seals, double O-ring stem seals, characterized disk, maximum of ANSI Class IV (0.01%) leakage, suitable for use on water systems at 150 psig and 212° F. Minimum size for ball valves shall be 0.4 Cv.

CONTROL SYSTEM INSTRUMENTATION

Manufacturers: Averaging Type - Johnson Controls, or equal; Bulb Type - Johnson Controls, Ashcroft, Marshall, Weksler

ELECTRIC/ELECTRONIC THERMOSTATS

LOW VOLTAGE ELECTRONIC THERMOSTATS:

Manufacturers: Honeywell, Johnson Controls, Viconics, or equal.

Where unoccupied setpoints are specified, provide electronic programmable type with seven day setup/setback scheduling with a minimum of two occupied and unoccupied schedules per day through keypad entry on front of unit. For heating and cooling applications, provide automatic heating/cooling switchover. For applications that require integration to the building automation system, provide a BACnet communication interface. If a communication interface is specified, occupancy scheduling in the thermostat is not required. LOW LIMIT THERMOSTATS (freeze ‘stats):

Electric two-position type with temperature sensing element and manual reset for all applications except integral face and bypass steam heating coils which shall have auto-reset freeze ‘stats and latching relays (see execution section for details). Unit to be capable of opening control circuit if any one-foot length of sensing element is subject to a temperature below the setpoint. Length of sensing element to be not less than one lineal foot per square foot of coil surface areas. Unless otherwise indicated, set low limit controls at 36°F.
HUMIDISTATS

DUCT MOUNTING HUMIDISTATS:
Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 85 percent operating range, and single or double pole contacts.

TEMPERATURE CONTROL PANELS
Constructed of steel or extruded aluminum, with hinged door, keyed lock, and baked enamel finish. Install controls, relays, transducers, and automatic switches inside panels. Label devices with permanent printed labels and provide asbuilt wiring/piping diagram within enclosure. Provide raceways for wiring and poly within panel for neat appearance. Provide termination blocks for all wiring terminations. Label outside of panel with panel number corresponding to plan tags and asbuilt control drawings as well as building system(s) served.

Control panels that have devices or terminations that are fed or switch 50V or higher shall enclose the devices, terminations, and wiring so that Personal Protective Equipment (PPE) is not required to service the under 50V devices and terminations within the control panel. As an alternative, a separate panel for only the 50V and higher devices may be provided and mounted adjacent to the under 50V control panel.

For panels that have 120VAC power feeds provide a resettable circuit breaker. Provide label within the panel indicating circuit number of 120VAC serving panel.

Provide a service shutdown toggle switch for each air handling unit system located inside the temperature control panel that will initiate a logical shutdown of the air handling unit system. Label the switch so it is clear which position is shut down and which is auto.

TEMPERATURE SENSORS
Thermistor temperature sensor manufacturers: PreCon, BAPI, and ACI

Use thermistor or RTD type temperature sensing elements constructed so accuracy and life expectancy is not affected by moisture, physical vibration, or other conditions that exist in each application.

RTD’s shall be of nickel or platinum construction and have a base resistance of 1000Ω at 70°F and 32°F respectively. 100Ω platinum RTD’s are acceptable if used with temperature transmitters.

The temperature sensing device used must be compatible with the DDC controllers used on the project.

RTD
Accuracy (Room Sensor Only) minimum ± 1.0°F
Accuracy (Averaging) minimum ± 1.2°F
Accuracy (Other than Room Sensor or Averaging) minimum ± 0.65°F
Range minimum -40 - 220°F

Thermistor
Accuracy (All) minimum ± 0.36°F
Range minimum -30 - 230°F
Heat Dissipation Constant minimum 2.7 mW/°C

Temperature Transmitter
Accuracy minimum ± 0.1°F or ±0.2% of span
Output 4-20 mA

Provide limited range or extended range sensors if required to sense the range expected for a respective point.

Use RTD type sensors for extended ranges beyond -30 to 230°F. If RTD’s are incompatible with DDC controller direct temperature input, use temperature transmitters in conjunction with RTD’s.

Use wire size appropriate to limit temperature offset due to wire resistance to 1.0°F. If offset is greater than 1.0°F due to wire resistance, use temperature transmitter. If feature is available in DDC controller, compensate for wire resistance in software input definition.

Use averaging elements on duct sensors when the ductwork is ten square feet or larger. All mixed air and heating coil discharge sensors shall have averaging elements regardless of duct size.

In piping systems use temperature sensors with separable wells designed to be used with temperature element.
HUMIDITY SENSORS

Use capacitive thin-film polymer sensor types with a range of 0-100% RH. Accuracy to be no less than ±2% in the range of 20% RH to 80% RH with a response time of 120 seconds or less. Provide covers for room humidity sensors as specified for temperature sensors.

For outside air applications, use sensor designed for outside air use along with weather enclosure. Provide sensor equal to Vaisala Model HMD60UO w/ DTR503B enclosure and weather resistant mounting hardware.

POWER SUPPLIES

Provide all required power supplies for transducers, sensors, transmitters, and relays. All low voltage transformers shall have a resettable secondary circuit breaker and be listed as class 2 power supplies. All transformer assemblies in enclosures shall have isolated high and low voltage compartments with separate removable covers for connections.

PART 3 - EXECUTION

INSTALLATION

Install system with trained mechanics and electricians employed by the control equipment manufacturer or an authorized representative of the manufacturer. Where installing contractor is an authorized representative of the control manufacturer, such authorization shall have been in effect for a period of no less than three years.

Install all control equipment, accessories, wiring, and piping in a neat and workmanlike manner. All control devices must be installed in accessible locations. This contractor shall verify that all control devices furnished under this Section are functional and operating the mechanical equipment as specified in Section 23 09 93.

All cables to the electronic input/output devices, sensors, relays, and interlocking wiring (all of which shall be supplied and installed under this section of specification) interfaced with the Direct Digital Control System shall be extended into the 23 09 24 DDC panel with a minimum of 5 ft. of cable to allow for termination by the 23 09 24 DDC Contractor. This contractor shall provide a technician to inspect and validate all tubing, wiring, and field devices associated with the DDC interface in coordination with and under direction of the 23 09 24 DDC Contractor to ensure that each device is operating per the control sequences as specified in Section 23 09 93.

Label all control devices except for terminal unit devices with permanent printed labels that correspond to control drawings. Labeling for each device shall be unique within each mechanical system. Temperature control junction and pull boxes shall be identified utilizing spray painted green covers. Other electrical system identification shall follow the 26 05 53 specification.

Provide permanent printed labels on the nearest ceiling grid tee below control valves, controllers, power supplies, etc. such that the Owner can easily identify and locate from below the ceiling.

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

Mounting of electrical or electronic devices shall be protected from weather if the building is not completely enclosed. This Contractor shall be solely responsible for replacing any equipment that is damaged by water that infiltrates the building if equipment is installed prior to the building being enclosed.

Provide all electrical relays and wiring, line, and low voltage, for control systems, devices, and components. Install all high voltage and low voltage wiring (includes low voltage cable) in metal conduit, Electrical Non-metallic Tubing (ENT), or Electrical Metallic Tubing (EMT), as scheduled below and hereafter referred to generically as conduit except above accessible ceilings as noted below. See Wire and Air Piping Conduit Installation Schedule below for specific conduit or tubing to be used. All raceways, enclosures, fittings, and associated supports shall be provided and installed according to the requirements set forth in Division 26, NFPA 90 (NEC) and Chapter SPS 316 of the Wisconsin Administrative Code. All conduits shall be routed parallel and/or perpendicular to walls and adjacent piping. Raceways shall be located to maintain headroom and working clearance around equipment and devices that require inspection and service.

