UCDAVIS
HEALTH SYSTEM

UC DAVIS MEDICAL CENTER

A/C 9557740
SESP 1742 1P745 CT SCANNER REPLACEMENT

FACILITIES DESIGN AND CONSTRUCTION
4800 2ND AVENUE, SUITE 3010
SACRAMENTO, CA 95817
916-734-7024
WWW.UCDMC.UCDAVIS.EDU/FACILITIES/

100% CONSTRUCTION DOCUMENTS

HCAI PROJECT #: S241219-34-00

VOLUME 2

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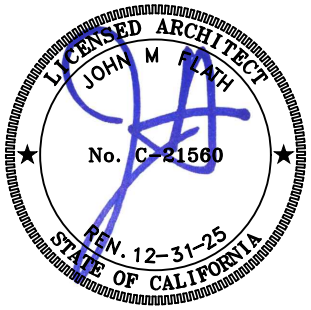
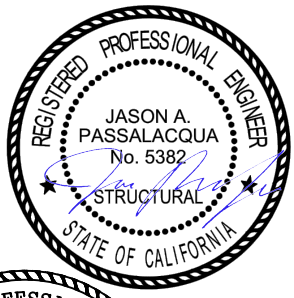
SIGNATURE SHEET



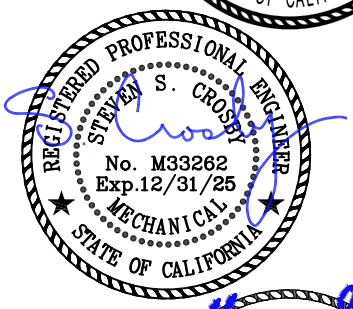
ARCHITECT

John Flath, AIA
Nacht and Lewis Architects
600 Q Street, Suite 100
Sacramento, CA 95811
916.329.4000



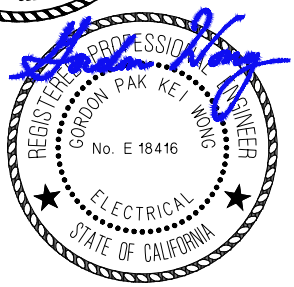
STRUCTURAL ENGINEER

Jason Passalacqua, PE
Buehler & Buehler Structural Engineers, Inc.
600 Q St, Suite 200
Sacramento, CA 95811
916.443.0303



MECHANICAL & PLUMBING ENGINEER

Scott Crosby PE
R&A Engineering Solutions, Inc.
601 University Drive, Suite 255
Sacramento, CA 95825
916.570.2827



ELECTRICAL ENGINEER

Gordon Pak Kei Wong, PE
EDGE Electrical Consulting.
400 R Street, Suite #333
Sacramento, CA 95811
916.256.2460

HCAI APPROVAL

REVIEWED IN ACCORDANCE WITH
THE REQUIREMENTS OF T24, CCR

APPROVED
S241219-34-00

Ray Sanchez
Senior Architect
12/17/2024

Department of Health Care Access and Information
Office of Statewide Hospital Planning & Development

OSHPD PROJECT NO.: S241219-34-00

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END OF TOC

SECTION 108000
TOILET AND BATH ACCESSORIES

PART I - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Provisions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Washroom accessories.

1.03 ACTION SUBMITTALS

A. Product data.

B. Samples: For each exposed product and for each finish specified, full size.

1. Approved full-size Samples will be returned and may be used in the Work.

C. Delegated Design Submittals: For grab bars.

1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.04 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.05 CLOSEOUT SUBMITTALS

A. Sample warranties.

1.06 WARRANTY

A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART II - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance: Design accessories and fasteners to comply with the following requirements:

1. Grab Bars: Installed units are able to resist 250 lbf (1112 N) concentrated load applied in any direction and at any point

2.02 MANUFACTURERS

A. Single Source Responsibility: Provide products of each type from a single manufacturer for entire Project.

B. Accessories:

1. Basis of Design Products: Subject to compliance with requirements, provide products by the following manufacturer:

a. Bobrick Washroom Equipment, Inc., 6901 Tujunga Ave.; North Hollywood, CA 91605-6213; Tel: 818-764-1000; web: www.bobrick.com

2. Acceptable Alternate: Subject to compliance with requirements, equivalent products by one of the following may be provided with written acceptance of the Architect.

a. American Specialties, Inc. (ASI); web: www.asigroup.us.

b. Bradley Corporation; web: www.bradleycorp.com.

c. Substitutions: Section 01 25 00..

2.03 MIRROR

A. Basis-of-Design Product: Bobrick B-165 Series.

B.

2.04 HAND HYGIENE DISPENSERS (U.F.C.I.)

A. ADA Compliant Surface-Mounted Hand Hygiene Dispenser.

1. Ecolab Model 9202-1193 (Hands-free model.)

2. Ecolab Model 9202-3603. (Manual model.)

2.05 PAPER TOWEL DISPENSERS (U.F.C.I.)

A. ADA Compliant Surface-Mounted Continuous Hand Towel Dispenser: Unit shall be continuous flow type.

1. Tork Model 552528 (Large model.)

2. Tork Model 552538 (Mini model at locations where Large will not fit.)

2.06 TOILET TISSUE DISPENSERS (U.F.C.I.)

A. ADA Compliant Toilet Tissue Dispenser: Unit shall be continuous flow type. Dispensers that control delivery shall not be used per CBC 11B-604.7.1.

B. Surface-Mounted Toilet Tissue Dispensers For Two Rolls:

1. Tork Model SCA 5555290.

2. Capacity: 2 rolls - 2.3 inch core toilet tissue rolls up to 7.4 inch diameter

2.07 TOILET SEAT COVER DISPENCER

A. Basis-of-Design Product: Bobrick B-221 Series.

2.08 GRAB BARS

A. Basis-of-Design Product: Grab Bar with snap flange covers, satin finish, and in lengths as shown on drawings: Bobrick B-5806 Series.

1. Compliance: Universal/accessibility design, including ADA-ABA and ICC/ANSI for structural strength.

a. Capacity: Designed to support 900 lbs. (408 kg) in compliant installations.

2. Description: Grab bar with 90 degree return to flange. Clearance between grab bar and finished wall is 1-1/2 inches (38mm).

3. Grab Bar Materials: 18-8, Type 304, 18 gauge (1.2mm) stainless steel tubing with satin finish, ends of grab bar pass through flanges and are heliarc welded to flanges to form one structural unit, outside diameter 1-1/4 inches (32mm).

4. Mounting Flanges: Concealed, 18-8, Type 304, 1/8 inch (3mm) thick, stainless steel plate.

a. End Flanges: 2 inches x 3-1/8 inches (50mm x 80mm) with two holes for attachment to wall.

b. Intermediate Flanges: 2-5/8 inches x 3-1/8 inches (65mm x 80mm) wide x 3-1/8 inch (80mm) diameter.

5. Snap Flange Covers: 18-8, Type 304, 22 gauge (0.8mm) drawn stainless steel with satin finish, 3-1/4 inch (85mm) diameter x 5/8 inches (16mm) deep; snap over mounting flange to conceal mounting screws.

6. Mounting Accessories: Provide the following optional mounting accessories as scheduled and indicated on the Drawings and as required for complete installation.

a. Mounting Kits: Provide optional Bobrick Part No. 252-30 Mounting Kit; 3 Type 304 stainless steel, Phillips round-head, sheet-metal screws for each flange.

b. Grab Bar Fasteners: Provide optional Bobrick Part No. 251-4 WingIt Grab Bar Fastener; round-head, Phillips 18/8 stainless steel screws and grab bar fastener for each flange.

c. Anchor Devices: Provide optional Bobrick Part No. 2586 Optional Mounting Kit; for 1/2 inch (13mm) panels for each flange

2.09 HOOKS

A. Hat and Coat Hooks:

1. Basis of Design: Bobrick Model B-682 / 6827

2. Finish: Bright polish or satin as selected by Architect.

3. Projection from Wall: 3-1/16 inch (80mm).

4. Flange and Support Arm: 18-8, Type 304, 22 gauge (0.8mm) stainless steel.

5. Mounting: Concealed bracket, all-welded, 16 gauge (1.6mm) stainless steel; secured to wall plate with a stainless steel setscrew.

6. Concealed Wall Plate: 18-8, Type 304, 16 gauge (1.6mm) stainless steel.

7. Hook: 18-8, Type 304, 12 gauge (2.8mm) stainless steel, welded to support arm

2.10 PERFORMANCE REQUIREMENTS

A. Structural Performance: Design accessories and fasteners to comply with the following requirements:

1. Grab Bars: Installed units are able to resist 250 lbf (1112 N) concentrated load applied in any direction and at any point

2. Or equal.

PART III - EXECUTION

3.01 INSTALLATION

A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to comply with specified structural-performance requirements

END OF SECTION 10801

SECTION 130900
RADIATION PROTECTION

PART I – GENERAL

1.01 SECTION INCLUDES

A. Sheet lead applied to gypsum board.

B. Sheet lead applied to gypsum plywood.

C. Lead lined doors.

D. Lead lining to door and glazed frames.

E. Leaded glass.

1.02 RELATED SECTIONS

A. Division 8, Section 081000 – HOLLOW METAL DOORS AND FRAMES

B. Division 8, Section 082100 – WOOD DOORS

C. Division 8, Section 087100 – FINISH HARDWARE

D. Division 8, Section 088100 – GLASS AND GLAZING

E. Division 8, Section 092500 – GYPSUM BOARD

F. Section 099000 – PAINTING

1.03 REFERENCES

A. ASTM B 29 – Standard Specification for Refined Lead.

B. ASTM B 749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.

C. ASTM C 1048 - Standard Specification for Heat-Treated Flat Glass--Kind HS, Kind FT Coated and Uncoated Glass.

D. ASTM C 1396/C 1396M - Standard Specification for Gypsum Board.

E. ASTM D 5516 – Standard Test Method for Evaluating the Flexural Properties of Fire-Retardant Treated Softwood Plywood Exposed to Elevated Temperatures

F. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials

G. ASTM E 119 – Fire Tests of Building Construction and Materials.

H. NCRP Report 49 - Structural Shielding Design and Evaluation for Medical Uses of X Rays and Gamma Rays of Energies up to 10 MeV; National Council on Radiation Protection and Measurements.

I. NCRP Report 147 – Structural Shielding Design for Medical X-Ray Imaging Facilities.

J. Comply with requirements of CCR Title 24 where standards and criteria exceed NCRP Reports No. 49 and No. 147.

K. U.S. Department of Labor Occupational Safety and Health Administration (OSHA):
   1. OSHA standard 29 CFR 1910.1025 – Lead.
   2. OSHA standard 29 CFR 1926 – Safety and Health Regulations for Construction.
   3. OSHA standard 29 CFR 1926.62 – Lead.
   4. CAL-OSHA Title 8 Sec 1532.1, Sec 5198, and Sec 5216

1.04 DEFINITION

A. Radiation Protection: Contain, without leakage, emitted radiation from radiology equipment scheduled for installation (see drawings), measured at wall surface with a measuring device simulating the emitting equipment.

B. Protection: Walls, fixed control screens, including wall interruptions for doors, and glazing.

1.05 SUBMITTALS

A. See Section 013300 - Shop Drawing, Product Data and Samples, for submittal procedures.

B. Shop Drawings: Indicate layout, details, dimensions, interface with adjoining work.

C. Product Data: Provide data on leaded glass, leaded plastic, and lead-lined systems.

D. Manufacturer's Certificate: Certify that lead-lined gypsum board and plywood systems and all related items to be furnished hereunder, meet or exceed the requirements specified under this Section and are in compliance with Physicist of Record report(s), and that the applicator is qualified and approved to install the materials in accordance with manufacturer's product data.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with NCRP Reports No. 49 and No. 147.

B. Maintain one copy of each document on site.

C. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

D. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years documented experience.

E. Single Source Responsibility: Provide radiation protection materials, equipment and accessories produced as standard products from a single manufacturer, regularly engaged in the protection of x-ray shielding material.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Lead-Lined-Door Frames: Comply with applicable requirements of Section 081000 – Hollow Metal Door and Frames. Protect frames during transit, delivery, storage and handling to prevent damage.
   1. Deliver frames crated to provide protection during transit and job storage.
   2. Inspect frames for damage upon delivery. Repair minor damage, provided repaired finish is equal in all respects to new work and is acceptable to Architect; otherwise, remove and replace damaged frames.

3. Store frames under cover. Place on wood supports at least 4 inches high, or on floors in manner that will prevent rust and damage.

B. Lead-Lined Wood Doors: Comply with applicable requirements of Section 082100 - Wood Doors. Protect doors during transit, storage and handling to prevent damage, soiling and deterioration.
   1. Comply with manufacturer's instructions and National Wood Manufacturers Association (NWMA) recommendations on care and finishing of wood doors.
   2. Packaged prefinished doors individually at factory prior to shipping, using manufacturer's standard plastic or paper wrapping.

C. Lead-Lined Gypsum Board and Plywood: Comply with applicable requirements of SECTION 092500 - GYPSUM BOARD ASSEMBLIES and SECTION 061000 - ROUGH CARPENTRY. Protect all materials during transit, delivery, storage and handling to prevent damage.
   1. Deliver materials in original packages, containers or bundles bearing brand name and identification of manufacturer or supplier.
   2. Store materials inside under cover. Keep materials dry, protected from weather, surface contamination and damage from construction traffic and other causes.
   3. Handle to prevent damage to edges, ends or surfaces.
   4. Avoid breaking adhesive bond between lead sheets and substrate materials.

D. Lead Glass: Clear, Lead-bearing for x-ray radiation protection, thickness to specified lead equivalent according to shielding report.

E. See Section 016100 – Product Requirements

1.08 REGULATORY REQUIREMENTS

A. Conform to applicable health and occupation code for integrity of radiation protection and continuity of protected construction.

1.09 PRE-INSTALLATION MEETING

A. Convene one week prior to commencing work of this section.

1.10 PROJECT CONDITIONS

A. Coordinate the work with construction of partitions, placement of frames.

PART II – PRODUCTS

2.01 X-RAY RADIATION PROTECTION MANUFACTURERS

A. Manufacturers:
   1. A & L Shielding Inc. or equal
   2. Ameray Corporation.
   3. Atomic Industries, Inc.
   4. NELCO
   5. Ray-Bar Engineering Corp.
   6. Or equal.

B. Sheet Lead and Associated Materials:
   1. Sheet Lead: ASTM B 749, and Federal Specification QQ-L-201F, Grade C, lead (lbs/sq ft) as indicated on drawings.
   2. Gypsum Board: ASTM C 1396/C 1396M, paper/paper faced, square edges and square ends; 48” x 96” size, 1/2” or 5/8” thick.

3. Fire Rated Gypsum Board: Min. 5/8" thick, where required as part of a rated assembly laminate lead to back of gypsum board approved as part of specified UL rated assembly.
4. Plywood Panels: EWA graded CDX INT, Group 2 species, touch-sanded, fire-retardant treated having Underwriters Laboratories stamp signifying a FR-S rating certifying a 25 or less flame spread and smoke developed value, when tested in accordance to ASTM E-84. Board thickness shall be as indicated on the Drawings.
   a. Fire-retardant-treated wood products shall be free of halogens, sulfates, ammonium phosphate and have no added formaldehyde.
   b. Size limitations for CDX Plywood is 48" x 96" x ¾" thickness.