In general, support all raceways from the building structure. No component of a raceway system shall be secured to corrugated metal roof deck. Do not impose on the installations of other trades. Securing conduit,
Conduit shall be a minimum of 1/2 " for low voltage control provided the pipe fill does not exceed 40%.

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

Low voltage wiring can be run without conduit above accessible lay-in tile ceilings. All wiring in mechanical rooms, above inaccessible hard ceilings, exterior locations, and in any exposed areas, and in all other locations shall be installed in conduit. Wire for wall sensors shall be installed in conduit concealed in the wall. Wiring for radiation valves shall be installed in conduit concealed in the wall. For retrofit installations, all wiring for sensors and valves shall be installed in conduit concealed in new walls. Sensor wiring for existing walls shall be installed without conduit and concealed in the wall (fished) where possible. If running wire concealed in the existing wall is not possible, install in surface raceway as specified or if not specified, consult with the AE for raceway type and color to be provided.

Where low voltage wiring is installed free-air, installation shall comply with the following:

- Wiring shall utilize the cable tray wherever possible.
- Wiring shall run at right angles and be kept clear of other trades work.
- Wiring shall be supported utilizing "J" or "Bridal-type" steel mounting rings anchored to ceiling concrete, piping supports, walls above ceiling or structural steel beams. Mounting rings shall be of open design (not a closed loop) to allow additional wire to be strung without being threaded through the ring. For mounting rings that do not completely surround the wire, attach the wire to the mounting ring with a strap.
- At HVAC terminal units only, where the wiring serves a specific device; e.g., controller, actuator, transmitter, etc. associated with the unit, the j-hooks or Bridal rings required to support the wiring, may be secured to the rods or straps that support the ductwork or piping that serves the unit. Wall penetrations shall be sleeved.
- Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If wiring "sag" at mid-span exceeds 6-inches; another support shall be used.
- Wall penetrations shall be sleeved, and fire stopped as specified.
- Wiring shall not be supported from existing cabling, existing tubing, plumbing or steam piping, ductwork, any component of a suspended ceiling, or electrical or communications conduit.

Control panels serving equipment fed by emergency power shall also be served by emergency power. This contractor shall be responsible for all 120VAC power, not provided in the Division 26 specifications, required for equipment provided under this section. Power shown for temperature control panels on plans may be utilized by the 23 09 24 and/or 23 09 23, and 23 09 14 contractors.

Provide communication trunk wiring to integrated devices (i.e., VFD’s, Flow Meters, Chillers, Lighting Panels, Electrical Meters, etc.) and terminal unit controllers that are specified to be connected to the building automation system. Communication trunk wiring shall be as required by the equipment specified under the 23 09 23, 23 09 24, or 23 09 25 Sections and shall be routed to the DDC panel designated for that equipment as shown on the plans or the closest DDC panel if not designated. If communication trunks require daisy chained style wiring, provide two communication cables to the DDC panel so that the communication trunk is not dead ended.

Install all communicating thermostats and terminal unit DDC controls and associated sensors furnished under Section 23 09 14, 23 09 23, 23 09 24, or 23 09 25 that are field mounted at the terminals units (not terminal unit controls that are mounted in centralized temperature control panels). For terminal units, i.e., fin tube radiation, convectors, cabinet unit heaters, fan coils, where the DDC controller is to be installed in the terminal unit enclosure, the DDC controller shall be installed in a location within the terminal unit enclosure designed to house controls. In no cases shall DDC controllers be installed in the convective or forced air flow stream of the terminal unit.
All wiring in control panels shall be terminated on a terminal strip. Wire nuts are not acceptable. A maximum of two wires shall be terminated under any one terminal.

All pneumatic tubing, cabling and electrical wiring terminated at controllers, devices and terminal strips are to be permanently tagged or labeled with permanent adhesive labels within one inch of terminal strip with a numbering system to correspond exactly with the “Record Drawings”. Jumpers where both ends of the wire are visible and terminations are within 6” of each other do not need to be labeled. Spare wires are to be labeled as “Spare” with unique number designations.

After completion of installation, test and adjust control equipment. Submit data showing set points and final adjustments of controls.

CONTROL VALVES
All temperature control valves furnished by the control manufacturer are to be installed by the Mechanical Contractor under the coordinating control and supervision of the Control Contractor in locations shown on plans or where required to provide specified sequence of control.

ROOM THERMOSTATS AND TEMPERATURE SENSORS
Check and verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Locate room thermostats and sensors 42 inches above floor. Align with light switches and humidistats. For drywall installations, thermostat mounting shall use a back-box attached to a wall stud, drywall anchors are not acceptable.

Any room thermostats or sensors mounted on an exterior wall shall be mounted on a thermally insulated sub-base. Subbase to provide a minimum of one half inch of insulation.

Where thermostats or sensors are mounted on exterior walls or in any location where air transfer will affect the measured temperature or humidity seal the conduit and any other opening that will affect the measurement.

Provide guards on thermostats and sensors in entrance hallways, other public areas, or in locations where thermostat is subject to physical damage.

For reheat coil discharge temperature sensors, mount in the duct a minimum of three feet downstream of the reheat coil.

LOW LIMIT THERMOSTATS (Freezestats)
Install low limit controls where indicated on the drawings or as specified. Unless otherwise indicated, install sensing element on the downstream side of heating coils. When air handling units have chilled water coils downstream of the heating coil, the element shall be located at the entering side of the chilled water coil. For single row heating coils in air handling units without chilled water coils, the element shall be run in the shadow of the heating coil tubing as much as possible or be located a minimum of 2 feet downstream of the heating coil.

Distribute (serpentine) sensing element horizontally across the coil to cover every square foot of coil; on larger coils this may require more than one instrument.

Mount the unit head in an accessible location as to allow for resetting after low limit trips while still meeting manufacturer's installation requirements for proper function. Mount units using flanges and element holders. Provide duct collars or bushings where sensing capillary passes through sheetmetal housings or ductwork; seal this penetration to eliminate air leakage. Elements shall be supported across coils or openings adequately to prevent movement from air current. Support methods shall be those suitable for use in air plenums with temperatures of up to 180 deg F. Metal fastening clips are the preferred method. Securing elements by use of plastic or nylon cable ties will not be accepted. Special attention should be paid to ensure elements will not rub on fasteners or other edges that will eventually cause damage.

Integral Face and Bypass Steam Heating Coil Freezestats:
For integral face and bypass coils the elements are to be run vertically on the face of the heating coil inside the damper enclosure, this will require drilling the frame to run element around the by-pass. Provide an auto-reset freezestat for each coil vertical heating tube. The head of the freezestat shall be mounted outside the unit, if possible, above the coils and any excess capillary shall be mounted out of the air stream above the coil. If the head of the freezestat cannot be mounted outside of the unit, it should be mounted downstream of the coil. Provide latching relays with LED indicator of relay status for each freezestat so that the relay
will remain latched after the freezestat resets. Label each freezestat and corresponding relay to provide an
easy method to determine which freezestat(s) have tripped. Provide a momentary reset switch and connection
for remote contact reset from the DDC system for resetting the freezestat alarm. The relays shall be unlatched
after a power fail. Mount latching relays in a hinged cover panel mounted at a maximum of five feet above
the floor in an accessible location on the AHU. Reset switch shall be mounted on the cover and be labeled
“Freezestat Reset”.