5. Screws/Nails: Standard steel screws or nails for wood or steel stud application.

C. Fabrication:
1. Lead Laminated Gypsum Board: Fabricate with a single thickness, unpierced, monolithic sheet of lead bonded to one surface of board, extend lead sheet 1" beyond one side and one end of board.
2. Lead Lined Wood Doors: Specified in Section 082100 - Wood Doors
3. Lead Lined Door and Glazed Frames: Specified in Section 081000 – Hollow Metal Doors and Frames
4. Lead Batten Strips (Ribbon Lead): lead strips, free from any imperfections, conforming to ASTM B29, having same thickness as lead lining on plywood. Provide 2 inch [50mm] wide lead strips for straight runs and 3 inch [76mm] wide lead strips at corners as required.
5. Lead Lining at Electrical Boxes, Medical Gas Penetrations, and Similar Conditions: Shall be shielded with the same thickness as lead in walls.
6. Hardware: Specified in Section 087100.

D. Components and Accessories:
1. Leaded Glass: ASTM C 1048 fully tempered, clear, lead content equivalent to protection requirements of adjacent lead sheet protection.
2. Control Windows: Prefabricated lead frame, thickness to suit wall; included with lead glass glazing strips, anchors and fasteners. Construct frame to overlap lead plastic perimeter not less than ⅜" and provide removable glass stops.
3. View Window Frames and Clear lead plastic.
4. Window Glazing Screws: Steel.
5. Radiation Protection Plaque: Wall mounted, designating lead thickness in wall, degree of continuity, exceptions.
6. All components and accessories to meet manufacturer's standards maintaining equivalent system protection.
7. Lead Lined Astragals are utilized between a pair of lead lined doors. Shielded astragals are to be 2" wide 304 stainless steel with a vertical #4 brush grained finish with required lead lining the height of the door

E. Finishes:
1. Field painted surfaces: As specified in Section 099000 - Painting.

PART III – EXECUTION

3.01 EXAMINATION

A. Verify that substrate construction is ready to receive work and opening dimensions are as indicated on shop drawings.

B. Request inspection by UCD Health Physicist for all radiation protection materials prior to installing, and all lead protections, patches or penetrations installations prior to installation of gypsum board as specified in Section 014550.

3.02 INSTALLATION - SHEET LEAD

A. Lap edges and ends of lead sheets 1". Apply lead patches, same thickness as lead sheet, over penetrations (except screw heads), to achieve continuity of protection.

B. Extend lead protection from finished floor to a height of 84".

C. Comply with OSHA requirements for lead handling, cutting, installing, and disposal. Use only non-powered tools to cut gypboard. Other requirements include use of gloves when handling lead, eye protection, floor protection, and proper disposal of lead and lead shavings.

D. Refer to the UCDH Physicist report at the end of this section.

3.03 INSTALLATION - COMPONENTS AND ACCESSORIES

A. Install components and accessories in accordance with manufacturer's instructions as shown, and as specified.

B. Install lead lined frames as specified in the section where the frames are specified and in accordance with the lead lining fabricator's instructions.

C. Install lead lined doors as specified in the section where the doors are specified; coordinate installation of door hardware.

D. Install lead-lined gypsum board over support with lead face against supports, with steel fasteners spaced at 4" on center. Lap edges and ends of lead 1". Apply lead patches with same thickness as lead sheet over penetrations, except screws.
   1. Predrill gypsum board or drill pilot holes for fasteners to prevent deformation of fasteners and distortion of gypsum board.
   2. Apply gypsum board with long edged parallel to supports and lead lining facing supports. Provide blocking at end joints. Install lead strips 1-½" wide and same thickness as gypsum board lead lining to face of supports and blocking where joints occur. Secure lead strips to blocking and supports with fasteners along outer edge.
   3. Fasten gypsum board to supports with standard steel fasteners spaced as recommended by board manufacturer. Drive fastener heads slightly below exposed surface.
   4. Comply with all provisions of Section 09250 - Gypsum Board, for joint treatment and preparation for finishing.

F. Install leaded glass in prepared frames in accordance with "wet method" described in Section 08810 – Glass and Glazing.

G. Install floor lead per specification 130900 2.01.B.1 adhere the lead to the existing concrete deck with epoxy and roll the material flat with a weighted roller to get the lead smoothed out completely. Apply a thin coat of Ardex self leveling flooring material over the lead shielding and transitional areas to create an even level floor. Do not sand the floor after leveling that could expose the lead shielding. Apply flooring over the Ardex surface.
   1. Sheet Size: Required width, length and area as shown on plans, multiple pieces for overall required area coverage is acceptable with proper overlaps not less than ½".
   2. Floor to be smooth, flat, level, clean and free of dust or oil for application of the lead shielding.
   3. Lead to be clean and degreased. Adhesive or mastic to be rated for the proper bonding of metal.
   4. Apply sheet lead in required single thickness and size, or as multiple pieces for area coverage.
   5. Joints to have a minimum of ½" overlap. All lead to be bonded tight and rolled flat on floor.

3.04 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 014550 - Inspection of Work.

B. Inspection and testing will be performed by a Health Physicist or Medical Physicist of the University Office of Environmental Health and Safety (EH&S) in coordination with regulatory agency requirements, to ascertain conformance of installation regarding radiation passage for leakage.

C. Repair or replace defective work including other work affected thereby and conduct additional testing to satisfaction of health physicist, at no additional expense to Owner.

3.05 PROTECTION

A. See Section 016100 – Product Requirements.

3.06 CLEANING

A. See Section 017400 - Cleaning.

END OF SECTION 130900

SECTION 132810
HAZARDOUS MATERIALS MANAGEMENT – LEAD & OTHER HAZARDOUS MATERIALS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. WORK INCLUDED - GENERAL

1. The Contractor shall furnish all labor, material, equipment, services, testing, employee training, respirator fit testing, medical exams, transportation, and daily expense to meet the requirements of this Specification.
2. The Contractor shall obtain all required permits, licenses, registrations, notifications, and regulatory approvals required by law (federal, state and local) and University of California Davis Medical Center (UCDMC) policy.
3. All lead-related activities associated with this Contract shall be performed during the work period specified in each contract.
4. The Contractor shall guard against unnecessary disturbances or damage to sensitive finishes on buildings, building systems, and equipment.

B. WORK INCLUDED – SPECIFIC

1. The Contractor is responsible for identifying the exact locations and number of work areas listed below by referring to University supplied Project Drawings and by working with the University's Representative or University's Hazardous Materials Consultant.
2. This project includes work on building components that are known to contain lead, specifically lead lined walls, cabinets, and doors. This project is a renovation project and not considered a lead abatement project with regards to the requirements of Title 17. Cal/OSHA Title 8 1532.1 Lead in Construction worker health and safety regulations apply.

1.2 SITE CHARACTERIZATION

No testing of materials was conducted for this project, since some of walls, doors and Biodex cabinets are known to contain lead sheeting.

Building Component	Substrate	Color	Test Location
Lead Lined Walls	Gypsum	N/A	See Drawings
Lead Lined Doors	Unknown	N/A	See Drawings

A. Hazardous materials, other than lead sheeting or lining that have the potential to be disturbed at this Project site are listed in the table below:

Material Description	*Type of Hazard*	Location
Fluorescent Light Bulbs	Mercury	See Drawings
Light Ballasts	Universal Waste	See Drawings
Mold Contamination	Mold	Possible minor amounts at base of walls from housekeeping activities

B. Where light fixtures are required to be removed, the Contractor shall recycle all fluorescent light tubes and non-PCB containing ballasts as Universal Wastes as required in Title 22. Packaging of light tubes and light ballasts shall be in accordance with regulatory standards for safe storage and transport by a hazardous waste hauler.

C. Prior to handling other hazardous materials at the Project site, the Contractor shall review University's protocols with a UCDHS EH&S Representative.

1.3 ABBREVIATIONS AND DEFINITIONS

A. Abbreviation

AA	Atomic Absorption – Flame (EPA SW-846)
ABATEMENT	Removal of all Lead in the Building/Location or Specific Component
AIHA	American Industrial Hygiene Association
AL	Action Level (30 μg/M^3 per 8 hour TWA)
BLL	Blood Lead Level
CCR	California Code of Regulations
CDPH	California Department of Public Health
CEPA	California Environmental Protection Agency
CFR	Code of Federal Regulations
CSLB	Contractor's State Licensing Board
DIR	Division of Industrial Relations
dL	Deciliter
DOSH	Division of Occupational Safety and Health
DOT	Federal Department of Transportation
DTSC	California Department of Toxic Substances Control
EH&S	Environmental Health and Safety - UCDHS
ELLAP	Environmental Lead Laboratory Accreditation Program
ELPAT	Environmental Lead Proficiency Analytical Testing Program
EPA	U.S. Environmental Protection Agency
FVC	Forced Vital Capacity
FEV	Forced Expiratory Volume
GFCI	Ground Fault Circuit Interrupter
HEPA	High Efficiency Particulate Air
HUD	U.S. Department of Housing and Urban Development
HVAC	Heating, Ventilation, and Air Conditioning
ICRA	Infection Control Risk Assessment
INTERIM CONTROLS	Removal at specific locations to accommodate remodel < 20 years
LBP	Lead Based Paint (paints, varnish, shellac, etc. >0.5% lead by weight, >5,000 ppm, or > 1.0 mg/cm^2)
LCM	Lead Containing Material – materials tested to contain any measurable levels of lead
μg	Microgram = part per billion (ppb)
SDS	Safety Data Sheet

NAAQS	National Ambient Air Quality Standards
NAM	Negative Air Machine
NESHAP	National Emissions Standard for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NPE	Negative Pressure Enclosure
NVLAP	National Voluntary Laboratory Accreditation Program
O&M	Operations and Maintenance
OSHA	Federal Occupational Safety and Health Administration
PEL	Permissible Exposure Limit (50 μg/M^3 8 hr. TWA)
PLCM	Presumed Lead Containing Material
PPE	Personal Protective Equipment
RCRA	Resource Conservation and Recovery Act
TCLP	Toxicity Characteristic Leaching Procedure (mg/L)
TTLC	Total Threshold Limit Concentration (wet-weight mg/kg)
TSP	Trisodium Phosphate
TWA	Time Weighted Average
STLC	Soluble Threshold Limit Concentration (mg/L)
UCDHS	UC Davis Health System
ULPA	Ultra Low Penetrating Air
XRF	X-ray Fluorescence
ZPP	Zinc Protoporphyrin

B. Definitions: The following definitions are provided for additional clarification and may exceed Federal, State or local regulatory requirements.

1. Lead Abatement - “Abatement” means any set of measures designed to reduce or eliminate lead hazards or lead-based paint for public and residential buildings, but does not include containment or cleaning.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23 Shop Drawings, Product Data and Samples, and Section 01 77 00 Closeout Procedures.

B. Submit proposed material substitutions complying with requirements listed in Section 01 60 00 Product Requirements.

C. References: Submit names, addresses and telephone numbers of Project Managers or Owners (not employed by Contractor) for whom Contractor has performed jobs of similar size and character to the work specified in this Contract.

D. General: Submittal requirements listed below shall be completed and accepted by University’s Representative prior to scheduling the start of project site work. Work shall not begin until such approval has been given, and a bound copy of project submittal is placed at an easily accessible location at the project site.

E. Notifications and Permits: Submit copies of all regulatory agency notifications and permits.

1. Contractor is required to submit a “Lead-Work Pre-Job Notification” (8 CCR 1532.1(p)) for all projects, if there is greater than 100 square feet or greater than 100 linear feet of materials containing lead greater than 5,000 ppm, 0.5% by weight, or 1.0 mg/cm^2 to be removed. If these quantities are exceeded, a copy of the notification to Cal/OSHA shall be provided to the UCDHS EH&S Representative.

2. Since are more than 100 square feet of lead line building components that will be removed on this project, written notification to Cal/OSHA is required.

F. Worker Training and Safety Programs

1. Training Certificates: For each employee who will be employed on the Project, submit a copy of employee's lead training that meets Cal/OSHA training requirements under Title 8 Section 1532.1 Lead in Construction. Based on the work being performed involving removal of lead lined gypsum walls, at a minimum, lead awareness training is required for this project.
2. Qualifications of person taking Personal Air Samples: Submit information regarding training and qualifications of the field technician who will be collecting personal air samples.

G. Safety Programs: On company letterhead, submit confirmation that the Contractor has written safety programs for:

1. Injury Illness Prevention (T8 CCR 3203) (mandatory for all projects),

2. Hazard Communication (T8 CCR 5194) (mandatory for all projects),

3. Fall Protection (T8 CCR 1620 – 1621, 1632 – 1633, 1635.1 – 1637, 1640 – 1655, 1669 – 1672, 3209 - 3239) (when applicable),

4. Lock Out Tag Out (T8 CCR 3314) (when applicable),

5. Confined Space (T8 CCR 5156) (when applicable).

6. Respiratory Protection (8 CCR 5144) (when applicable)

7. Medical Surveillance (8 CCR 1532.1(i)) (when applicable)

8. Lead Compliance (8 CCR 1532.1(e)(2)) (when applicable)

H. Work Plan and Schedule: Submit proposed Work Plan and schedule. The Work Plan shall be project specific and address project site preparation, site and engineering controls, worker protection and exposure monitoring, and protection of building occupants from exposure to lead. Schedule of work must be submitted and approved before work begins. University's Representative will forward a copy to the Hazardous Material Consultant for review prior to commencement of work.

I. Product Data Sheets and Safety Data Sheets (SDS): For all products proposed for use on the project, submit copies of the manufacturers' safety data sheets to the UCDHS EH&S Representative for review, and copies of the Product Data Sheets to the University Representative for review.

J. Laboratory Qualifications: For any laboratory performing lead analysis the Contractor shall submit evidence of ELLAP and ELPAT certification and accreditation. Laboratories performing worker exposure sample analysis must submit evidence of AIHA IHLAP certification for metals if they do not have ELLAP or ELPAT certification.

K. HEPA/ULPA Equipment Test: Submit copies of leak test (DOP tests) results to the University's Representative prior to starting project site work. Leak testing shall be performed at the project site and shall be witnessed by the UCDHS EH&S Representative or the Hazardous Materials Consultant. The leak test results shall identify equipment by

make, model and serial number. No equipment which fails the leak testing may be used at UCDHS, unless it is exclusively exhausts outdoors. Vacuums which fail may be used within full negative pressure enclosures at the discretion of UCDHS EH&S.

L. Emergency Contact List: Submit an emergency contact list; include name, phone number, fax number and pager number for Contractor's supervisor or competent person and subcontractor's telephone numbers who can be reached on a 24-hour basis.

M. Hazardous Waste Disposal Plan: Submit a Waste Disposal Plan that includes estimated number of containers), size of container(s), hazardous material transporter name and proposed disposal site or the recycling company before start of project. The disposal facility and recycling company shall be approved by the UCDHS EH&S representative prior to off-haul.

N. Lead As-Built Summary: Submit a Lead As-Built Summary within 14 calendar days of the last day of field Work and prior to a request for final application for payment. The summary shall include a description of lead containing materials that were removed and a description of lead containing materials that remain in the project area.

1.5 CONTRACTOR QUALIFICATIONS

A. Contractor licensing for this work will require a B, C33, or C61/D-38 and appropriate lead training for employees to perform lead related work.

1.6 RULES AND REGULATIONS

A. The Contractor shall comply with the most recent edition of applicable Federal, State, local, and University standards, laws, codes and regulations. If a conflict exists between referenced regulatory requirements and Contract Documents, the Contractor shall notify the University's Representative in writing and request the conflict be resolved. Contractor performing work contrary to mandated laws shall bear full legal and financial responsibility for the violations.

B. The list of regulators and regulations, cited below, serve as a reference for the most commonly used standards governing the lead industry:

1. FEDERAL REGULATORS AND REGULATIONS
   a. EPA - Environmental Protection Agency
      (1) 40 CFR Part 261 et al. - Resource Conservation and Recovery Act
      (2) Title X - Residential Lead Poisoning Prevention Act
      (3) National Ambient Air Quality Standards (40 CFR 50)
   b. OSHA - Occupational Safety and Health Administration
      (1) 29 CFR 1926.62 - Construction Lead Standard
      (2) 29 CFR 1910.1025 - General Industry Lead Standard
      (3) 29 CFR 1910.147 - Lock Out - Tag Out
   c. DOT - Department of Transportation
      (1) 49 CFR Parts 173, 178 and 179
2. STATE REGULATORS, LAWS AND REGULATIONS
   a. Cal/OSHA - California Division of Occupational Safety and Health
      (1) 8 CCR 1532.1 - Construction Lead Standard
      (2) 8 CCR 5216 - General Industry Lead Standard
      (3) 8 CCR 5194 - Hazard Communication
      (4) 8 CCR 5157 - Confined Space
      (5) 8 CCR 5144 – Respiratory Protection

(6) 8 CCR 3203 - Injury and Illness Prevention

b. DTSC - Department of Toxic Substances Control
   (1) (Health and Safety Code Chapter 6.5 Hazardous Waste Control, Article 6 Transportation and Article 6.5 Hazardous Waste Haulers
   (2) CCR, Title 22, Division 4, Sections 66000, et al.
c. CIWMB - California Integrated Waste Management Board
d. California Department of Public Health (CDPH)
   (1) CCR, Title 17, Division 1, Chapter 8
e. SWRCB State Water Resources Control Board – CCR, Title 23
f. CSLB - California Contractors State License Board
g. Health and Safety Code 25157.8 (AB 2784 Natural Resources)

1.7 NOTIFICATION AND PERMITS

A. The Contractor is responsible for notifying Federal, State and local agencies, obtaining all required permits/extensions and paying all related fees, as required.

B. UC Davis Health System

1. To obtain a Hot Work Permit from the UCDHS Fire Protection Office, call 916-734-3036 for instructions.
2. A Uniform Hazardous Waste Manifest shall be prepared by the Contractor or the transporter and approved by UCDHS EH&S for each load of hazardous waste transported from the work site. EH&S must notified at least 48 hours prior to the anticipated time of shipment for waste materials and for recycled materials.
3. Copies of records of non-hazardous waste removed from the project shall be provided to UCDHS EH&S, which may include Bill of Lading, non-hazardous waste receipts, etc.

C. Sacramento Metropolitan Air Quality Management District (SMAQMD) has no notification requirements for lead related work.

D. Contractor is to submit a Lead-Work Pre-Job Notification to CAL/OSHA as required by 8 CCR 1532.1.

1.8 UNIVERSITY CONTACTS

A. **University's Representative: Zach Price**

1. **Phone: 916-919-6319**

B. **UCDHS EH&S Representative:Kaila Benton-Vitz**

1. **Phone: 916-734-2740**
2. **Fax: 916-734-7309**

C. **University Hazardous Material Consultant: Entek Consulting Group, Inc.**

1. **Phone: (916) 632-6800**
2. **Fax: (916) 632-6812**

PART 2 - PRODUCTS

2.1 MATERIALS

A. Safety Data Sheets (SDS)

1. The Contractor shall provide SDS for all products used on UCDHS job sites. The SDS files shall be located near the Project site entrance at all times the product is used or stored onsite.

2. One complete set of Safety Data Sheets is to be provided to UCDHS EH&S for review prior to the start of work. (see 1.4I)

B. Encapsulants

1. It is not anticipated encapsulants will be required for this project. If used, the choice of the correct encapsulant for a project is determined by agreement between the Contractor and the University's Representative. Two factors to consider in the choice are wear life (aim for 20 years) and usage patterns. Products shall be applied using a brush, roller or an airless sprayer. The Contractor shall follow strict manufacturer's instructions regarding surface preparation, ambient air conditions, depth of material penetration, recommended thickness of a dry application, and curing time.
   a) For penetrating and lockdown purposes Foster 32-60, Certane 909, or equal is recommended.
   b) For bridging purposes Foster 32-32, Certane 2000, or equal is recommended.
   c) For high temperature applications, e.g., steam pipes, Foster 84-18, Certane 1000, or equal is recommended.
2. Any proposed equal to the products listed above must meet the following criteria: submit product information prior to the start of the Project and must receive approval by the University Representative and UCDHS EH&S Representative; non-toxic and non-irritating as defined by the Hazardous Substance Control Act; sufficiently tinted to provide contrast with the material being coated; and have a minimum 60 psi Batelle Standard impact rating.
3. All products shall be rated UL Class A and have a flame resistance/spread rate less than or equal to 25 as designated by the ASTM code E 162. Any exceptions must be pre-approved by UCDHS Fire Prevention Office (916-734-3036).

C. Polyethylene Products

1. Floor and wall sheeting used for lead containments or critical barriers are required to have a minimum thickness of: a) 6-mil (floor) and 4-mil (walls); and, b) meet the following standards -- ASTM E-84, with a flame resistance/spread rate less than or equal to 25 ASTM (E-162).
2. The polyethylene sheeting used for containment or critical barriers shall be frosted or black. Polyethylene bags or sheeting used for waste may be clear.

D. Paint Removers

1. No paint removal chemicals are anticipated for this project.
2. If used, all paint removers shall be pre-approved by UCDHS EH&S. Methylene chloride based paint removers are not permitted on this project.
3. The use of paint removers on the project must strictly comply with manufacturer application instructions and safety warnings.

2.2 EQUIPMENT

A. HEPA/ULPA vacuums and negative air machines must be leak tested on-site by a firm independent of the Contractor, who are trained and qualified to perform the challenge testing of portable HEPA filtered equipment, shall follow the manufacturers recommended test procedure, and shall use the recommended test challenge agent.

B. Tools and equipment shall arrive at the project site free of lead debris and dust.

C. HEPA/ULPA vacuum exteriors must be clean when they arrive on project site. All openings on the vacuum, hoses, and negative air units shall be taped shut when they are brought onto the project site and when they are taken from the project site..

D. All electric tools and equipment shall be connected to a GFCI.

E. Power tools used to prepare surfaces containing lead must be connected to a HEPA/ULPA vacuum.

F. Heat guns with a working temperature less than or equal to 1100º F are permitted.

PART 3 - EXECUTION

3.1 SAFETY

A. In accordance with State and Federal laws, Contractor shall be responsible for conditions of the project site; including the safety of all persons and property during the performance of work. To ensure effective communication in safety matters the Contractor shall participate and conduct the following meetings:

1. A pre-construction safety meeting is required to be held with the University's Representative, University Hazardous Material Consultant, and the UCDHS EH&S Representative prior to the start of the project. The following subjects shall be discussed: Division 13 Specifications; impact to building occupants; waste disposal, and work related safety programs.
2. On the first day of lead related work, the Contractor shall conduct a safety meeting (tailgate) for its employees and subcontractor employees that alert them to the specific hazards of the project. The Contractor must conduct the safety meeting in the primary language of its employees. If needed, more than one primary language presentation must occur. This same initial safety meeting must be provided to all personnel new to the project before they are permitted to start work.
3. On a weekly basis, the Contractor shall conduct a safety meeting with its employees.

3.2 WORK SITE PREPARATION

A. Prior to beginning any on-site work preparation, the Contractor shall walk the project area with the University Hazardous Material Consultant and UCDHS EH&S Representative to discuss site characterization, regulated area set-up, access controls, background samples, security, and safety issues.

B. Post all regulatory notices, permits, sign-in-out roster, at the primary entrance to the project site.

C. The Contractor, in coordination with the University Hazardous Material Consultant and UCDHS EH&S Representative shall ensure all electrical and HVAC equipment servicing the work area is disconnected and locked out. Electrical tools in the work zone must be connected to a GFCI.

D. The Contractor shall seal existing critical barriers, including HVAC openings, windows, vents, open pipes, skylights, ducts, doorways, corridors, and diffusers with double layers of plastic and cardboard or plywood inserts as necessary.

E. The Contractor shall install approved backflow prevention devices before connecting to the University's domestic water system, if necessary. Contact the University's Representative for a list of approved devices.

F. Contractor is obligated to coordinate inspection schedules with the University's Representative and the University Hazardous Material Consultant.

G. The Contractor shall establish project site control barriers.

3.3 WORK SITE CONTROL

A. The Contractor shall restrict the work areas to authorized personnel; including, the Contractor's employees, University's Representatives, UCDHS EH&S Representative, University Hazardous Material Consultant and regulatory agency representatives.

B. At regulated project sites, the Contractor shall use caution tape to demarcate the boundary of the work zone and post lead warning signs.

1. The following sign is required by Title 8, CCR 1532.1

DANGER
LEAD WORK AREA
MAY DAMAGE FERTILITY OR THE UNBORN CHILD
CAUSES DAMAGE TO THE CENTRAL NERVOUS SYSTEM
DO NOT EAT, DRINK OR SMOKE IN THIS AREA

C. All unauthorized personnel are to remain outside the regulated area. The Contractor shall call the University's Representative, EH&S Representative or the University Hazardous Material Consultant if unauthorized UCDHS staff or the public enters the containment area.

3.4 RECORDKEEPING

A. The Contractor shall maintain the following records at the regulated work area:

1. Site Log (sign-in/sign-out).
2. Incident Log and Emergency Action Plan.
3. Personal air sampling results if collected.
4. Area sample results from inside and outside the regulated area if collected.
5. Lead training certificates, respirator fit tests (if worn), and medical clearance certificates (if respirators are used).
6. Federal, state or local notifications.

B. All Items 1 through 6 shall be submitted with the "As-Built" summary Identified in "Project Close-Out".

C. The University Hazardous Material Consultant shall retain all sample records (wipe, bulk, initial, area (perimeter), and clearance samples). Results are reported on a daily basis to UCDHS EH&S and to the Project Manager. At the end of the project, all sampling records are submitted as a complete package in the project close out to the Project Manager.

3.5 ADMINISTRATIVE CONTROLS

A. Any remediation project performed in high heat environments requires the Contractor to comply with T8 CCR 3395, including providing sufficient breaks to maintain a safe environment for their workers.

3.6 ENGINEERING CONTROLS

A. Negative Pressure Enclosure (NPE)

1. Containment protocols shall follow the ICRA requirements when building materials will be disturbed, or removed creating potential dust release.
2. Mini-containments: The construction of a mini-containment requires a minimum of one layer of 6-mil polyethylene and a HEPA/ULPA vacuum or HEPA filtered negative air unit exhausting from the containment.
3. HEPA vacuumed assisted tools shall be used for drilling, cutting, sawing, or removing lead containing paint from surfaces, unless a paste type stripper product is used.

B. Lead Shielding

1. Where lead shielding, lead lined walls, lead lined windows, lead lined cabinets or lead lined doors are to be removed, the contractor shall install 6-mil plastic on the floor immediately surrounding the component being removed that contains the lead shielding. If ceilings containing lead shielding are removed, the entire floor area shall be sealed with plastic.
2. The lead shielding shall be removed using manual tools such as screw drivers, razor knives, shears, and pry bars. Power tools, heat guns, cutting torches, and other high temperature generating processes are prohibited due to rapid friction and heat increasing the potential to create lead fumes or dust.
3. Contractor shall use methods to minimize airborne lead to the greatest extent possible (e.g., removing an entire wall instead of removing sheetrock from lead shielding prior to removal).

C. HEPA/ULPA Equipment

1. The Contractor shall ensure all HEPA/ULPA filtration units are leak tested on project site by an independent testing contractor. Each piece of equipment shall be tested in compliance with the ANSI Z9.2 Standard (trapping and retaining 99.97% of all test particles of 0.3 microns). Documentation of testing is to be maintained at the work site. The UCDHS EH&S representative or Hazardous Materials Consultant shall be present to observe the challenge testing of all HEPA systems brought onsite.
2. The Contractor shall HEPA/ULPA vacuum visible debris prior to set-up, during the removal process and at the conclusion of each shift.
3. HEPA/ULPA equipment used to establish negative air pressure within a space must run continuously (24-hours a day) until the project is complete.
4. The Contractor shall ensure make-up air is drawn through an inlet that can be easily sealed in the event of a negative air failure. The inlet sealing method must also be effective when there is a failure in the system after normal work hours.
5. All HEPA/ULPA filters must be disposed as hazardous waste.
6. Any HEPA system that has been removed from the project site and brought back to the project site shall be challenge tested again before being placed in use.

D. Wet Methods

1. Wet methods shall be considered if it is practicable. Prior to removing LCM/PLCM, the Contractor shall adequately wet the material with water.

E. Removal Operations

1. All lead lined components shall be removed as intact as possible and placed into leak tight containers before removed from the interior of the project area.
2. Ensure all accumulated debris is completely sealed by the end of the shift. After gross debris is bagged, use wet wipe methods and HEPA/ULPA vacuums to clean the polyethylene sheeting.

F. Infection Control

1. An Infection Control Risk Assessment (ICRA) will be developed for this project by the University's Representative and approved by the UCDMC Infection Prevention. Depending upon the location of the work and the potential for dust generation that could impact patient care, the ICRA may require more stringent controls than those described under this specification. Adequacy of controls may be verified by periodic airborne particle counting, conducted by EH&S or a designee. Contractor understands that any operations generating excess particles in uncontained locations will cause Contractor to modify site controls. Contractor is responsible for maintaining controls to avoid pollution of patient care spaces.

3.7 WORKER PROTECTION

A. The following protective measures are required for lead-related work associated with this project. These measures are not intended to be all-inclusive:

1. Employee Training/Supervision
   a. The Contractor shall provide information to its employees about lead and other hazards per the Hazard Communication standard (8 CCR, 5194) and other Cal/OSHA standards as appropriate for the project.
   b. All contractor and subcontractor personnel are to be trained to the level of their project assignment in accordance with 8 CCR 1532.1, which at a minimum will require lead awareness training (1-2 hours in length).
2. Respiratory Protection
   a. The Contractor shall provide respiratory protection to all employees where there is the potential for exposure to lead dust at or above the permissible exposure limit per Title 8 5144 Respiratory Protection. If the lead lined components are removed relatively intact and if there is no dust or particulate generated, respirators will not be required. Therefore, the work practices chosen by the contractor will define if respirators will be required based on the methods of removal that may or may not generate finely divided particles.
   b. The Contractor's employees who wear a respirator must have passed a fit test within the previous 12 months to perform contract work at the University.
3. Protective Clothing and Other Personal Protective Equipment
   a. The Contractor shall provide workers with sufficient sets of protective clothing. Tyvek™, Kleenguard™ or equivalent, coveralls (with hood and feet protection) or equal are acceptable. The Contractor shall also provide coveralls to qualified UCDMC personnel, University Hazardous Material Consultant, State and local officials.

b. Note that work in sterile areas may require multiple sets of clothing or staging of additional protective clothing to ensure sanitary conditions are maintained.
c. The Contractor shall provide rubber, latex or Nitrile gloves, eye protection, earplugs and hard hats as needed per the 8 CCR, Hazard Communication and Personal Protective Equipment standards.