TEMPERATURE CONTROL PANELS

Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron
supports. All control panel openings shall be plugged. Conduits and other penetrations on the top of the
cabinets shall be sealed on the exterior of the cabinet with silicone caulk to resist water penetration. One
cabinet may accommodate more than one system in same equipment room. Provide permanent printed
labeling for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

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

PRECONSTRUCTION REVIEW MEETING

This contractor shall attend a meeting or meetings as required prior to construction to review the control
system on the project. The meeting attendees shall consist of the AE of Record, DFD, CxP, User Agency,
Section 23 09 14 Contractor, Section 23 09 23 or 23 09 24 Contractor, and the Division 23 Contractor. All
sequences covered within specification section 23 09 93 and related system configurations and devices shall
be reviewed in detail and any corrections to the sequences and mechanical systems shall be made through
the DFD construction change process.

CONSTRUCTION VERIFICATION

Contractor is responsible for utilizing the construction verification checklists supplied under specification
Section 23 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01.

AGENCY TRAINING

All training provided for agency shall comply with the format, general content requirements and submission
guidelines specified under Section 01 91 01.

Contractor to provide factory authorized representative and/or field personnel knowledgeable with the
operations, maintenance and troubleshooting of the system and/or components defined within this section for
a minimum period of 1 hour.

END OF SECTION
**PROJECT:**
4th FL BIOCHEMICAL SCIENCES-COON LAB RENOVATION

**LOCATION:**
MADISON, WI

**SYSTEM:** Existing Air Handling Unit “AC-2”

### DDC INPUT / OUTPUT SUMMARY TABLE

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<tr>
<th>POINT DESCRIPTION</th>
<th>HARDWARE</th>
<th>SOFTWARE</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>OUTPUT</td>
<td>INPUT</td>
</tr>
<tr>
<td></td>
<td>DIGITAL</td>
<td>ANALOG</td>
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<td>Exhaust Air Damper</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Return Air Damper</td>
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<td></td>
</tr>
<tr>
<td>Humidification Steam Valve</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Chilled Water Valve</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Heating Steam Valve</td>
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<tr>
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<td>Supply Fan Status</td>
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<tr>
<td>Global Outdoor Air Humidity</td>
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<td>Return Air Humidity</td>
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<tr>
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**QTY. 6 Actuators**

**QTY. 3**
SECTION 23 09 93
SEQUENCE OF OPERATION FOR HVAC CONTROLS
BASED ON DFD MASTER SPECIFICATION DATED 5/27/2021

PART 1 - GENERAL

SCOPE
This section includes control sequences for HVAC equipment as well as equipment furnished by others that may need monitoring or control. Included are the following topics:

PART 1 - GENERAL
Scope
Related Work
Description of Work
Submittals
Operation and Maintenance Data
Design Criteria

PART 2 - PRODUCTS
Not Applicable

PART 3 - EXECUTION
General Control
Hydronic Reheat Coil Control
Computer Room Air Handling Unit Control
Oxygen Depletion Sensors
Existing Constant Volume Mixed Air Handling Unit Control ((E)AC-2)
Functional Performance Testing

RELATED WORK
Applicable provisions of Division 1 govern work under this Section.
Section 01 91 01 – Commissioning Process
Section 23 08 00 – Commissioning of HVAC
Section 23 09 23 - Direct Digital Controls (DDC)
Section 23 09 14 - Pneumatic and Electric Controls
Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC – Coordination
Division 23 - HVAC - Equipment provided to be controlled or monitored.
Division 26 - Electrical - Equipment provided to be controlled or monitored.
Division 28 - Electronic Safety and Security

REFERENCE
The A/E must properly coordinate the necessary power wiring.
Section 23 09 14 work includes furnishing and installing all field devices, including electronic sensors for the DDC of this section, equipment, and all related field wiring, interlocking control wiring between equipment, pneumatic tubing, sensor mounting, etc., that is covered in that section.
Motorized control dampers and actuators, thermowells (temperature sensing wells), automatic control valves and their actuators are also covered in Section 23 09 14.

DESCRIPTION OF WORK
Control sequences are hereby defined as the manner and method by which automatic controls function. Requirements for each type of operation are specified in this section.
Operation equipment, devices and system components required for automatic control systems are specified in other Division 23 control sections of these specifications.
All temperature, humidity, and pressure sensing, and all other control signal transportation for the control sequences shall be furnished under Section 23 09 14. All pneumatic, electronic, and electric input/output signals shall be extended under Section 23 09 14, with adequate lead length for termination within the appropriate control panel being provided under Section 23 09 23.
Sequences for equipment controlled by Direct Digital Controls (DDC) as specified are accomplished by hardware and software provided under Section 23 09 23. Sequences for equipment controlled by pneumatic or electric self-contained controls are accomplished by hardware provided under Section 23 09 14.

**SUBMITTALS**

Refer to Division 1, General Conditions, Submittals, Section 23 05 00 and Section 23 09 23, and 23 09 14 for descriptions of what should be included in the submittals.

Shop drawings shall be provided by contractor(s) providing equipment under Sections or 23 09 23 and 23 09 14. The contractor providing the DDC equipment shall provide a complete narrative of the sequence of operations for equipment that is controlled through the DDC system. The contractor providing the 23 09 14 equipment shall provide a complete narrative of the sequence of operation for equipment that is controlled directly from that equipment (without control logic through the DDC system). The narrative of the sequence of operation shall not be a verbatim copy of the sequences contained herein but shall reflect the actual operation as applied by the contractor.

**OPERATION AND MAINTENANCE DATA**

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:

1. All final setpoints shall be documented on the as-built control drawings as determined by working in conjunction with the balancing contractor.

**DESIGN CRITERIA**

Reference Section 23 09 14.

**PART 2 - PRODUCTS**

Not applicable to this Section – reference Sections 23 09 23 and 23 09 14 for product descriptions.

**PART 3 - EXECUTION**

**GENERAL:**

BACNET OBJECTS:

All hardwired points listed in 23 09 15 and any setpoints, timers, or other control elements that are specified to be adjustable (adj.) in the following control sequences shall be mapped as BACnet objects and be available on the user interface to be adjusted. Consult with the user agency HVAC and/or DDC personnel prior to programming to determine if there are any items that they do not want to have mapped as BACnet objects. This is especially important for DDC controlled items that are duplicative, i.e., air terminal units.

BACNET ADDRESSING:

BACnet instance ID’s shall be coordinated with the agencies established BACnet instance ID addressing scheme. If there is not such a scheme in place, the contractor(s) providing BACnet DDC controllers shall work with the agency to establish such a scheme and document this in the as-built control drawings. BACnet/IP addressing shall be coordinated with the agency prior to installation. BACnet MSTP addressing shall be addressed to provide for consecutive addressing to provide for the best speed of response. Max Master address shall be set appropriately for speed of response.

USER INTERFACE/FEATURE SOFTWARE:

Consult with the user agency HVAC and/or DDC personnel prior to programming to determine BACnet object naming conventions, user views, graphic layout, security matrix, alarming, trending, and scheduling preferences desired by the agency. Failure to consult and come to agreement prior to programming shall require the DDC contractor to make changes in the above listed items as desired by the user agency to the system at no cost. Section 23 09 15 feature software checkmarks are guides only and are not specific to what is required by the user agency.

SETPOINTS:

All setpoints indicated in the control specification are to be adjustable. The setpoints shall be readily available to be modified in the mechanical system software system summary (either textual or graphic based) and under the same software level as hardware points. Some less used setpoints may be provided on a lower
software level, if requested by the user Agency for clarity. The setpoints indicated herein are only specified as a calculated starting point (or initial system operation). It is expected that setpoint adjustments and control loop tuning shall be required to provide optimum system operation based on requirements of the building. The control contractor shall work with the balancing contractor and the user Agency to provide the final system setpoint adjustments and control loop tuning after the system is in operation and building is in use. Document all final setpoints on the as-built control drawings. Any questions regarding the intended operation of the HVAC equipment and control systems shall be referred to the HVAC design engineer through the appropriate construction communication process. The following setpoints should be used as initial setpoints unless otherwise specified in the individual control sequences or instructed by the user Agency. If the contractor fails to check with the user Agency for final setpoints, they shall adjust setpoints at no additional cost.

Occupied Space Terminal Unit Heating: 68º F
Occupied Space Terminal Unit Cooling: 76º F
Unoccupied Space Terminal Unit Heating: 62º F
Unoccupied Space Terminal Unit Cooling: 82º F
Entry Way Heating: 60º F
Mechanical or Unoccupied Space Ventilation: 82º F
Mechanical or Unoccupied Space Heating: 60º F

ANTI-CYCLING:

When HVAC equipment or a sequence is specified to be started and stopped by a temperature, humidity, pressure setpoint or any other controlled variable, there shall be an adjustable differential setpoint that shall be set to prevent short cycling of the systems and equipment due to minor changes in the controlled variable. Temperature differential setpoints shall be set at 2º F and non-temperature setpoints shall be set at 10% of the controlled range unless otherwise specified. Setpoints shall indicate at when the process should be turned on. Heating and cooling differentials shall be set for above setpoint and shall be used to turn the process off. For example, an economizer sequence called to switch at 68º F, would turn on at 68º F and off at 70º F since it is a cooling function. A heating lockout setpoint of 50º F would turn on heating control at 50º F and off at 52º F. Non-temperature differentials shall be set above setpoint if the setpoint is indicating a minimum value or below setpoint if the setpoint is indicating a maximum value. Provide minimum runtime timers for loads that are cycled to prevent over-cycling. Timers shall be set as specified or as needed to prevent damage or excessive wear to the equipment. Unless otherwise specified in the individual control sequences, fans and pumps shall have a minimum runtime on timers of 15 minutes (adj.) and off timers of 5 minutes (adj.) and staged condensing units shall have on timers of 10 minutes (adj.) and off timers of 5 minutes (adj.) or the recommended timers by the manufacturer. Safeties shall override runtime timers.

DEADBANDS:

Provide deadbands for all DDC control loops to prevent constant hunting of output signals to controlled devices. Deadbands shall be set to provide adequate control around setpoint as follows unless otherwise specified in the individual control sequences:

Temperature Control: ±0.5º F
Humidity Control: ±1% RH
Airflow Control: ±2% of total flow
AHU Static Pressure Control: ±0.01 in. w.c.

ALARMS:

Provide all alarmed points with adjustable time delays to prevent nuisance tripping under normal operation and on equipment start-up. For all commanded outputs that have status feedback, provide an alarm that shall indicate the commanded output is not in its commanded state. Provide alarms on all points as indicated on point charts. For existing campus automation systems, add/delete what is called on the point charts for after consultation with user Agency to provide consistent alarming throughout the automation system.

For devices that have form “C” contacts available for alarm monitoring, use closed contacts for the Normal condition and open contacts on Alarm condition. This shall provide a level of supervision by detecting a break in the wiring.

EQUIPMENT START/STOP FAILURE STATES:

All start/stop points for equipment shall utilize normally open contacts unless called out specifically in the individual control sequences.
CURRENT SWITCH SETUP:
When current switches are used for proving fan or pump status, they shall be set up so that they will detect belt or coupling loss by the reduction in current draw on loss of coupled load. The current switch set up shall be redone by the 23 09 14 contractor after the balancer is complete.

FAN INTERLOCKING
Provide interlocks between supply and return or exhaust fan systems as scheduled on the plans or called out in individual control sequences. If DDC controlled, interlocks shall be done through DDC start/stop points unless otherwise specified in individual control sequences. If not DDC controlled, interlocks shall be accomplished via hardware interlocks between fan starters or VFD’s.

THERMOSTATS AND SENSORS:
All devices and equipment including terminal units, specified to be controlled in a control sequence by a thermostat or sensor, shall be provided with a thermostat or sensor, whether or not the device is indicated on the plans. Consult the HVAC design engineer for the thermostat or sensor location.

ORIGINAL EQUIPMENT MANUFACTURER (OEM) CONTROLLER DDC INTEGRATION:
Provide DDC programming to define all equipment integral input/output points, setpoints, data points, calculations, etc. that are available through the manufacturer’s communication interface. Consult with the Agency DDC operations personnel to determine if some of the points should be omitted (for clarity or lack of value). The following equipment shall be integrated into the DDC system:
- Existing Laboratory Fume Hood Control
- Computer Room Air Handling Units
- Lighting Control (furnished by Div. 26)
- Existing (E) AC-2

WATCH DOG TIMER
Where the integrated system consists of programmable DDC controllers with BACnet objects mapped to an enterprise level Building Automation System (BAS) and it is shown that the BACnet objects do not indicate when they are offline on the enterprise level BAS when communication is lost between the two systems, software algorithms shall be provided to alarm when communication is lost. The integrated system shall program a binary data object that is toggled on and off at an adjustable rate (initially one minute) that shall be monitored by the enterprise level BAS which shall alarm if the toggling ceases.

WEEKLY SCHEDULING
Provide scheduling of DDC terminal units in groups based on occupancy. Work with the user Agency to determine how many groups are required and which zones should be included. Individual terminal units shall be able to receive temporary schedules that shall override the group schedules. Temporary override buttons at the zone sensor (where specified on point charts) shall override the scheduling to occupied. When groups that consist of more than 20% of terminal units are indexed to occupied, the associated air handling unit shall start if not already running.

DDC CONTROLLER COMMUNICATION BUS CONFIGURATION
The actively controlled primary mechanical equipment (AHU’s, hot water, chilled water, boilers, etc.) DDC controllers shall be configured to be located on the same supervisory controller BACnet MSTP communication trunk unless the supervisory controller capacity prevents it. If this is the case, the primary mechanical equipment DDC controllers shall be separated onto supervisory controllers in such a way that the systems that need to share information for operation and interlocking shall reside on the same supervisory controllers. When AHU systems have associated exhaust fan systems that are interlocked and designed to operate together as a combined air system within a building, these must be on the same BACnet MSTP trunk. Peer to peer communication shall be used for interlocks and data sharing between the AHU and exhaust fans systems when possible to limit air system disruptions in the event of a supervisory controller failure. Other critical building systems that require communication between DDC controllers to operate shall be on the same BACnet MSTP communication trunk. Terminal unit controllers shall be located on a separate BACnet MSTP trunks if necessary, to allow for primary equipment to reside on the same BACnet MSTP trunk. If the DDC controllers used for control of primary mechanical equipment and interlocks or point information is required for proper operation as described above do not use BACnet MSTP communication but use Ethernet communication, the DDC controllers shall be connected to the same Ethernet switch. If the controllers cannot be connected to the same switch, hardwired points between controllers shall be used to share information.

CONTROLLED VARIABLE REQUIREMENTS
All controlled variables, i.e., static pressure, differential pressure, temperature, humidity, etc., shall be wired directly to the DDC controller in which the software PID loop or other similar software loop resides unless the control sequence specifically allows the controlled variable to be routed over the network. Where a
controlled variable is used for reset of a PID loop, the controlled variable shall be allowed to be shared over
the network unless specified to be directly wired to the DDC controller.

CALCULATED DATA POINTS

Provide a calculated data point for outside airflow for all fans that have return and outside air mixing dampers
and the points required to allow for the following equation:
Outside Airflow = Supply CFM x (MAT-RAT)/(OAT-RAT)
Where Supply CFM is measured either on variable volume fans or as balanced on constant volume units,
MAT is Mixed Air Temperature, RAT is Return Air Temperature, and OAT is Outside Air Temperature.
This point is designed as a check for outside air flow stations accuracy and outside air ventilation minimum
damper positions. It should be noted that the accuracy of the calculated outside airflow will diminish as
outside air temperature approaches return air temperature. It should be used as a check only when the RAT
and OAT are greater than 20 DegF and the accuracy of the RAT and OAT temperature sensors are assured.