4. Medical Surveillance
a. As required by 8 CCR 1532.1, the Contractor shall establish a medical surveillance program for all employees performing lead work if work is expected to exceed the Action Level for more than 30 days per year. In addition, all personnel required to wear a respirator shall have an medical evaluation to assure they are capable of wearing a respirator per T8 CCR 5144.
b. The Contractor shall demonstrate all project personnel are participating in the medical surveillance program with evidence supported in the pre-job submittal.

3.8 PERSONAL HYGIENE

A. The Contractor shall require that no employee be allowed to apply cosmetics, or consume food, tobacco products, or beverages in the regulated work area.

B. The Contractor shall establish a location outside the work area, which shall be designated for employee eating and drinking. Employees must utilize the on-site decontamination facilities for clean-up prior to entering the designated eating/drinking location. The eating area shall be kept clean of dust on all horizontal surfaces. Cleaning stations shall include clean water, soap, and towels. Al workers shall clean face, hands and lower arms before leaving the work area for break periods, and at the end of the work shift.

3.9 AIR MONITORING PROGRAM

A. Personal Air Samples - Contractor Responsibility

1. If lead lined materials are removed relatively intact and there is no dust generation, air sampling would not be required. Shearing or scoring lead lined materials is one method where lead dust will not be released.
2. If the contractor use work practices that will generate lead dust, the contractor shall conduct initial and daily exposure assessments in accordance with T8 1532.1.
3. Exposure assessments are to be conducted in accordance with 8 CCR 1532.1(d).

B. Area Sampling

1. Daily Perimeter Monitoring – University Hazardous Material Consultant Responsibilities
a. The University Hazardous Material Consultant is responsible for monitoring the perimeter of the work zone if the work practices chosen by the contractor generate finely divided particles of lead. Air samples that exceed 30 ug/m^3 per 8 hr. TWA require the University Hazardous Material Consultant to halt work and notify the UCDHS EH&S Representative. Work may resume after the Contractor has identified and corrected the work practice that led to the high airborne lead levels.
2. Daily Monitoring – University Hazardous Material Consultant Responsibilities
a. The University Hazardous Material Consultant is responsible for monitoring air quality within the regulated area, including the clean room if

the work practices chosen by the contractor generate finely divided particles of lead.

b. Any sample at or above 30 μg/M^3 TWA in the clean room requires a cessation of work until the area is cleaned and the cause of the problem has been determined and solved. The UCDHS EH&S Representative is to be notified immediately of any such actions. The Contractor shall thoroughly clean the spaces using the HEPA vacuum and wet wiping techniques.

c. Air samples in the work zone that exceed the protection level of a respirator require a cessation of activity. The Contractor's competent person and the University Hazardous Material Consultant shall review work practices with the UCDHS EH&S.

3.10 SPECIFIC WORK PROTOCOLS

A. Specific work protocols, cited below, provide minimum guidance for the performance of site work.

1. Initial Site Clean-Up
   a. No pre-cleaning is required for this project.
   b. LBP/LCM contaminated chips or debris, etc. generated during the project shall be collected while workers are wearing proper respirators and disposable coveralls, and using HEPA vacuums, wet methods, polyethylene bags, lead warning labels and proper disposal protocols.
2. Interim Controls (In-Place-Management)
   a. This is a control measure to reduce or eliminate lead exposure for less than 20 years. It is not considered abatement. Several strategies are used to control potential exposure to LCM left in place; including, dust removal, paint stabilization, treatment of impact/friction surfaces, and soil coverings. No Interim Controls for lead are included in this project.
   b. Dry blasting LCM is not permitted except by special circumstances pre-approved by the UCDHS EH&S Representative.
   c. Water blasting LCM surfaces will not be allowed.
3. Abatement
   a. Lead abatement is not planned for this project. Abatement is meant to permanently control a lead hazard for a period of time greater than 20 years.
   b. The renovation project may impact lead in building components, but any disturbance to lead in paint must follow the Lead in Construction requirements of 8 CCR 1532.1.
   c. If the contractor needs to remove paint from surfaces, there are many options to consider including use of paint removal paste (such as Peel Away or equivalent), wet sanding, and HEPA equipped shrouded tools when disturbing LCM surfaces.
   d. Dry blasting LCM is not permitted except by special circumstances pre-approved by the UCDHS EH&S Representative.
   e. Water blasting LCM surfaces will not be allowed.

3.11 INSPECTIONS

A. Inspection Responsibilities - Contractor

1. Prior to beginning any lead-related work, the Contractor's supervisor shall inspect the regulated work areas for any building damage, hazardous conditions and/or irregularities that may contribute to an unsafe work environment. Any condition that

poses a hazard or potential hazard to the Contractor's employees or the University's employees, patients and visitors must be immediately reported to the University's Representative.

2. The Contractor is responsible for notifying and allowing sufficient time for the University Hazardous Material Consultant to conduct inspections at all phases of the project.
3. The Contractor shall establish emergency response protocols for a manometer alarm sounding after they have left the project site. Under no circumstances shall the Contractor shut off negative air machines, unless the project has received final clearance. Dust control requirements under the ICRA Permit will require the work space to be placed under negative pressure for the duration of the demolition phase and new construction phase.
4. All waste shall be characterized and separated by the Contractor. Wastes will be sampled individually as directed by the University Hazardous Materials Consultant to determine levels of lead before containerizing for shipment.

B. Inspection Responsibilities – University Hazardous Material Consultant

1. The University Hazardous Material Consultant shall walk the project site with the Contractor and the UCDHS EH&S Representative to review scope of work, pre-cleaning operations and any safety or security issues. The University Hazardous Material Consultant may attend the Contractor's safety meetings.
2. If minor lead related work requires removal of paint from surfaces using a paste, or work practices using HEPA filtered equipment, the hazard control measures shall be evaluated by the University Hazardous Material Consultant or University EH&S.
3. Prior to lead related work activities beginning, the University Hazardous Material Consultant shall match on-site personnel with lead training certificates, fit tests and medical exam records. Workers without on-site documentation shall not be allowed in the regulated area.
4. The University Hazardous Material Consultant is responsible for:
   a. Reviewing all sampling data and all waste stream profiles.
   b. Alerting the UCDHS EH&S Representative of any sample result exceeding 30 $\mu g/m^3$ per 8 hr. TWA.
   c. Review Contractor's performance and non-compliance report to the Project Manager.
5. The University Hazardous Material Consultant shall file a report of activities with the University's Representative and the UCDHS EH&S Representative on an agreed upon schedule.
6. After abatement or interim control activities are complete, the University Hazardous Material Consultant shall verify completeness of all visible debris is removed.
7. University Hazardous Material Consultant shall review contractor's waste characterization for the most efficient disposal for the University; all recommended disposal processes must be reviewed and approved by the UCDHS EH&S Representative.

3.12 ENCAPSULATION, FINAL CLEAN-UP AND RESTORATION

A. Encapsulation

1. Encapsulation for lead painted components is not anticipated for this project.

B. Final Clean-Up

1. Contractor shall clean entire project area of dust from all surfaces within the construction work area using HEPA vacuum and/or wet wiping techniques.

C. Restoration

1. Fixtures, equipment or objects relocated to storage areas designated by the University's Representative shall be restored to their exact position. The Contractor assumes full financial responsibility for damage to these objects.

3.13 WASTE DISPOSAL

A. Packaging Lead Waste
1. All lead containing waste material must be packaged and labeled in accordance with U.S. DOT, DTSC and EPA requirements.

B. Storing Lead Waste
1. At the end of each shift, all lead waste shall be stored in leak-tight containers and placed in a lockable container or shipped off site. Accumulated waste shall not be allowed to remain in the regulated work area overnight. No container shall be allowed to remain at the project site for greater than 90 continuous days from date the first waste container was generated.

C. Uniform Hazardous Waste Manifest Procedures
1. The Contractor or transporter is responsible for providing appropriate Uniform Hazardous Waste Manifests for the transport of hazardous waste materials. Only authorized EH&S personnel can sign on behalf of the UC Davis Medical Center (generator).
2. If the lead lined components are to be recycled, a Uniform Hazardous Waste Manifest is not required, since it would not be considered a waste.

D. Transporting Lead Waste to Class 1 Landfill
1. A DTSC registered waste transporter, hired by the Contractor, is responsible for transporting hazardous lead waste from the Medical Center to (Chemical Waste Management, 35251 Old Skyline Road, Kettleman City, CA 93239), an EPA permitted disposal facility. Under certain conditions, UCDHS EH&S will permit hazardous lead waste to be transported to an alternative facility.
2. The transporter shall make pick-ups during normal Working hours - 8:00 AM to 5:00 PM, Monday through Friday. The Contractor must comply with DOT label requirements for their vehicles.
3. The Contractor must make shipments of lead waste containing less than 1,000 mg/kg lead but greater than 350 mg/kg of lead to a Class 1 landfill. This shipment does not require a registered waste hauler.

E. Disposal
1. The selection of a Treatment, Storage and Disposal Facility as an alternative to a landfill for disposal of lead waste must be reviewed and approved by the EH&S representative prior to arranging for the shipment of the waste.
2. The Contractor shall provide waste documents from the Waste Disposal site as verification of the weight and proper disposal site, to the UCDHS EH&S Representative within 15 days of each container disposal.
3. Lead waste that has been contaminated with another hazardous waste (e.g. solvents) must be tested and disposed according to all applicable standards.
4. All lead waste will be sampled for Characterization before determination of Hazardous or Non-Hazardous material is made. Sequence of testing is as follows:
   a. A TTLC result of ≥1,000 mg/kg is considered a hazardous waste.
   b. TTLC with a result of ≥50 mg/kg of lead must be retested using STLC method.
   c. A STLC result of ≥5.0 mg/l must be retested using TCLP.
   d. A TCLP result of ≥5.0 mg/l deems the waste Federal RCRA.
   e. A STLC of ≥5 mg/l is categorized as State Hazardous Waste (Class 1).

f. A TTLC with a result of >350 mg/kg but <5.0 mg/l (STLC and TCLP) must go to landfill permitted to accept this level of lead although it is not hazardous. (See Item 6 below)

5. Contractor shall provide a waste stream report to the University Hazardous Material Consultant identifying the number of containers and an explanation of how the samples were taken (composite or individual container sampling). A waste stream profile must be conducted on each unique waste stream. Confirmation will be provided by the Consultant, indicating all waste streams have been sampled per project specifications.

6. All waste with total lead >350 ppm (mg/kg) disposed of in California, must be disposed of at a permitted Class 1 Hazardous waste landfill, or at other landfills that have specific permits to accept these wastes. However, the wastes are not classed as hazardous wastes unless for a reason other than lead content. The California hazardous waste threshold for total lead is ≥1,000 mg/kg and the soluble threshold concentration (STLC) for lead is ≥5 mg/l.

F. Recordkeeping

1. The Contractor shall provide the UCDHS Project Manager with copies of all waste disposal documents and all recycled materials documents.

G. Fees

1. The Contractor is responsible for all fees and charges related to lead waste transport and disposal operations; including, waste steam profiles. Refer to SW-846-1311 (TCLP) and CCR, Title 22 Section 66261 (STLC) for waste stream identification requirements

H. Non-Hazardous Waste Manifest

1. The UCDHS EH&S Representative or Hazardous Materials Consultant (if authorization is provided by UCDHS) is responsible for reviewing and signing non-hazardous waste manifests. Prior to the Representative signing the manifest, the University Hazardous Material Consultant shall inspect the load and confirm its non-hazardous status.

I. Recycled Metals

1. Recycling ferrous or non-ferrous metals with adhered lead paint is encouraged by the UCDHS. The UCDHS expects that all lead shielding building components such as walls, glass, doors, cabinets, etc., will be recycled. This section defines "Hazardous Waste" for the purpose of defining waste stream as material that is placed in a land fill. Employee protection regulations remain the same during disturbance of lead. The Contractor is required to remove all loose and flaking paint if painted components contain lead. The Contractor is responsible for removing all other hazardous material that is unacceptable by the recycling firm. The Contractor is required to recycle where possible. The contractor will obtain a letter from the recycler acknowledging that the recycler is aware of the lead paint and/or lead lining-shielding and has an Injury Illness Prevention Program (IIPP) that addresses the handling of this material that meets OSHA and EPA regulations. There is no UCDHS requirement for testing (TTLC, STLC, or TCLP) the recycle material stream.

3.14 CLEARANCE PROTOCOL

A. Abatement and Interim Control Projects

1. Lead abatement is not planned for this project; therefore, clearance wipe sampling is not currently planned. If however, there is lead abatement due to an identified lead hazard, the following will be conducted;
2. Prior to any clearance sampling, the regulated areas shall be visually inspected by the University Hazardous Material Consultant for the presence of LBP chips, visible settled dust or debris. Final clearance sampling shall not take place until the area has successfully passed this visual clearance. The Consultant shall follow the U.S. Housing and Urban Development (HUD) clearance wipe sampling protocol, which includes wiping one square foot of the surface being tested using an "S" pattern with an approved commercial lead sampling wipe. Clearance wipe sampling shall be conducted in locations most likely to be contaminated.
2. The University Hazardous Material Consultant and University's Representative following HUD guidelines and CDPH Title 17 requirements, shall select the total number of clearance samples for each job site and shall use the Title 17 criteria for clearance purposes.

3.15 PROJECT CLOSE OUT

A. Before the final certificate for payment is issued to the Contractor the following information shall be provided to the University's Representative:

1. Using Exhibit 25 Lead Remediation-As-Built Summary (located in the Exhibits section of the Contract Documents) provide "As-Built" summary to include:
   a. Contractor's name, addresses, CSLB certification number, DOSH registration number, and tax identification number.
   b. Name of hazardous transporter, address, phone number and registration number.
   c. ELAP laboratory name(s), addresses, and phone number(s) used to perform AA (flame), TCLP, TTLC or STLC analysis.
   d. Building name and campus address.
   e. Project name and contract number.
   f. Describe scope of Work; Interim Controls or Abatement and location (room number[s]); provide drawings detailing the areas in which lead work that were accomplished.
   g. Provide an inventory of the LCM/PLCM removed from the project site. Include: building system, quantity, note whether the project was Abatement or Interim Controls, the percentage of the total lead job for each building system type and cost.
   h. Total dollar amount paid by the University for lead-related work including invoice date(s) and date(s) payment received.
   i. Number of employees who worked on the project
   j. Date on-site work began
   k. Date on-site work was completed
   l. Work methods
   m. Did the University provide specification (answer yes or no).
   n. Name, address, phone number and EPA registration number of waste disposal site.
   o. Note that all copies of waste documents from the Waste Disposal site for hazardous material must be received by the University's Representative as part of this section.
   p. The Contractor shall provide copies of all laboratory reports lead work protocols, and disposal documents requested by the University's Representative.

q. All documents relating to actual employees used for remediation purposes (see Section 3.4, A).