HYDRONIC REHEAT COIL CONTROL:

Provide a DDC space temperature sensor to control a modulating electronic control heating coil valve to
maintain space temperature. When space temperature is below setpoint modulate the heating coil valve open.
The reverse shall occur when space temperature is above setpoint. Provide a discharge air temperature sensor
for monitoring purposes. The heating coil valve shall be commanded closed whenever the associated AHU
is off.

Setpoints shall be as follows:

Mass Spec Lab
Heating: 67 DegF (adj.), 5 DegF deadband from cooling setpoint of CRAH units.
Cooling: 72 DegF (adj.)

Offices/Workspaces/Meeting Rooms
Heating: 68 DegF (adj.)
Cooling: 76 DegF (adj.)

Microscope Room/Lab
Heating: 72 DegF (adj.)
Cooling: 72 DegF (adj.)

Microscope Lab Prep
Heating: 72 DegF (adj.)
Cooling: 72 DegF (adj.)

Tool Shop
Heating: 68 DegF (adj.)
Cooling: 76 DegF (adj.)

COMPUTER ROOM AIR HANDLING UNIT CONTROL:

Upflow Unit (Mass Spec Lab):
Unit furnished with a factory controller capable of interfacing with building management system through a
BACnet card. Sequence described is for reference, factory controller contains pre-set PID algorithms. When
unit is on, fan will start and run for a full minute prior to any temperature control function beginning. On a
call for cooling, the two-way chilled water control valve shall be modulated to maintain the space temperature
setpoint of 72 DegF (adj.). The PID algorithm modulates the valve to constantly correct for error and
maintain the temperature setpoint. The unit fan speed shall modulate proportionally to the modulation of the
chilled water valve, modulation is scaled between the minimum and maximum fan speed settings.

Wall Mount Unit (Microscope Service Room):
Unit furnished with a factory controller capable of interfacing with building management system through a
BACnet card. Sequence described is for reference, factory controller contains pre-set PID algorithms. When
unit is on, fan will start and run for a full minute prior to any temperature control function beginning. On a
call for cooling, the two-way chilled water control valve shall be modulated to maintain the temperature
setpoint of 80 DegF (adj.). The PID algorithm modulates the valve to constantly correct for error and
maintain the temperature setpoint. The unit fan runs continuously during operation.

OXYGEN DEPLETION SENSOR:
Upon detection of low oxygen, audio and visual alarms shall activate at the sensor, BMS and associated entry doors to space.

EXISTING CONSTANT VOLUME MIXED AIR HANDLING UNIT CONTROL ((E)AC-2):

GENERAL:

The Existing Air Handling unit is constant air volume, indoor air unit. The unit is being converted from pneumatic control to direct digital controls.
The Existing Air Handling unit is equipped with the following:
Supply fan with starter.
Return fan with starter.
Heat reclaim coils.
Chilled water coil for cooling.
Steam coils for heating and reheating.
Filter banks.
Steam humidifier.
Actuators furnished by TCC. (Refer to specification 23 09 14)

FAN CONTROL:

Start/Stop:
The DDC system shall start and stop the supply fan. Provide scheduling as desired by the user agency. Return fan is interlocked with supply fan through hard-wire interlock with fan starter. Existing laboratory exhaust fans associated with (E)AC-2 are assumed to be hard-wire interlocked with supply fan starter.

Current Status Switch:
Provide for both supply and return fans and set up as described under GENERAL, Current Switch Setup, in this Section.

VENTILATION AIR CONTROL:

Minimum Outside Ventilation Air Flow Control:
When the unit is started, the outside air damper shall be positioned at its minimum position to maintain the scheduled outside air flow ventilation rate. The control contractor shall work with the balancing contractor to calibrate the outside air damper minimum position to establish the minimum scheduled ventilation airflow.

DISCHARGE AIR TEMPERATURE CONTROL:

Discharge Air Temperature Control:
The pre-heat coil valve shall modulate to maintain a pre-heat discharge air temperature setpoint of 39º F (adj.) and modulate the steam heating and cooling coil valves in sequence to maintain a unit discharge air temperature of 55º F (adj.).

Steam Heating Coil Control:
Modulate the steam control valves as sequenced under discharge air control.

HUMIDIFICATION:

Unit is equipped with a steam humidifier. Steam humidification valve shall be modulated to maintain a space relative humidity as sensed by a duct mounted humidity sensor in the return air path. A relative humidity setpoint shall be reset linearly between 30%RH (adj.) at an outdoor air temperature of -15º F (adj.) to 50%RH (adj.) at an outdoor air temperature of 55º F (adj.). The steam humidification valve shall be
closed when outdoor air temperature is above 55°F (adj.). Discharge relative humidity shall have a high limit of 85%RH.

SAFETIES:
General: All safeties shall be hard wired to the supply fan starter or VFD safety circuits. Starters shall not function in the “Hand” or “Auto” and VFD’s shall be disabled if they are indexed to the “Auto” or “Hand” position in either the VFD or bypass modes.

Freezestat:
Install electric freezestat(s) (in same locations as previous) to shut down the unit (see Unit Shutdown for additional information) if the temperature downstream of the heating coil drops below 35°F (adj.). The electric freezestat shall act independently of the DDC system via hardware interlock and shall override the DDC system control signal to open the heating coil control valve(s). A freezestat trip shall notify the DDC system that shall send an alarm to the operator interface.

High-Limit Humidistat:
If the unit discharge air relative humidity reaches 85%, the humidistat will independently via hardwire interlock override the DDC control system signal and close the steam humidification valve. An alarm shall be sent to the DDC system operator interface.

ALARMS:
Pre-Heat Discharge Air Temperature:
If the pre-heat discharge air temperature is 5°F (adj.) below setpoint for a period of 5 minutes (adj.), the DDC system shall be notified, and an alarm shall be sent to the operator interface.

Unit Discharge Air Temperature:
If the unit discharge air temperature is 5°F (adj.) above or below setpoint for a period of 5 minutes (adj.), the DDC system shall be notified, and an alarm shall be sent to the operator interface.

Fire Alarm Shutdown:
Upon a Fire Alarm System alarm, the fire alarm control module provided by the electrical contractor at the temperature control panel shall change state of its contacts. This shall cause the unit to be shut down (see Unit Shutdown for additional information) and all fire/smoke and smoke dampers within this system shall close. An auxiliary contact shall be provided to notify the DDC system of a fire alarm shutdown. Upon reset of the fire alarm system, the unit shall restart automatically without user intervention subject to any restart delays. See Section 28 31 00 for fire alarm system programming requirements for AHU’s.

UNIT SHUTDOWN:
Whenever the air handling unit is indexed off, the supply and return fans shall stop. If the return fan fails off, the supply fan shall be commanded off. If the supply fan fails, the return fan shall be commanded off. The failed fan shall continue to be commanded on and when the failed fan status proves on, the non-failed fan shall be restarted, and the unit shall resume normal operation. On a failure of either the supply or return fan, an alarm shall be sent through the DDC system. Whenever both supply and return fans are off for any reason or there is a fan failure the following shall occur:

The outside air dampers and relief air dampers shall Close, and the return dampers shall open.

The chilled water control valve(s) shall close.

The heating coil control valve(s) shall remain under control from the mixed air sensor to maintain 55 °F (adj.). Freezestat shall override heating control valve(s) open.