END OF SECTION 132810

SECTION 210500
BASIC MATERIALS AND METHODS FOR WET PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Minor modifications to wet pipe fire sprinkler systems to maintain complete area coverage, including

1. Sprinkler heads

2. Sprinkler piping materials

1.02 SUBMITTALS

A. Submit product data, warranties, operating and maintenance data.

B. Submit drawings, calculations and other supporting documents as required for review and approval by the Authority Having Jurisdiction.

1. All drawings, calculations, and other supporting documents shall be prepared by, or under responsible charge of, an Architect, Structural Engineer, or Mechanical Engineer licensed to practice in California and shall include the signature and seal or stamp of the licensee.

1.03 QUALITY ASSURANCE

A. Provide Work and materials in accordance with the latest rules and regulations of the California State Fire Marshal and the California State Department of Public Health, Titles 17 and 24; the California Plumbing Code, the California Fire Code, and California Mechanical Code, IAPMO; the NFPA Pamphlet 13, 14, 24, 291; and other applicable laws or regulations.

B. Where the standards of the drawings and specifications for materials and/or workmanship are higher than the requirements of the regulations cited above, the drawings and specifications shall take precedence; otherwise the documents shall govern.

C. Provide materials and apparatus that bear the UL label where such label is applicable.

D. Coordinate fire alarm system operation with Owner. Maintain coverage during construction, and coordinate any necessary disruptions.

1.04 SITE VISITATION

A. Visit the site prior to bidding and become familiar with existing conditions and other factors which may affect the execution of work. Include all related costs in the initial bid proposal.

PART 2 PRODUCTS

2.01 PRODUCTS

A. Provide piping per NFPA 13 and NFPA 14 codes suitable for the system and to match existing piping.

1. Standard-Pressure, Wet-Pipe Sprinkler System, NPS 2 (DN 50) and Smaller:

    a. Standard-weight, black-steel pipe with threaded ends and uncoated, gray-iron fittings.

B. Sprinkler heads: Recessed, Semi-recessed, or exposed: Type and finish to match existing.

2.02 ACCEPTABLE MANUFACTURERS

A. Sprinkler Heads and Accessories:

1. Automatic Sprinkler

2. Grinnell

3. Reliable

4. Viking

5. Central

PART 3 EXECUTION

3.01 INSTALLATION

A. Install piping per NFPA codes, state and local regulations, ordinances and requirements of authorities having jurisdiction.

B. Modify, relocate and extend existing piping to accommodate new work:

1. Relocate existing sprinkler heads as required to provide complete area coverage.

2. Provide additional sprinkler heads as required to provide additional coverage. Provide hydraulic calculations in support of any change in flow.

3. Provide sprinkler heads to match existing types in appearance, finish, and function.

C. Coordinate location of sprinkler heads to avoid interference with locations of designated lighting fixtures and air outlets.

D. Conceal piping to the greatest extent practical.

E. Center ceiling mounted elements in center of ceiling tiles unless otherwise noted.

F. Test piping systems for leaks per NFPA codes and verify alarms for proper operation.

G. Instruct Owner’s personnel in proper operation of the systems.

3.02 SPRINKLER HEADS

A. Fusible Link Temperature Ratings:

1. Select to suit specific hazard area in accordance with NFPA 13.

2. Place sprinklers in upright or pendant position as required, with the deflector parallel to the ceiling.

B. For suspended ceilings select standard, recessed or pendant type with brass or chrome-plated finish and escutcheon.

C. For exposed areas select standard upright type with brass or chrome-plated finish and escutcheon.

END OF SECTION 210500

SECTION 220510
BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. The intent of Division 22, and 23 Specifications and Drawings is to provide complete and workable plumbing systems as shown, specified and required by applicable codes. Include all work specified in Division 22 and 23 and shown on the Drawings, including appurtenances, connections, demolition, appliances, and incidental accessories to make work complete and ready for operation.

B. The Drawings that accompany the Division 22, and 23 Specifications are diagrammatic. They do not show every offset, pipe fitting, or elbow that may be required to install work in the space provided and avoid conflicts. Locations of all items not definitely fixed by dimensions are approximate only. Coordinate Division 22, and 23 work as required by Division 01.

C. Include minor details not usually shown or specified, but necessary for proper installation and operation of a system or piece of equipment in work and in bid price, the same as if specified or shown.

1.03 ENFORCEABLE CODES

A. The code publications listed below form a part of this specification. This list is not exclusive, local and other codes may also apply:

1. 2022 California Administrative Code (CAC), Part 1, Title 24, California Code of Regulations (CCR).

2. 2022 California Building Code (CBC), Part 2, Title 24, CCR, (Based on the 2021 International Building Code).

3. 2022 California Electrical Code (CEC), Part 3, Title 23, CCR, (Based on the 2020 National Electrical Code).

4. 2022 California Mechanical Code (CMC), Part 4, Title 24, CCR, (Based on the 2021 Uniform Mechanical Code).

5. 2022 California Plumbing Code (CPC), Part 5, Title 24, CCR, (Based on the 2021 Uniform Plumbing Code).

6. 2022 California Fire Code (CFC), Part 9, Title 24, CCR, (Based on the 2021 International Fire Code).

1.04 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subjected to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. PE: Polyethylene plastic.

2. PVC: Polyvinyl chloride plastic

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber

2. NBR: Acrylonitrile-butadiene rubber.

1.05 REFERENCES

A. Publications and Standards listed below form a part of this specification to the extent referenced. The Publications and Standards are referenced to in the text by basic designation only.

1. Applicable municipal, county, and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws, and ordinances.

2. Standards and requirements of local utility companies.

3. National Electrical Manufacturer’s Association Standards.

4. National Electrical Safety Code.

5. National Electrical Testing Association.

6. Underwriter’s Laboratories, Inc. Standards.

7. American National Standards Institute.

8. American Society for Testing Materials Standards.

9. National Fire Protection Association Standards.

10. American Society of Mechanical Engineers Boiler and Pressure Vessel Codes.

11. American Water Works Association.

12. Occupational Safety and Health Act.

13. Uniform Mechanical and Plumbing Codes with applicable State of California amendments.

14. Commercial and Industrial Insulation Standards.

15. American Gas Association.

16. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

17. Sheet Metal and Air conditioning Contractor's National Association Standards.

18. Air-Conditioning and Refrigeration Institute Standards.

19. American Welding Society.

1.06 SUBMITTALS

A. Comply with requirements of Division 01.

B. Coordination Drawings: Each trade shall be responsible for their own respective coordination drawing effort with the HVAC contractor being the coordination effort team leader. Drawings shall be electronic (AutoCAD) and each trade shall have the ability to coordinate electronically (xref) into each other's drawings for collision checking and spatial conditions. When coordination effort is completed contractors shall sign drawings demonstrating that they are buildable shop drawings. Coordination drawings can also be used as the contract "as-builts" at project completion.

C. Submit required copies of shop drawings, product data, samples, schedules and reports as required by individual Division 21, 22, and 23 Sections.

1.07 QUALITY ASSURANCE

A. Provide Work and materials in accordance with the latest rules and regulations of the California State Fire Marshal and the California State Department of Public Health, Titles 17 and 24; the California Plumbing Code and California Mechanical Code, IAPMO; the NFPA Pamphlet 13, 14, 24, 291; and other applicable laws or regulations.

B. Where the standards of the drawing and specifications for materials and/or workmanship are higher than the requirements of the regulations cited above, the drawings and specifications shall take precedence; otherwise the regulations shall govern.

C. Provide materials and apparatus that bear the UL label where such label is applicable.

D. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code – Steel".

1.08 DELIVERY, STORAGE AND HANDLING

A. Protect materials from corrosion and breakage. Store materials above grade. Provide appropriate covering.

B. Replace any materials which are damaged or degraded by improper storage with new.

1.09 SITE VISITATION

A. Visit the site prior to bidding and become familiar with existing conditions and other factors which may affect the execution of the work. Include all related cost in the initial bid proposal.

1.010 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08.

D. Coordinate all equipment and piping layout with other trades.

1.011 WARRANTY

A. Comply with the requirements of Division 01.

B. Provide manufacturer’s written warranties covering defects in materials and workmanship of products and equipment utilized for this project.

C. Each complete system shall be warranted for a period of one year from the date of Substantial Completion.

D. Each system shall be free of defects in materials and workmanship, and shall perform satisfactorily under all conditions of load or service.

E. The warranties shall provide that all additional controls, protective devices, or equipment be provided as necessary for operation of the system or equipment.

F. Replace or repair faulty materials or workmanship at no additional cost to the Owner.

G. See specific sections for additional equipment warranty items.

1.012 OPERATING INSTRUCTIONS MANUALS

A. Provide 2 copies of complete Manual, bound in booklet form, plus an electronic copy on permanent storage media. Each manual shall contain the following information:

1. List of all equipment with manufacturer’s name, model number, and local representative, service facilities, and the normal channel of supply for each item.

2. Manufacturer's literature describing each item of equipment with detailed parts list.

3. Equipment service schedules and IOMs.

4. Equipment Warranties.

5. Certificates of Inspection.

6. Record Drawings and related Shop Drawings.

7. Water System Balance Reports.

1.013 RECORD DRAWINGS

A. Maintain at the site an up to date set of prints of Engineering Drawings which clearly indicate (by shading, coloring or some other acceptable method) the daily extent of Work installed.

B. Indicate on Drawings changes in elevation, location, or size of material deviating from original design.

C. Clearly indicate any dimension changes in elevation, location, size or material, and offsets for valves.

D. Locate all underground, concealed or buried piping by two or more dimensions per turn of pipe between each direction change.

E. Show all elevations (invert or centerline) with the point of elevation change clearly located.

F. Number and letter valves to correspond with numbers and letters of valve charts.

G. At conclusion of contract work, provide the Owner's Representative with a complete set of reproducible drawings with all changes clearly marked to reflect as-built conditions. These drawings shall be labeled "As-Builts". Updated Coordination drawings can be used as the contract "As-Built" drawings at project completion.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer's names and model numbers used for materials, processes, or equipment in Division 21, 22, and 23 provide the basis for design and the minimum standards of quality, utility and appearance.

2.02 SUBSTITUTIONS

A. For substitutions see Division 01.

B. If not specified in Division 01:

1. Substitutions only from the list provided.

2. Contractor is responsible for all alterations required to make substituted product work.

3. Contractor is responsible for all coordination of other trades required by substitution.

4. Contractor is responsible for any engineering and structural or seismic modifications to the equipment supports and structures, etc.

2.03 PIPE, TUBE, AND FITTINGS

A. Domestic cold water: Hard copper tube, ASTM B 88, Typle L water tube, drawn temper. Wrought-copper solder-joint fittings, ASME B16.22, wrought-copper pressure fittings.

B. Waste and vent: Hubless cast-iron pipe, ASTM A 888 and Husky 2000 series couplings (or approved equal).

2.04 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

C. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8 Bag1, silver alloy for refrigerant piping, unless otherwise indicated.

PART 3 - EXECUTION

3.01 DEMOLITION

A. Comply with the requirements of Division 02.

B. Remove fixtures and equipment not to remain in service as shown on Drawings or as required. This includes the removal of associated appurtenances and supports.

C. Patch, cap, or repair existing work affected by this demolition in concealed spaces within six (6) inches of a live main or branch.

D. Deliver removed materials to be retained by the Owner for storage on-site as directed by the Owner's Representative. Properly dispose of all other removed material off site.

E. Where hazardous and carcinogenic materials are encountered, stop the work immediately and notify the Owner's Representative.

3.02 PIPING SYSTEMS – COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling tile removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes of direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve protruding from Wall: One-piece, deep pattern type.

b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.

c. Insulated Piping: One-piece, stamped-steel type with spring clips.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.

f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.

g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.

h. Bare piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 for materials.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 for materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.03 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipe and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook", using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook", "Pipe and Tube" chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.04 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.05 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout. Apply adhesive to existing concrete surfaces to assure bonding.

C. Place grout, completely filling equipment bases, and surrounding any and all anchors. Avoid air entrainment. Provide a smooth finished surface. Allow grout to cure before placing in service.

3.06 MANUFACTURER'S IDENTIFICATION

A. Manufacturer's nameplate, name, or trademark shall be permanently affixed to all equipment and materials furnished under this Specification. The nameplates of Subcontractor or Distributor are not acceptable.

3.07 CUTTING AND PATCHING

A. Comply with requirements of Division 01.

B. Cut completed Work only where sleeves, openings, chases, and similar items were inadvertently omitted and only with specific permission of the Owner's Representative. In no case shall reinforcing steel be cut without specific written permission of the Owner's Representative.

C. Provide sleeves, caps, plates, escutcheons, flashing, and similar items required to fill or close the openings.

D. Provide final grouting, concrete, asphalt, masonry, painting, and other materials as required to complete patch work.

E. Where cutting occurs on any building fire or smoke compartment separation, repair to maintain the integrity of the separation, including all necessary automatic dampers and UL approved through penetration systems.

F. Where cutting and patching occurs in streets, sidewalks, alleys, and the like, cooperate fully with the Owner's Representative and municipal or other government bodies to match existing materials.

3.08 OPERATION BY OWNER

A. The Owner may require operation of parts or all of respective installations prior to final acceptance. Cost of utilities for such operation shall be paid by Owner.

3.09 TEST AND ADJUSTMENTS

A. Labor, materials, instruments, and power required for testing provided under respective Sections for Work under that Section.

B. Test shall be performed as specified or as required by regulating authority having jurisdiction. Submit to Owner's Representative certification that tests have been performed in accordance with Contract Documents.

C. Pressure test piping before connection to equipment. No piping, equipment, or accessories shall be subjected to pressures exceeding their indicated rating.

D. Repair or replace defective Work and repeat tests until particular systems, and component parts thereof, receive approval of Owner's Representative and regulating authority.

1. Any damages resulting from test shall be repaired and damaged materials replaced at no cost to Owner.

E. Equipment and systems which normally operate during certain seasons of the year shall be tested during the appropriate season.

1. Perform test on individual equipment, systems, and their controls.

2. Whenever the equipment or system under test is inter-related with, and depends upon the operation of other equipment or systems and their controls for proper operation, functioning, and performance, the latter shall be operated simultaneously with equipment or system being tested.

F. No piping or ductwork shall be closed up, furred in, or covered before testing. Notify regulating authority and Owner's Representative 3 days before test are to be conducted.

G. Test all systems as specified under various applicable Sections. Duration of test shall be determined by the authority having jurisdiction and in no case less than the time specified.

H. Drain water used for testing from the system after test are complete. Repair or replace any damages caused by freezing of water left in system at no expense to the Owner.