All fire/smoke dampers associated with the air handling system shall close.

UNOCCUPIED CONTROL:
The following programming shall be provided even though (E)AC-2 is intended to operate continuously in Occupied mode based on the program types served.

General:
Occupied/unoccupied schedule shall be set at the DDC operator interface. When indexed to unoccupied the unit shall shutdown.
Unit Cycling to Maintain Setback/Setup Temperatures:
Cycle the air handling unit on to maintain the setback and setup temperature zone setpoints to maintain 58°F and 86°F respectively. Minimum on runtime timer shall be set for 15 minutes (adj.) and the off timer for 30 minutes (adj.).

AHU HEAT RECOVERY COIL CONTROL:
The heat recovery coil shall be sequenced with the pre-heat coil, economizer dampers (if used), and chilled water coils to maintain the AHU discharge air temperature. The heat recovery coil shall be used as the first stage of pre-heat subject to frost control.

FUNCTIONAL PERFORMANCE TESTING
Contractor is responsible for utilizing the functional performance test forms supplied under specification Section 23 08 00 in accordance with the procedures defined for functional performance testing in Section 01 91 01.

END OF SECTION
PART 1 - GENERAL

SCOPE
This specification section describes the products and execution requirements relating to the furnishing, installation, testing, and commissioning of a complete Access Control System and placing it into satisfactory operation.

In general, work consists of installation of new access control field devices, head-end equipment and all associated cabling and components as part of this project. The new access control equipment shall be connected to an existing Lenel Onguard system, scheduled to have a completed installation by the time this system is installed.

CLASS 1 NOTICE:
Notice is hereby given in accordance with Section 16.855(10), Wisconsin Statutes, that the Division believes it is in the best interests of the State to contract the following work from only one source, without the usual statutory procedures:

Included are the following topics:
PART 1 - GENERAL
Scope
Related Work
Quality Assurance
References
Inspections and Permits
Submittals
PART 2 - PRODUCTS
General
Control Panel (Controller)
Credential Readers and Keypads
Miscellaneous Field Devices
Cabling
PART 3 - EXECUTION
General
Coordination
Continuity of Existing Services and Systems
Installation
Identification and Labeling
Acceptance Testing
Documentation
Warranty

Major features of the Access Control System and responsibilities to furnish and/or install equipment, install cabling, and terminate cabling are as follows:

Division 08 contractor-furnished, Division 08 contractor-installed
- Electric Latches and Strikes
- Push-bars with integrated request-to-exit switches
- Power-transfer Door Hinges
- Door-Position Switches

Agency-furnished, Division 28 contractor-installed
Division 28 contractor-furnished, Division 28 contractor installed

- Control Panels (Controllers)
- Control Panel Enclosures

Cabling:
- Field Device to Controller (incl. signal and power)
- Network Cabling (Controller to Network Switch)
- Cable Termination at Field Devices
- Cable Termination at Controller

- Control Panels (Controllers)
- Control Panel Enclosures
- Credential Readers and/or Keypads
- Door lock Power Supplies
- Access Control System Final Check-Out and Commissioning

Agency-furnished, Agency-installed or Existing

- Badging System
- Central Equipment Hardware
- Central Equipment Software / Credential Database
- Database Updates (door assignments, scheduling other programming)
- Network Switches

All raceways and pull boxes, conduit and cables supports, grounding hardware, and bonding as required for a full and functioning system shall be installed and documented by this Division 28 Contractor, as detailed in this and related section(s).

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

Section 01 91 01 or 01 91 02 – Commissioning Process
Section 08 71 00 – Door Hardware
Section 26 05 26 – Grounding and Bonding for Electrical Systems
Section 26 05 29 – Hangers and Supports for Electrical Systems
Section 26 05 33 – Raceway and Boxes for Electrical Systems
Section 26 05 36 – Cable Tray for Electrical Systems
Section 26 05 53 – Identification for Electrical Systems
Section 27 05 53 – Identification for Communications Systems
Section 27 10 00 – Structured Cabling

QUALITY ASSURANCE

Bidder Qualifications

The intent of these quality assurance requirements is to ensure that the installing contractor has the capabilities to engineer, install, and commission the devices as specified under this section.

Installing contractor must be a firm specializing and experienced in Access Control system installation for no less than 3 years.

Installing contractor must be a branch office or an authorized representative of the manufacturer of the specified Access Control System “as required to support the required warranty. Such authorization must have been in effect for a period of not less than three years at the time of Bidding and remain so throughout project.

Installation of equipment and cabling shall be done by qualified staff in the direct employ or directly subcontracted and under the supervision of the manufacturer or Authorized Representative.
REFERENCES
All work and materials are to conform to applicable rules and requirements of the Wisconsin State Electrical Code (SPS 316), the National Electrical Code (NFPA 70), other applicable National Fire Protection Association codes, the National Electrical Safety Code, Federal Communications Commission (FCC) rules, and present manufacturing standards (including NEMA).

All materials shall be listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

Other applicable standards are as follows:
FCC Part 15 as applicable to the equipment type(s) included
UL 294 Standard for Access Control System Units

INSPECTIONS AND PERMITS
Refer also to Division 1, General Conditions, Permits, Regulations, Utilities and Taxes.

Obtain and pay for all required state or local installation inspections and permits except those provided by the Architect/Engineer. Deliver originals of required certificates to DFD Construction Representative. Include copies of the certificates and reports in the Operating and Maintenance Manuals.

SUBMITTALS
General
Under the provisions of Division 1, prior to the start of work, submit:
• Bidder Qualifications
• Shop Drawings

Group Submittals to include complete documentation of related systems, products, and accessories in a single submittal.

Submittals shall be electronic format (ADOBE Portable Document format “.pdf”) thereof.

Bidder Qualifications
Furnish documentation of contractor capabilities as identified under “Quality Assurance / Bidder Qualifications” above.

Where installing contractor is an authorized representative of the Card Access System manufacturer, submit written confirmation of such authorization from the manufacturer. Indicate in letter of authorization that installing contractor has successfully completed all necessary training required for engineering, installation, and commissioning of equipment. Letter should indicate the start date of such authorization.

Shop Drawings
• Product data for all equipment, hardware cabling and miscellaneous components proposed.
• Schematic drawings - specific to project - of all circuits from the field devices to the required connection points. The diagrams shall show schematic wiring of equipment and all connections to be made to devices. Terminal connections in the equipment shall be numbered to correspond to the diagrams for use in making connections. Wiring diagrams shall be coordinated so that terminal numbering, circuit designation and equipment or device designations are the same on all drawings. All drawings must be submitted and approved by the Engineer before installation starts, but such approval will not waive specification requirements unless specifically stated.

Mark submittal package with specification section number. Do not mix sections in a single submittal.

Work shall not proceed without Engineer approval of the submitted items.
No substituted materials shall be installed except by written approval from the Engineer.

**Test Plan**
Submit Test Plan during construction. See Part 3.

**Mock-ups**
Upon request, provide a mock-up of Control Panel enclosure. Include applicable hardware, cabling, interface types (barrier strip, modular jack, etc.).

**PART 2 - PRODUCTS**

**GENERAL**
All contractor-furnished items shall be compatible with the existing system as identified above.
New system devices installed as part of this project will integrate into the existing campus-wide system. No substitutions will be allowed unless otherwise noted.

Licensing where applicable will be provided by the owner.

**CONTROL PANEL (CONTROLLER)**

**Control Panel and Enclosure**
Control Panel: Mercury Controllers
Control Panel Enclosure: Kele 30” x 42”, or as required.

**CREDENTIAL READERS AND KEYPADS**

**Proximity Card Reader**
Frequency: 125 kHz and 13.56 MHz.
Output format: Wiegand and Open Supervised Device Protocol (OSDP)
Read Range: up to 8.0 inches (Wall-mount); up to 6.0 inches (Mullion-mount). Dependent upon installation conditions and credential type.
Power: 5-16 VDC
Bluetooth enabled to support mobile devices.
Able to support Smart Card Operating System (SCOS) type cards.
Polycarbonate housing, IP55 rated for indoor and outdoor use, operating temperature of -22 to 150 degrees Fahrenheit.
Reader provides visual – typically a change in color of LED from red to green – and an audible indication of acceptance or denial of credentials when card is presented to the reader.

**Mullion-mount: HID Signo 40**
Proximity Card Readers manufactured by others shall be considered equals provided they meet or exceed in performance and quality as specified.
Color: Architect to select standard color option. Confirm during shop drawing review.
MISCELLANEOUS FIELD DEVICES

Request-to-Exit (REX)
Refer to drawings and schedules for applicable REX type(s).
Integral to Door Hardware type: By Division 08 Contractor.

Door Position Switches
Refer to Door Hardware specifications for make and model number.
By Division 08 Contractor.

CABLING
General
All cables shall be suitable for installation in the environment defined.
Any cabling installed unenclosed shall meet a CMP rating (or approved substitutes as defined by the referenced NEC).
Cables shall be Underwriters Laboratory (UL) listed and comply with Article 800 (Communications Circuits) of the National Electrical Code.

Field Device to Controller
Per manufacturer’s recommendations.

Horizontal (Telecom) Cabling
Refer to specification Section 27 10 00 – Structured Cabling for cable and termination requirements for horizontal links designated for Access Control System locations.

PART 3 - EXECUTION

GENERAL
The complete installation shall be done in a neat, workmanlike manner in accordance with Division 26 of these documents and manufacturer’s recommendations.
Review the project drawings to identify rough-in, cabling and device requirements of all controlled and monitored doors.

COORDINATION
Coordinate with the Division 08 contractor regarding the doorframes and hardware equipment which is associated with the Access Control System. Verify rough-in and installation requirements for all door frame mounted and/or door mounted control and monitoring equipment.
Prior to start of construction, confirm installation requirements with the Agency. The coordination shall include, but not be limited to, hardware, cabling and wiring requirements including types, sizes, color-coding schemes, labeling, wire way requirements, termination responsibilities, and cable identification requirements.
Prior to the start of system installation, schedule and facilitate a pre-installation meeting with the pertinent hardware, lock, exit device, and door closer manufacturers’ representative(s), UW Police Department representative, and related trades to coordinate materials, techniques, and to sequence complex hardware items and system installation. Proper installation and adjustment of hardware is to be reviewed. Convene at least one week prior to commencement of access control installation. Provide written documentation of the meeting including date, attendee/participant list and minutes. Distribute to A/E, Agency and DFD within seven (7) days of the meeting date.
Coordinate with Division 26 installer to confirm required cabling pathways, device rough-ins, and line-voltage power requirements.

Coordinate hardware placement, cabling, and interface requirements relating to elevator cab-mounted credential readers (if applicable) with the elevator contractor.

**CONTINUITY OF EXISTING SERVICES AND SYSTEMS**

No outages shall be permitted on existing systems except at the time and during the interval specified by Agency and site representatives. Obtain written approval for any outages.

Schedule any outage when the interruption causes the least interference with normal site schedules and business routines. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours.

Refer to General Requirements.

Restore any service interrupted as a result of this work to proper operation as soon as possible.

**INSTALLATION**

**General**

Receive, store and install Access Control System equipment and cabling as specified.

Comply with the manufacturer’s instructions and recommendations for installation of all products.

Provide all system wiring between all components in accordance with manufacturer’s guidelines. Each cable for each device shall be home run. No splices are allowed unless otherwise noted.

Intermediate termination points within a wire run would be considered a splice. If intermediate termination points are allowed, with prior approval of the Agency and the Engineer, provide pull boxes and terminal strips permanently labeled with the numbering scheme per Agency’s requirements.

Mount all credential readers where shown on plans. Placement shall be in accordance with Americans with Disabilities Act (ADA) requirements.

Provide wiring to request-to-exit devices located in electrified door hardware.

**Controller Installation - General**

Install, wire, and power per manufacturer’s recommendations.

**Cable Installation - General**

Route Cable for field devices in raceway unless otherwise noted.

Route system cabling to equipment per the Access Control System installation diagrams. Provide all interconnecting cabling from the head-end, between controllers, and between peripheral devices.

Route cabling/conduit on secure side of door.

Where cables are to be installed unenclosed (without raceway) the cable shall meet NEC requirements for the application and installation environment. See Cable Installation - Unenclosed below.

Route in conduit, all exposed vertical cable extensions to devices located below the finished ceiling.

Install and terminate cable as required at each door location.
Observe cable manufacturers minimum bend radius in all instances. Take care in the use of cable ties to secure and anchor the station cabling. Do not overtighten cable ties as to compress the cable jacket. No sharp burrs should remain where excess length of the cable tie has been cut.

All cable shall be free of tension at both ends. Provide strain relief connectors at each device and junction box where cables enter.

Use suitable cable fittings and connectors.

**Cable Installation – Unenclosed**

Where unenclosed cable installation is permitted and as designated on the plan drawings, route cabling to avoid areas of high traffic (i.e., aisle way) and as close as possible to outlining walls. Cable route shall be a minimum of ten (10) feet above finished floor. Provide protection for exposed cables where subject to damage.

Route cabling neatly at right angles and be kept clear of other trades work.

Support cabling at a maximum of 4-foot intervals utilizing “J-Hook” or “Bridle Ring” supports anchored to structure. Cable sag at mid-span shall not exceed 6-inches. Install supports to maintain cable bend to larger than the minimum bend radius.

Do not attach-to or support cabling from existing cabling, plumbing or steam piping, ductwork, suspended ceiling supports, or electrical or communications conduit. Do not place cable directly on the ceiling grid or attach cable in any manner to the ceiling grid wires.

Provide 4-feet slack in each cable in accessible ceiling at each device location. Secure cable slack-coiled from 100% to 200% of the cable recommended minimum bend radius– (wire tied) at the last cable support before the cable reaches the device and shall be.

**Field Device Installation**

Field devices are shown on the drawing locations diagrammatically and shall not be used for dimensioning of final location. The exact location of door control devices shall be determined by the Division 28 contractor and verified with the General and Division 08 contractors.

Multiple devices (i.e. intercoms, card readers, etc.) at door locations shall be mounted adjacent to each other.

Mount Credential Readers at 42” AFF to center unless noted otherwise on drawings.

Card reader stations shall not be mounted back-to-back on a common wall. Maintain separation to eliminate one card reader reading through the wall to a card reader on the opposite side.

When mounting credential readers on a new surface-mounted box, match box dimensions to the dimensions of the credential reader. (Example: For mounting HID ProxPro II 5455 or reader of similar dimension, a Wiremold V5752 2-gang alarm device box, or equivalent, is appropriate.)

Coordinate with Division 26 all 120-volt connections to access control panels, and at remote and local door power supply locations as indicated on the drawings.

**Door Control Interface Wiring**

Obtain from the Division 08 contractor all necessary cut sheets, wiring diagrams, and manufacturer’s installation instructions.

Install door control wiring at each door location according to manufacturer’s wiring instructions and as provided by the hardware supplier, including standard locations and all special function controls for interlocking doors and fire release door locations.
IDENTIFICATION AND LABELING
Label all installed electronic access control cabling and equipment.