I. Test and balancing of air and hydronic systems specified under other appropriate Sections.

3.010 TERMINATIONS AND CLEANING

A. The Work includes removing tools, scaffolding, surplus materials, barricades, temporary walks, debris, and rubbish from the Project promptly upon completion of that portion of the Work. Leave the area of operations completely clean and free of these items.

B. During the course of construction, cap all ducts, pipes, and electrical conduits in approved manner to insure adequate protection against entrance of foreign substances.

C. Disconnect, clean, and reconnect, whenever necessary, to locate and remove obstructions from any system. Repair or replace any Work damaged in the course of removing said obstructions at no additional cost to the Owner.

3.011 INSTRUCTIONS FOR OWNER'S PERSONNEL

A. Prior to acceptance of Work and during time designated by the Owner's Representative, provide qualified personnel to operate each system for a period of 48 hours during 2 consecutive work days.

B. During operating period, fully instruct Owner's personnel in complete operation, adjustment, and maintenance of each system.

C. See specific sections for additional startup and training procedures.

3.012 PROJECT CLOSEOUT

A. Special tools or safety equipment: Provide one of each tool or piece of safety equipment required for proper operation and maintenance of equipment installed under this Work.

B. KEYING: Provide 3 keys for each lock furnished under this Work.

END OF SECTION 220510

SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.

2. Fastener systems.

1.03 DEFINITIONS

A. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.04 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers using performance requirements and design criteria by the manufacturer.

1.05 SUBMITTALS

A. Product Data: For each type as applicable.

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.

3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.02 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

D. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

E. Install lateral bracing with pipe hangers per California Building Code seismic requirements.

F. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

G. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

I. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.03 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches or less.

3.04 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Isolate hangers from copper piping and tubing with felt lined hangers or 2 layers of 10 mil tape.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel “J” Hangers (MSS type 5) or Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18, or Tolco Fig. 109A): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

a. Light (MSS Type 31): 750 lb.

b. Medium (MSS Type 32): 1500 lb.

c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

END OF SECTION 220529

SECTION 220553
PLUMBING IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Valve identification
2. Piping identification
3. Signage

1.02 REFERENCE STANDARDS

A. ANSI/ASME A13.1 – Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: Submit samples of each color, lettering style, and other graphic representation required for each identification material or system.

C. Schedules:

1. Valve identification chart and schedule, including valve numbering system, valve tag number location, function type, and valve manufacturer's name and model number.
2. Lists of pipe and equipment to be labeled.

1.04 QUALITY ASSURANCE

A. Coordinate color coding with the University's Representative for preferred color schemes and service abbreviations and valve and equipment numbering schemes prior to submittal review.

B. Coordinate installation of identifying devices with completion of covering of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices, pipe identification and flow arrows before installing acoustical ceilings and similar concealment.

E. Coordinate painting schemes of plumbing piping, if required, with University's Representative prior to submittal review.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer:

1. Brady/Seton
2. Stranco
3. Rowmark
4. Or equal

2.02 MANUFACTURER'S IDENTIFICATION

A. Manufacturer's nameplate, name, or trademark shall be permanently affixed to all equipment and material furnished under this Specification. The nameplates of the Subcontractor or Distributor are not acceptable.

2.03 VALVE IDENTIFICATION

A. Attached to stem of each control valve and line shutoff valve installed under Division 22, with No. 16 brass chain, color-coded plastic laminate tag. Engrave laminate tags with 1-inch designated numbers in accordance with typed schedule showing valve size, locations, service, similar to the following form:

RW: 3-inches
Shutoff, Toilets
3rd Floor
Column F-8

1. Engrave identification tags "normally open" (green) or "normally closed" (red).
2. Do not identify valves where the use is obvious, such as equipment isolation valves.
3. Tag all valves except fixture stops.
4. Label plumbing valves "Plbg" plus valve identification number.
5. Number tags to conform to directory listing number, location, and use.

B. Access panel markers: Provide manufacturer's standard 1/16 inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8 inch center hole to allow attachment.

2.04 PAINTED IDENTIFICATION MATERIALS

A. Stencils: Standard fiberboard stencils, prepared for required applications with the letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than3/4 inch high letters for access door signs and similar operational instructions.

B. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.

C. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated for piping systems, comply with ANSI A13.1 for colors.

2.05 PIPE IDENTIFICATION

A. General requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Small pipes: For external diameters less than 6 inches (including isolation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.

2. Adhesive lap joint in pipe marker overlap.

3. Laminated or bonded application of pipe marker to pipe (or insulation).

4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inches.

D. Large pipes: For external diameters of 6 inches and larger (including isolation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:

1. Laminated or bonded application of pipe marker to pipe (or insulation).

2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 inch wide; full circle at both ends of pipe marker, tape lapped 3 inches.

3. Strapped to pipe application of semi-rigid type, with manufacturer’s standard stainless steel bands.

E. Pipe Label Contents: Include identification of piping service using piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application. Include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

F. Locate pipe markers as follows:

1. Within one foot of each valve, fitting, thermometer or gauge (except on plumbing fixtures).

2. At each branch or riser take off.

3. At each passage through walls, floors and ceiling construction.

4. At each pipe passage to underground.

5. On all horizontal pipe runs every 20 ft, at least twice in each room and each story traversed by piping system.

6. Identify piping contents, flow direction, supply and return.

7. Where capped piing is provided for future connections, provide legible and durable tags indicating symbol identification.

8. At wall and ceiling access panels.

9. Practicable variations or changes in locations and spacing may be made with specific approval of the University's Representative to meet specific conditions.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

B. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.02 PIPE SYSTEM IDENTIFICATION

A. General: Provide for all systems unless indicated otherwise.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. At access doors, manholes, and similar access points that permit view of concealed piping.

2. Near major equipment items and other points of origination and termination.

3. 50 feet intervals.

C. Types: Install pipe markers of one of the following types on each system, and include arrows to show normal direction of flow:

1. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2 inches beyond ends of lettering.

2. Stenciled markers, with lettering color complying with ANSI A13.1.

3. Plastic pipe markers, with application system as indicated under "Materials" in this Section. Install on pipe insulation segment where required for hot non-insulated pipes.

4. Stenciled markers, black or white for best contrast, wherever continuous color-coded painting of piping is provided.

D. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

1. Near each valve and control device. Within one foot of each valve, fitting, thermometer or gauge (except on plumbing fixtures).

2. At each branch or riser take off, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.

3. At each passage through walls, floors and ceiling construction, or enter non-accessible enclosures.

4. At each pipe passage to underground.

5. At access doors, manholes and similar access points which permit view of concealed piping. At wall and ceiling access panels. Practicable variations or changes in locations and spacing may be made with specific approval of the University's Representative to meet specific conditions.

6. Near major equipment items and other points of origination and termination.

7. Spaced intermediately at maximum spacing of 50 feet (15m) along each piping run, except reduce spacing to 25 feet (8 m) in congested areas of piping and equipment.

8. On all horizontal pipe runs every 20 ft, at least twice in each room and each story traversed by piping system.

9. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

10. Where capped piping is provided for future connections, provide legible and durable tags indicating symbol identification.

11. Identify piping contents, flow direction, supply and return.

3.03 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve cock and control device in each piping system; exclude check valves, and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.

B. Valves Concealed in Suspended Ceilings: Provide 1/4-inch-high plastic tape marker identifying the valve number on the nearest ceiling grid member.

3.04 ADJUSTING AND CLEANING

A. Adjusting: Relocate any plumbing identification device which has become visually blocked by Work of this Division or other Divisions.

B. Cleaning: Clean face of identification devices.

3.05 EXTRA STOCK

A. Furnish minimum of 5% extra stock of each plumbing identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.

1. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

END OF SECTION 220553

SECTION 220719
PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic hot-water piping.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.04 INFORMATIONAL SUBMITTALS

A. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.05 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency. Insulation Installed Indoors to have a Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

2.02 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

2.03 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

2.04 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following: ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.05 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136. Width: 3 inches. Thickness: 11.5 mils. Adhesion: 90 ounces force/inch in width. Elongation: 2 percent. Tensile Strength: 40 lbf/inch in width. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.06 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application. Verify that systems to be insulated have been tested and are free of defects. Verify that surfaces to be insulated are clean and dry. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets per manufacturer’s instructions.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above-ambient services, do not install insulation to the following: Vibration-control devices, Testing agency labels and stamps, Nameplates and data plates, & Cleanouts.

3.04 PENETRATIONS

A. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

B. Insulation Installation at Floor Penetrations: Install insulation continuously through floor penetrations.

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

3.06 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

3.07 PIPING INSULATION SCHEDULE, GENERAL

A. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.

2. Underground piping.

3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.08 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 and Smaller: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: Thickness per current California Energy Codes.

END OF SECTION 220719

SECTION 221116
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Domestic water pipes, tubes, and fittings inside buildings.

2. Water-hammer arresters.

3. Ball Valves

1.03 ACTION SUBMITTALS

A. Product Data: For all products listed.

1.04 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.05 LEAD FREE REQUIREMENTS

A. Any pipe, plumbing fitting, fixture, solder or flux in contact with domestic water must comply with the lead free requirements of California Health and Safety Code 116875 AB 1935.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

2.02 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14.

B. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.03 COPPER TUBE AND FITTINGS

A. Hard Copper Tube, ASTM B 88, Type L water tube, drawn temper. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings. Solder-joint or threaded ends only. Use Solder Filler Metals ASTM B 32, lead-free alloys. Flux ASTM B 813, water flushable. Brazing Filler Metals AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.04 WATER-HAMMER ARRESTERS

A. Manufacturers to be “Smith, Jay R. Mfg. Co.”, “Watts; a Watts Water Technologies company.”, “Zurn Industries, LLC.” Or equal. Comply with Standard ASSE 1010 or PDI-WH 201. Type of Copper tube with piston. ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.05 BALL VALVES

A. Two-Piece Bronze Ball Valves with Full Port. Bronze, Brass or Stainless Steel Trim. Standard: MSS SP-110. SWP Rating: 150 psig. CWP Rating: 600 psig. Body Design: Two piece Bronze. Ends: Threaded. Seats: PTFE. Stem: Bronze. Ball: Chrome-plated brass. Port: Full. Hand lever actuator.Use Manufacturers: “Milwaukee Valve Company.”, “NIBCO INC.”, “Watts; a Watts Water Technologies company.” Or Equal.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb. Install piping free of sags and bends.

C. Install seismic restraints on piping as required by local jurisdiction.

D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

G. Install piping to permit valve servicing.

H. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

I. Install sleeve seals for piping penetrations of concrete walls and slabs. Install escutcheons for piping penetrations of walls, ceilings, and floors.

J. Ream ends of pipes and tubes and remove burrs. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

K. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows: Apply appropriate tape or thread compound to external pipe threads. Do not use pipe or pipe fittings with threads that are corroded or damaged.

L. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

3.02 HANGER AND SUPPORT INSTALLATION

A. Horizontal Piping: Individual Straight Horizontal Piping Runs 100 Feet and Less use: MSS Type 1 adjustable steel clevis hangers. If Longer Than 100 Feet: MSS Type 43, adjustable roller hangers. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Install hangers for copper tubing with the following maximum 60 inch horizontal spacing and with 3/8-inch rod.

3.01 IDENTIFICATION

A. Provide Printed plastic with contact-type, permanent-adhesive backing label. Domestic Cold-Water Piping: Green background with White lettering. Include flow direction arrow. Domestic Hot Water Piping: Yellow background with Black lettering. Include flow direction arrow.

3.02 FIELD QUALITY CONTROL

A. Piping Inspections: Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures. Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements. If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection. Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Piping Tests: Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained. Prepare reports for tests and for corrective action required.

3.03 ADJUSTING

A. Perform the following adjustments before operation: Close drain valves, hydrants, and hose bibbs. Open shutoff valves to fully open position. Open throttling valves to proper setting. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch. Adjust calibrated balancing valves to flows indicated. Remove plugs used during testing of piping and for temporary sealing of piping during installation. Remove and clean strainer screens. Close drain valves and replace drain plugs. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.04 CLEANING

A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

B. Clean and disinfect potable domestic water piping as follows: Purge new piping and parts of existing piping that have been altered, extended, or repaired before using. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

END OF SECTION 221116

SECTION 221316
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.

2. Special pipe fittings.

1.02 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.04 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.01 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: “Charlotte Pipe and Foundry Company.”, “Dallas Specialty & Mfg. Co.”, “NewAge Casting.” Or Equal.

B. Hubless Cast Iron pipe and fittings shall be manufactured from gray cast iron and shall conform to ASTM A 888 and CISPI Standard 301. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and listed by NSF International. Couplings shall comply with Standards ASTM C 1277 and CISPI 310. Stainless-steel corrugated shield with stainless-steel bands and tightening devices. ASTM C 564, rubber sleeve with integral, center pipe stop. As per University design requirements - above or underground no hub waste piping shall use 4-band couplings and no hub sanitary vent piping shall use 2-band couplings.

2.02 CLEANOUTS

A. Cast-Iron Wall Cleanouts comply with Standard ASME A112.36.2M. Include wall access. Size Same as connected drainage piping. Hubless, cast-iron soil pipe test tee as required to match connected piping.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and

calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping at indicated slopes free of sags and bends. Install soil and waste drainage at 2 percent downward in direction of flow. Slope Vent Piping at 1 percent down toward vertical fixture vent or toward vent stack.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

G. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

H. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction. Connect drainage piping in sizes indicated, but not smaller than required by plumbing code. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

I. Install sleeve seals for piping penetrations of concrete walls and slabs.

J. Install escutcheons for piping penetrations of walls, ceilings, and floors.

K. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

3.02 HANGER AND SUPPORT INSTALLATION

A. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments and Install stainless-steel pipe hangers for horizontal piping in corrosive environments. Use MSS Type 1, adjustable, steel clevis hangers. Support horizontal piping and tubing within 12 inches of each fitting and coupling. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

B. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters: NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod. NPS 3: 60 inches with 1/2-inch rod. NPS 4 and NPS 5: 60 inches with 5/8-inch rod. NPS 6 and NPS 8: 60 inches with 3/4-inch rod. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

3.03 IDENTIFICATION

A. Provide Printed plastic with contact-type, permanent-adhesive backing label. Yellow background with Black lettering at least one inch high. Include flow direction arrow.

3.04 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures. Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements. If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection. Contractor is to prepare inspection reports and have them signed by authorities having jurisdiction.

B. Clean interior of piping by removing dirt and debris from interior of piping as work progresses. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work. Place plugs in ends of uncompleted piping at end of day and when work stops.

C. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

END OF SECTION 221316

SECTION 224300
HEALTHCARE PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following healthcare fixtures and specialties:

1. Water closets

a. Flushometer valves

2. Toilet seats

3. Scrub sinks

4. Handwash sinks

5. Sink faucets

6. Supports and fittings

1.02 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, colors, and finishes for fixtures.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For plumbing fixtures and faucets to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 GENERAL

A. All plumbing fixtures, accessories and methods are to be compliant with California AB 1953 Low Lead requirements, and the Safe Drinking Water Act.

B. Acceptable Manufacturers:

1. American Standard

2. Kohler

3. Just Mfg.

4. Zurn

5. Or Equal

C. Coordination: Ensure compatibility between fixture, faucet, waste, and all other appurtenances associated with a plumbing fixture installation.

1. Coordinate sink hole quantity and placement to match faucet

2. Coordinate water closet spud size with flushometer valve.

2.02 WATER CLOSETS

A. Water Closets: Wall mounted, top spud, accessible. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5. Material: Vitreous china. Type: Siphon jet. Style: Flushometer valve. Automatic valve with lever handle, or as listed on drawings. Height: Handicapped/elderly.

a. Water Consumption: 1.28 gal. per flush, or as listed on drawings

b. Spud Size: NPS 1-1/2.

B. Water Closets: Floor mounted, floor outlet, top spud, accessible. Standards: ASME A112.19.2/ CSA B45.1 and ASME A112.19.5. Material: Vitreous china. Type: Siphon jet. Style: Flushometer valve. Automatic valve with lever handle, or as listed on drawings. Height: Handicapped/elderly.

a. Water Consumption: 1.28 gal. per flush.

b. Spud Size: NPS 1-1/2.

2.03 FLUSHOMETER VALVES

A. General: ASSE 1037. Minimum Pressure Rating: 125 psig. Integral check stop, backflow-prevention device, and outlet-tube-mounted bedpan washer. Automatic with lever handle, hard-wired. Material: Brass body with corrosion-resistant components. Finish: Chrome plated.

1. Consumption: 1.28 gal. per flush, or as compatible with water closet.

2. Minimum Inlet: NPS 1.

3. Outlet: NPS 1-1/4, extended length.

4. Option: Outlet-tube-mounted bedpan washer.

2.04 TOILET SEATS

A. Toilet Seats: Standard: IAPMO Z124.5. Material: Plastic with antimicrobial agent. Type: Commercial (heavy duty). Shape: Elongated rim, open front. Hinge: Check. Hinge Material: Noncorroding metal.

2.05 SCRUB SINKS

A. Scrub Sinks: Stainless steel or vitreous china, wall mounted. Standard: ASME A112.19.3/ CSA B45.4. Support: Type II sink carrier. Sink Mounting Height: Handicapped/elderly according to ICC A117.1.

2.06 HANDWASH SINKS

A. General: Wall or counter mounted stainless steel or vitrous china general purpose sink. Standard: ASME A112.18.1, ASME A112.19.3/ CSA B125.1, SCA B45.4. As shown on drawings.

1. Vitreous china counter mount: Waste overflow. Self rimming design. Installation: ADA compliant, unless otherwise specified.

2. Stainless steel counter mount: Type 304 stainless steel, 18 ga minimum. Fully coated underside. Self rimming top. Non-porous brushed finish.

3. Vitrous china wall hung: Waste overflow. Mount using concealed arm carrier system.

2.07 SINK FAUCETS

A. Sink Faucets: Automatic, hard-wired, electronic-sensor-operated mixing valve. Standards: ASME A112.18.1/CSA B125.1 and UL 1951. Configuration: Hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor. Body Type: Single hole or as listed on drawings. Body Material: Solid brass. Finish: Polished chrome plate.

1. Spout Type: Rigid, gooseneck.

2. Spout Outlet: Laminar flow.

2.08 LAMINAR-FLOW, FAUCET-SPOUT OUTLETS

A. Description: Chrome-plated brass, faucet-spout outlet that produces non-aerating, laminar stream. Include external or internal thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes faucet flow.

2.09 SUPPORTS

A. Description: Waste-fitting assembly as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.

1. Water Closet Carrier: ASME A112.6.1M.

2. Type I Sink Carrier: ASME A112.6.1M.

3. Type II Sink Carrier: ASME A112.6.1M.

4. Type III Sink Carrier: ASME A112.6.1M.

5. Type IV Sink Carrier: ASME A112.6.1M.

2.010 SUPPLY FITTINGS

A. Standard: ASME A112.18.1/CSA B125.1.

B. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.

C. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

D. Operation: Loose key.

E. Risers: NPS 1/2 chrome-plated, rigid-copper pipe and brass straight or offset tailpieces, or chrome-plated, soft-copper flexible tube.

2.011 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid with NPS 1-1/2 DN 40 tailpiece.

C. Trap:

1. Size: NPS 1-1/2.

2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated brass or steel wall flange.

2.012 GROUT

A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout. Non-shrink; for interior and exterior applications. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.

2. Use carrier supports without waste fitting for fixtures with tubular waste piping.

3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install floor-mounted healthcare water closets on bowl-to-drain, connecting fitting attachments to piping or building substrate.

D. Install counter-mounted fixtures in and attached to casework.

E. Install water-supply piping with stop on each supply to each fixture to be connected to water-distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

F. Install laminar-flow, faucet-spout fittings in faucet spouts unless otherwise specified.

G. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks.

H. Seal joints between healthcare plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

I. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.

3.03 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flushometer valves to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.04 CLEANING AND PROTECTION

A. After installing fixtures, inspect and repair damaged finishes.

B. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed fixtures and fittings.

D. Do not allow use of healthcare plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224300

SECTION 226113
MEDICAL GAS AND VACUUM PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Medical gas and vacuum pipes, tubes, and fittings
2. Conventional joining methods.
3. Swage lock compression fittings.
4. Zone Valve Boxes.
5. Valves and specialties.
6. Service connectors.

B. Medical gas systems include:

1. Medical air
2. Medical Oxygen
3. Nitrous Oxide
4. Nitrogen and instrument air
5. Other compressed gasses
6. Medical and dental vacuum and waste anesthesia gas disposal

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Brazing or alternate joining method certificates for installers.

C. Material Certificates: Signed by Installer certifying that medical gas and vacuum piping materials comply with requirements in NFPA 99 for positive-pressure medical gas systems.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For medical gas and vacuum piping specialties to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Air Piping Systems for Healthcare Facilities: According to ASSE Standard #6010 for medical-gas-system installers.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is certified by the Nationally Inspection Testing Certification as a medical gas verifier, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE Standard #6020 for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers.

C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. General: Pressurized medical gasses, laboratory use gasses, and vacuum piping systems for use in health care and life support systems.

2.02 PIPES, TUBES, AND FITTINGS

A. Comply with NFPA 99.

B. For all positive pressure gas and compressed air and vacuum piping: Piping, tubing, and fittings shall have been manufacturer cleaned, purged, and sealed as for oxygen service, according to CGA G-4.1.

1. Each length of tubing shall be delivered plugged or capped by the manufacturer and kept sealed until prepared for installation.

2. Fittings and other components shall be delivered manufacturer sealed and labeled, and kept sealed until prepared for installation.

C. Copper Medical Gas Tube: ASTM B819, Type K and Type L, seamless, drawn temper. Include standard color marking "MED" or "OXY/MED" in green for Type K tube and in blue for Type L tube.

1. NPS 1 ¼ (DN32) and smaller: Type L

2. NPS 1 ½ (DN40) and larger: Type K

3. Vacuum piping: Type L

D. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.

E. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

F. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.

1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness, full-face type.

2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

G. Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing. Working-Pressure Rating: 200 psig (1380 kPa) minimum. End Connections: Plain-end copper tube.

2.03 CONVENTIONAL JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

B. Threaded-Joint Tape: PTFE.

2.04 SWAGE-RING COMPRESSION FITTINGS

A. General: Drive ring and compression fitting assembly. Axially swaged, elastic strain preload fittings. Completed seal having pressure and temperature ratings equal or greater than brazed joints. For use on copper tube per ASTM B819, ASTM B88

1. Acceptable manufacturer: Lokring Technology, LLC

2. Fitting material: 360 brass per ASTM B16. Cleaned to CGA G-4.1 standard OC. Fittings individually bagged. Compliant with NFPA 99-2016.

2.05 ZONE VALVE BOXES

A. Zone-Valve Box Assemblies:

1. Description: Formed steel box with cover, anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.

a. Positive pressure medical gas valves shall have been manufacturer cleaned, purged, and sealed as for oxygen service, according to CGA G-4.1. Valves shall be delivered sealed and labeled and kept sealed until prepared for installation.

b. Interior Finish: Factory-applied white enamel. Cover Plate: Stainless-steel with frangible or removable windows. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

2.06 VALVES AND SPECIALTIES

A. General: Gas system components cleaned, purged, and sealed as for oxygen service, according to CGA G-4.1. Valves shall be delivered sealed and labeled and kept sealed until prepared for installation.

B. Ball Valves: Standard: MSS SP-110. Description: Three-piece body, brass or bronze. Pressure Rating: 300 psig (2070 kPa) minimum.

1. Ball: Full-port, chrome-plated brass. Seats: PTFE or TFE. Handle: Lever type with locking device. Stem: Blowout proof with PTFE or TFE seal.

2. Ends: Manufacturer-installed ASTM B819, copper-tube extensions and manufacturer-installed ASTM B819, copper-tube extensions with pressure gage on one copper-tube extension.

C. Check Valves: Description: In-line pattern, bronze. Pressure Rating: 300 psig (2070 kPa) minimum. Operation: Spring loaded.

1. Ends: Manufacturer-installed ASTM B819, copper-tube extensions.

D. Medical Gas Safety Valves: Bronze body. ASME-construction, poppet, pressure-relief type. Settings to match system requirements.

E. Pressure Regulators: Bronze body and trim. Spring-loaded, diaphragm-operated, relieving type. Manual pressure-setting adjustment. Rated for [250-psig (1725-kPa)] <Insert value> minimum inlet pressure.

1. Capable of controlling delivered gas pressure within 0.5 psig for each 10-psig (5.0 kPa for each 100-kPa) inlet pressure.

2.07 SERVICE CONNECTIONS

A. General Requirements for Service Connections:

1. All positive pressure medical gas and vacuum service connections shall be manufacturer cleaned, purged, and sealed as for oxygen service, according to CGA G-4.

2. Suitable for specific medical gas pressure and service listed.

3. Include roughing-in assemblies, finishing assemblies, and cover plates.

4. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate.

5. Recessed-type units made for concealed piping unless otherwise indicated.

B. Roughing-in Assembly:

1. Steel outlet box for recessed mounting and concealed piping.

2. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.

3. Double seals that will prevent air leakage.

4. ASTM B819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.

C. Finishing Assembly:

1. Brass housing with primary check valve.

2. Double seals that will prevent air leakage.

3. Cover plate with gas-service label.

D. Quick-Coupler Pressure Service Connections:

1. Outlets with noninterchangeable keyed indexing to prevent interchange between services.

2. Constructed to permit one-handed connection and removal of equipment.

3. With positive-locking ring that retains equipment stem in valve during use.

E. D.I.S.S. Pressure Service Connections: Outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.

F. Cover Plates: One piece, aluminum or stainless steel. Permanent, color-coded, identifying label matching corresponding service.

PART 3 - EXECUTION

3.01 PREPARATION

A. Cleaning of Tubing: If manufacturer-cleaned and -capped fittings or tubing is not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:

1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1.

2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb (0.453 kg) of chemical to 3 gal. (11.3 L) of water.

a. Scrub to ensure complete cleaning.

b. Rinse with clean, hot water to remove cleaning solution.

3.02 PIPING INSTALLATION

A. Comply with NFPA 99 for installation of medical gas and vacuum piping.

B. Install medical gas and vacuum piping with 1 percent slope downward in direction of flow.

C. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.

D. Install branch connections to medical gas mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

E. Piping Restraint Installation: Install seismic restraints on all medical gas and vacuum piping.

F. Install unions in copper medical gas and vacuum tubing adjacent to each valve and at final connection to each machine, specialty, and piece of equipment.

G. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.03 VALVE INSTALLATION

A. Install shutoff valve at each connection to and from medical gas and vacuum source equipment and specialties.

B. Install check valves to maintain correct direction of flow from compressed medical gas equipment.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install pressure regulators on piping where reduced pressure is required.

F. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter of each air compressor.

3.04 JOINT CONSTRUCTION

A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

B. Threaded Joints: Apply appropriate tape to external pipe threads.

C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" chapter. Continuously purge joint with oil-free dry nitrogen during brazing.

D. Flanged Joints: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

E. Swage Ring Compression Fittings: Installation by certified installer using tooling by same manufacturer as the fittings. Follow all manufacturer installation procedures. Do not install within 8” of a brazed joint.

3.05 HANGER AND SUPPORT INSTALLATION

A. Vertical Piping: MSS Type 8 or Type 42, clamps.

B. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.

2. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.

C. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

D. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 (DN 20) and smaller: 72 inches (2100 mm) with 3/8-inch (10-mm) rod.

2. NPS 2 (DN 50) to NPS 1 (DN 25): 96 inches (3.4 m) with 3/8-inch (10-mm) rod.

3. NPS 4 (DN 100) to NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.

F. Install supports for vertical copper tubing every 10 feet (3 m).

3.06 IDENTIFICATION

A. Install identifying labels and devices for medical gas piping systems according to NFPA 99.

3.07 FIELD QUALITY CONTROL FOR MEDICAL GAS AND VACUUM PIPING IN HEALTHCARE FACILITIES

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical compressed-air piping in healthcare facilities and to prepare test and inspection reports.

B. Tests and Inspections:

1. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:

a. Initial blowdown.

b. Initial pressure test.

c. Cross-connection test.

d. Piping purge test.

e. Standing pressure test for positive-pressure medical compressed-air piping.

f. Repair leaks and retest until no leaks exist.

2. System Verification: Perform the following tests and inspections according to NFPA 99, ASSE Standard #6020, and ASSE Standard #6030:

a. Standing pressure test.

b. Individual-pressurization or pressure-differential cross-connection test.

c. Valve test.

d. Master and area alarm tests.

e. Piping purge test.

f. Piping particulate test.

g. Piping purity test.

h. Final tie-in test.

i. Operational pressure test.

j. Medical air purity test.

k. Verify correct labeling of equipment and components.

3. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

a. Inspections performed.

b. Procedures, materials, and gases used.

c. Test methods used.

d. Results of tests.

C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.08 PIPING SCHEDULE

A. Use flanges where connection to flanged equipment is required.

B. Medical Air, Oxygen, or other medical gas and vacuum piping equal or less than NPS 1 1/4 (DN 32): Type L, copper medical gas tube; wrought-copper fittings with brazed joints, or swage-ring compression fittings.

C. Medical Air, Oxygen, or other medical gas and vacuum piping larger than NPS 1 1/4 (DN 32): Type K, copper medical gas tube; wrought-copper fittings with brazed joints, or swage-ring compression fittings.

D. Instrument or Laboratory Air Piping Larger Than NPS 1 1/4 (DN 32) and Operating at More Than 90 psig (1275 kPa): Type K, copper tube; wrought-copper fittings; and brazed joints.

3.09 VALVE SCHEDULE

A. Shutoff Valves: Ball valve with manufacturer-installed ASTM B819, copper-tube extensions.

B. Zone Valves: Ball valve with manufacturer-installed ASTM B819, copper-tube extensions with pressure gage on one copper-tube extension.

END OF SECTION 226113

SECTION 230500
BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. The intent of Division 21, 22, and 23 Specifications and Drawings is to provide complete and workable mechanical systems as shown, specified and required by applicable codes. Include all work specified in Division 21, 22 and 23 and shown on the Drawings, including appurtenances, connections, demolition, appliances, and incidental accessories to make work complete and ready for operation.