Prior to installation, provide samples of all label types planned for the project. These samples shall include examples of the lettering to be used.

Label cables with the architectural door number for the opening served, the room number the opening is located in, the type of door device they serve ("reader", "REX", "lock", etc.), a unique numerical identification number for the control panel it originates in, and the room number the control panel is located in, on both ends of the cable. Example: “DOOR 1234A / RM 1234 / READER / CP 1 / RM B123”.

All system wiring shall be color coded as required by Agency. Maintain color coding and labeling throughout the system at all accessible locations to the cabling.

ACCEPTANCE TESTING
General
Conduct acceptance testing according to a schedule coordinated with the Agency and DFD.

Prior to testing, provide a summary of the proposed test plan. Test plan shall include – at minimum – proposed schedule, list of tests to be performed, equipment to be used, set-up, expected results and documentation format.

Testing shall not proceed without approval by the Engineer.

Schedule shall allow time for correction of defects and remedial work.

Representatives of the Owner may be in attendance to witness the test procedures. Provide a minimum of one (1) week advance notice to allow for such participation.

Supply all equipment and personnel necessary to conduct the acceptance tests.

Perform tests related to connected equipment of others only with the permission and presence of Contractor responsible for that equipment.

Assist the User Agency in the final system checkout and commissioning of the Access Control System.

Document all tests. Refer to the Article “DOCUMENTATION” below which details requirements.

Cable Testing
Visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. Provide the Engineer with written certification that this inspection has been made.

Test all cables to verify continuity in both door-open and door-closed conditions.

Test all cables for open circuits, ground faults or line-to-line short circuits.

System Testing
At minimum, verify the following are properly wired and labeled:
- Field Devices and Control Panels.
- Associated equipment such as Power Supplies.

Prior to the commencement of the Acceptance Tests, verify the installation and configuration of software related to the operation and control of the Access Control System.
Assist User Agency in testing overall functionality of the Access Control System. The tests shall include verification of the following:

- The functional operation of each controlled access door and circuit.
- Demonstrate normal and abnormal modes of operation and required responses to each.

**DOCUMENTATION**

**General**

Upon completion of the installation, provide project documentation to the Engineer for review.

Documentation shall include the items detailed in the sub-sections below. Provide approved test results and documentation in Operating and Maintenance Manuals.

At the request of any of the parties listed above, provide copies of the original test results.

Provide chart listing test results for each controlled door.

All documentation, including hard copy and electronic forms shall become the property of the State.

**Operation and Maintenance Manuals**

Submit quantities required by Division 1 and Section 26 05 00.

Provide documents in electronic format (Adobe Acrobat .pdf) and (when requested) hard copy.

At minimum, O&M Manuals shall include:

- Drawings annotated to show as-installed field device locations, cable routes, and major equipment locations
- Cabling Schematics
- Approved Submittals
- Test plan and test report sheets

**WARRANTY**

This Contractor shall guarantee the following for a period of two (2) years from date of substantial completion of this work:

- All provided materials and equipment
- Installation of all equipment, hardware, cabling and related components.

Warranties shall include labor, materials and travel time.

See Division 1, GENERAL CONDITIONS, and GENERAL REQUIREMENTS - Guarantee Documents and the individual technical sections for further requirements.

If while fulfilling requirements of this warranty, the Contractor disturbs other work, the Contractor shall arrange for such disturbed work to be restored to its original condition by the responsible Contractor. This shall be at no cost to the State.

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FOURTH LEVEL ELECTRICAL POWER PLAN

SCALE: 1/4" = 1'-0"

EX) L4NPL42- 4

SHARED OFFICE (2)

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LEVEL FOUR FLOOR PLAN - TECHNOLOGY

1. ALL INFORMATION OUTLETS SHOWN ON THIS SHEET SHALL BE SERVED FROM EXISTING TELECOM ROOM LOCATED AT 4244. FOR BID PURPOSES, ASSUME 275' PER DROP. COORDINATE PATCH PANEL PLACEMENT IN THE EXISTING TELECOM ROOM WITH DoIT NETWORK INFRASTRUCTURE.

2. INFORMATION OUTLET TYPE C4 IN THIS ROOM SHALL BE MOUNTED ON OVERHEAD TRAYS.

3. PROVIDE DIRECT FIBER OPTIC CABLE CONNECTION BETWEEN DEVICES. FIBER TYPE PER T5.1 RISER DIAGRAMS.

4. PROVIDE DIRECT CAT.6A CONNECTION BETWEEN DEVICES.

5. PROVIDE REDUNDANT FIBER OPTIC CABLE FOR MICROSCOPE. COIL MINIMUM 20' OF CABLE IN CEILING SPACE AT EACH END. FIBER TYPE PER T5.1 RISER DIAGRAMS.

6. PROVIDE HDMI 2.0 CABLE THROUGH UNDER CARPET RACEWAY TO BEHIND TV AT +72". HDMI CABLE SHALL RUN CONCEALED IN WALL AND THROUGH RECESSED 1.5" CABLE GROMMETT. CABLE SHALL HAVE 6' SLACK MINIMUM ON BOTH ENDS. CABLE GROMMETT SHALL BE BY C2G OR APPROVED EQUAL.

7. PROVIDE MULTI-PURPOSE CABLES FOR MEETING ROOM.

8. PROVIDE SHARED OFFICE SPACE IN CORRIDOR.

9. PROVIDE WORKSPACE FOR MICROSCOPE SERVICE.
3. CONFIRM CABLING PINNING CONFIGURATION WITH OWNER PRIOR TO START OF PROJECT. BLANK BLANK FILLER MODULE

THE FIRST MANUFACTURER LISTED IS THE BASIS OF DESIGN. "STANDARD COLOR" INDICATES FACTORY FINISH AVAILABLE AT NO ADDITIONAL CHARGE.

MANUFACTURER AND CATALOG NUMBER ONLY. EACH CONTRACTOR SHALL FIRST READ THE COMPLETE DESCRIPTION OF THE MATERIAL ON THESE DRAWINGS AND SPECIFICATIONS.

RESPONSIBLE FOR VERIFICATION OF QUANTITIES AND SHALL FURNISH ALL MATERIAL REQUIRED, WHETHER SPECIFIED OR NOT, TO PRODUCE A SATISFACTORY WORKING SYSTEM.

1. ELECTRONIC DOOR HARDWARE SUCH AS ELECTRIC STRIKES, ELECTRIC LATCH RETRACTION, ETC. SHALL BE PROVIDED AND INSTALLED BY OTHERS. REFER TO THE TECHNOLOGY EQUIPMENT SCHEDULE ON T5.1 FOR CREDENTIAL READER TYPE INFORMATION.

5. PROVIDE FIBER DISTRIBUTION CABINET AT DMP SERVER  FOR 24-STRAND FIBER OPTIC CABLE.

8. PROVIDE 24-STRAND SINGLE-MODE FIBER OPTIC CABLE FROM DMP SERVER TO EXISTING FIBER DISTRIBUTION CABINET.

LAB OUTLET WILL UTILIZE A CAT.6A CABLE. REFER TO INFORMATION OUTLET SCHEDULE ON THIS SHEET FOR MORE INFORMATION.

1. THIS RISER IS DIAGRAMMATIC AND MAY NOT SHOW ACTUAL ROUTING OR QUANTITIES OF MATERIALS SHOWN. THIS RISER IS KEYNOTE: 9. PROVIDE FIBER DISTRIBUTION CABINET AT DMP SERVER  FOR 24-STRAND FIBER OPTIC CABLE.

8. PROVIDE 24-STRAND SINGLE-MODE FIBER OPTIC CABLE FROM DMP SERVER TO EXISTING FIBER DISTRIBUTION CABINET.