B. The Drawings that accompany the Division 21, 22, and 23 Specifications are diagrammatic. They do not show every offset, pipe/duct fitting, or elbow that may be required to install work in the space provided and avoid conflicts. Locations of all items not definitely fixed by dimensions are approximate only. Coordinate Division 21, 22, and 23 work as required by Division 01.

C. Include minor details not usually shown or specified, but necessary for proper installation and operation of a system or piece of equipment in work and in bid price, the same as if specified or shown.

1.03 ENFORCEABLE CODES

A. The code publications listed below form a part of this specification. This list is not exclusive, local and other codes may also apply:

1. 2022 California Administrative Code (CAC), Part 1, Title 24, California Code of Regulations (CCR).

2. 2022 California Building Code (CBC), Part 2, Title 24, CCR, (Based on the 2021 International Building Code).

3. 2022 California Electrical Code (CEC), Part 3, Title 23, CCR, (Based on the 2020 National Electrical Code).

4. 2022 California Mechanical Code (CMC), Part 4, Title 24, CCR, (Based on the 2021 Uniform Mechanical Code).

5. 2022 California Plumbing Code (CPC), Part 5, Title 24, CCR, (Based on the 2021 Uniform Plumbing Code).

6. 2022 California Fire Code (CFC), Part 9, Title 24, CCR, (Based on the 2021 International Fire Code).

1.04 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subjected to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.

2. PE: Polyethylene plastic.

3. PVC: Polyvinyl chloride plastic

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber

2. NBR: Acrylonitrile-butadiene rubber.

1.05 REFERENCES

A. Publications and Standards listed below form a part of this specification to the extent referenced. The Publications and Standards are referenced to in the text by basic designation only.

1. Applicable municipal, county, and state mechanical, electrical, gas, plumbing, health and sanitary codes, laws, and ordinances.

2. Standards and requirements of local utility companies.

3. National Electrical Manufacturer’s Association Standards.

4. National Electrical Safety Code.

5. National Electrical Testing Association.

6. Underwriter’s Laboratories, Inc. Standards.

7. American National Standards Institute.

8. American Society for Testing Materials Standards.

9. National Fire Protection Association Standards.

10. American Society of Mechanical Engineers Boiler and Pressure Vessel Codes.

11. American Water Works Association.

12. Occupational Safety and Health Act.

13. Uniform Mechanical and Plumbing Codes with applicable State of California amendments.

14. Commercial and Industrial Insulation Standards.

15. American Gas Association.

16. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

17. Sheet Metal and Air conditioning Contractor's National Association Standards.

18. Air-Conditioning and Refrigeration Institute Standards.

19. American Welding Society.

1.06 SUBMITTALS

A. Comply with requirements of Division 01.

B. Coordination Drawings: Each trade shall be responsible for their own respective coordination drawing effort with the HVAC contractor being the coordination effort team leader. Drawings shall be electronic (AutoCAD) and each trade shall have the ability to coordinate electronically (xref) into each other's drawings for collision checking and spatial conditions. When coordination effort is completed contractors shall sign drawings demonstrating that they are buildable shop drawings. Coordination drawings can also be used as the contract "as-builts" at project completion.

C. Submit required copies of shop drawings, product data, samples, schedules and reports as required by individual Division 21, 22, and 23 Sections.

1.07 QUALITY ASSURANCE

A. Provide Work and materials in accordance with the latest rules and regulations of the California State Fire Marshal and the California State Department of Public Health, Titles 17 and 24; the California Plumbing Code and California Mechanical Code, IAPMO; the NFPA Pamphlet 13, 14, 24, 291; and other applicable laws or regulations.

B. Where the standards of the drawing and specifications for materials and/or workmanship are higher than the requirements of the regulations cited above, the drawings and specifications shall take precedence; otherwise the regulations shall govern.

C. Provide materials and apparatus that bear the UL label where such label is applicable.

D. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code – Steel".

E. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.08 DELIVERY, STORAGE AND HANDLING

A. Protect materials from corrosion and breakage. Store materials above grade. Provide appropriate covering.

B. Replace any materials which are damaged or degraded by improper storage with new.

1.09 SITE VISITATION

A. Visit the site prior to bidding and become familiar with existing conditions and other factors which may affect the execution of the work. Include all related cost in the initial bid proposal.

1.010 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08.

D. Coordinate all equipment, ductwork, and piping layout with other trades.

1.011 WARRANTY

A. Comply with the requirements of Division 01.

B. Provide manufacturer’s written warranties covering defects in materials and workmanship of products and equipment utilized for this project.

C. Each complete system shall be warranted for a period of one year from the date of Substantial Completion.

D. Each system shall be free of defects in materials and workmanship, and shall perform satisfactorily under all conditions of load or service.

E. The warranties shall provide that all additional controls, protective devices, or equipment be provided as necessary for operation of the system or equipment.

F. Replace or repair faulty materials or workmanship at no additional cost to the Owner.

G. See specific sections for additional equipment warranty items.

1.012 OPERATING INSTRUCTIONS MANUALS

A. Provide 2 copies of complete Manual, bound in booklet form, plus an electronic copy on permanent storage media. Each manual shall contain the following information:

1. List of all equipment with manufacturer's name, model number, and local representative, service facilities, and the normal channel of supply for each item.

2. Manufacturer's literature describing each item of equipment with detailed parts list.

3. Equipment service schedules and IOMs.

4. Equipment warranties.

5. Certificates of Inspection.

6. Record Blueprints and related Shop Drawings.

7. Air and Water Systems Balance Reports.

1.013 RECORD DRAWINGS

A. Maintain at the site an up to date set of prints of Engineering Drawings which clearly indicate (by shading, coloring or some other acceptable method) the daily extent of Work installed.

B. Indicate on Drawings changes in elevation, location, or size of material deviating from original design.

C. Clearly indicate any dimension changes in elevation, location, size or material, and offsets for valves.

D. Locate all underground, concealed or buried piping by two or more dimensions per turn of pipe between each direction change.

E. Show all elevations (invert or centerline) with the point of elevation change clearly located.

F. Number and letter valves to correspond with numbers and letters of valve charts.

G. At conclusion of contract work, provide the Owner's Representative with a complete set of reproducible drawings with all changes clearly marked to reflect as-built conditions. These drawings shall be labeled "As-Builts". Updated Coordination drawings can be used as the contract "As-Built" drawings at project completion.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer's names and model numbers used for materials, processes, or equipment in Division 21, 22, and 23 provide the basis for design and the minimum standards of quality, utility and appearance.

2.02 SUBSTITUTIONS

A. For substitutions see Division 01.

B. If not specified in Division 01:

1. Substitutions only from list provided.

2. Contractor is responsible for all alterations required to make substituted product work.

3. Contractor is responsible for all coordination of other trades required by substitution.

4. Contractor is responsible for any engineering and structural or seismic modifications to the equipment supports and structure, etc.

PART 3 - EXECUTION

3.01 DEMOLITION

A. Comply with the requirements of Division 02.

B. Remove fixtures and equipment not to remain in service as shown on Drawings or as required. This includes the removal of associated appurtenances and supports.

C. Patch, cap, or repair existing work affected by this demolition in concealed spaces within six (6) inches of a live main or branch.

D. Deliver removed materials to be retained by the Owner for storage on-site as directed by the Owner's Representative. Properly dispose of all other removed material off site.

E. Where hazardous and carcinogenic materials are encountered, stop the work immediately and notify the Owner's Representative.

3.02 INSTALLATION

A. General Installation Method:

1. Examine site related work and surfaces before starting work of any Section:

a. Report to Owner's Representative, in writing, conditions which will prevent proper execution of this work.

b. Beginning work of any Section without reporting unsuitable conditions to Owner's Representative constitutes acceptance of conditions by Contractor.

c. Perform any required removal, repair, or replacement of any unacceptable work caused by unsuitable conditions at no additional cost to Owner.

B. Provide a complete and properly operating system for each item of equipment called for under this work. Install in accordance with equipment manufacturer's written instructions, published standards, the best industry practices, and the Contract Documents.

C. Make installations in a neat, finished, and safe and professional manner. Install all materials and equipment in accordance with manufacturer's required or recommended procedures.

D. Coordinate with shop drawings for work done by other trades.

E. Verify all dimensions by field measurements.

F. Arrange for chases, sleeves, and openings in other building components during progress of construction, to allow for installation of ductwork and piping.

G. Coordinate the installation of required supporting devices and sleeves.

H. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations. Maintain all manufacturer required service clearances.

I. Install HVAC equipment to allow right of way for piping installed at required slope.

J. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

K. Install systems, materials, and equipment to comply with approved submittal data. Comply with arrangements indicated by the Drawings, recognizing that portions of the work are shown only in diagrammatic form.

L. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.

3.03 CUTTING AND PATCHING

A. Comply with requirements of Division 01.

B. Cut completed Work only where sleeves, openings, chases, and similar items were inadvertently omitted and only with specific permission of the Owner's Representative. In no case shall reinforcing steel be cut without specific written permission of the Owner's Representative.

C. Provide sleeves, caps, plates, escutcheons, flashing, and similar items required to fill or close the openings.

D. Provide final grouting, concrete, asphalt, masonry, painting, and other materials as required to complete patch work.

E. Where cutting occurs on any building fire or smoke compartment separation, repair to maintain the integrity of the separation, including all necessary automatic dampers and UL approved through penetration systems.

F. Where cutting and patching occurs in streets, sidewalks, alleys, and the like, cooperate fully with the Owner's Representative and municipal or other government bodies to match existing materials.

3.04 OPERATION BY OWNER

A. The Owner may require operation of parts or all of respective installations prior to final acceptance. Cost of utilities for such operation shall be paid by Owner.

3.05 TEST AND ADJUSTMENTS

A. Labor, materials, instruments, and power required for testing provided under respective Sections for Work under that Section.

B. Test shall be performed as specified or as required by regulating authority having jurisdiction. Submit to Owner's Representative certification that tests have been performed in accordance with Contract Documents.

C. Pressure test piping before connection to equipment. No piping, equipment, or accessories shall be subjected to pressures exceeding their indicated rating.

D. Repair or replace defective Work and repeat tests until particular systems, and component parts thereof, receive approval of Owner's Representative and regulating authority.

1. Any damages resulting from test shall be repaired and damaged materials replaced at no cost to Owner.

E. Equipment and systems which normally operate during certain seasons of the year shall be tested during the appropriate season.

1. Perform test on individual equipment, systems, and their controls.

2. Whenever the equipment or system under test is inter-related with, and depends upon the operation of other equipment or systems and their controls for proper operation, functioning, and performance, the latter shall be operated simultaneously with equipment or system being tested.

F. No piping or ductwork shall be closed up, furred in, or covered before testing. Notify regulating authority and Owner's Representative 3 days before test are to be conducted.

G. Test all systems as specified under various applicable Sections. Duration of test shall be determined by the authority having jurisdiction and in no case less than the time specified.

H. Drain water used for testing from the system after test are complete. Repair or replace any damages caused by freezing of water left in system at no expense to the Owner.

I. Test and balancing of air and hydronic systems specified under other appropriate Sections.

3.06 TERMINATIONS AND CLEANING

A. The Work includes removing tools, scaffolding, surplus materials, barricades, temporary walks, debris, and rubbish from the Project promptly upon completion of that portion of the Work. Leave the area of operations completely clean and free of these items.

B. During the course of construction, cap all ducts, pipes, and electrical conduits in approved manner to insure adequate protection against entrance of foreign substances.

C. Disconnect, clean, and reconnect, whenever necessary, to locate and remove obstructions from any system. Repair or replace any Work damaged in the course of removing said obstructions at no additional cost to the Owner.

3.07 INSTRUCTIONS FOR OWNER'S PERSONNEL

A. Prior to acceptance of Work and during time designated by the Owner's Representative, provide qualified personnel to operate each system for a period of 48 hours during 2 consecutive work days.

B. During operating period, fully instruct Owner's personnel in complete operation, adjustment, and maintenance of each system.

C. See specific sections for additional startup and training procedures.

3.08 PROJECT CLOSEOUT

A. Special tools or safety equipment: Provide one of each tool or piece of safety equipment required for proper operation and maintenance of equipment installed under this Work.

B. KEYING: Provide 3 keys for each lock furnished under this Work.

END OF SECTION 230500

SECTION 230523
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Bronze ball valves.

B. Related Sections:

1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.

2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.03 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of valve applicable to project.

1.05 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.1 for power piping valves.

3. ASME B31.9 for building services piping valves.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set angle, gate, and globe valves closed to prevent rattling.

4. Set ball and plug valves open to minimize exposure of functional surfaces.

5. Set butterfly valves closed or slightly open.

6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.

2. Handwheel: For valves other than quarter-turn types.

3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.

4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.

5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.

2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

3. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.

2. Grooved: With grooves according to AWWA C606.

3. Solder Joint: With sockets according to ASME B16.18.

4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE BALL VALVES

A. Three-Piece, Regular-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Conbraco Industries, Inc.; Apollo Valves.

b. Crane Co.; Crane Valve Group; Jenkins Valves.

c. Hammond Valve.

d. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-110.

b. SWP Rating: 150 psig.

c. CWP Rating: 600 psig.

d. Body Design: Two piece.

e. Body Material: Bronze.

f. Ends: Threaded.

g. Seats: PTFE or TFE.

h. Stem: Stainless steel.

i. Ball: Stainless steel, vented.

j. Port: Regular.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Locate valves for easy access and provide separate support where necessary.

B. Install valves in position to allow full stem movement.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball valve.

3.05 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.

2. Ball Valves: Three-piece, regular port.

3.06 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.

2. Ball Valves: Three-piece, regular port.

END OF SECTION 230523

SECTION 230553
HVAC PIPING AND EQUIPMENT IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Equipment identification

2. Valve, automatic control valves, dampers (including smoke and combination fire/smoke dampers) and automatic control dampers identification

3. Piping and ductwork identification

4. Signage

REFERENCE STANDARDS

B. ANSI/ASME A13.1 – Scheme for the Identification of Piping Systems.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: Submit samples of each color, lettering style, and other graphic representation required for each identification material or system.

C. Schedules:

1. Valve identification chart: Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special “flags”, in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.

2. Automatic control valve identification chart (obtain from the Building Management System contractor for inclusion with this submittal).

3. Damper identification chart (including smoke and combination fire/smoke dampers).

4. Automatic control damper identification chart (obtain from the Building Management System contractor for inclusion with this submittal).

5. Lists of pipe and equipment to be labeled.

6. Include list of wording, symbols, letter size, letter style, and color coding for each system.

1.03 QUALITY ASSURANCE

A. Coordinate color coding with the University's Representative for preferred color schemes and service abbreviations and valve and equipment numbering schemes prior to submittal review.

B. Coordinate installation of identifying devices with completion of covering of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices, pipe identification and flow arrows before installing acoustical ceilings and similar concealment.

E. Coordinate painting schemes of piping, if required, with University's Representative prior to submittal review.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer:

1. Brady/Seton

2. Stranco

3. Rowmark

4. Or equal

2.02 MANUFACTURER'S IDENTIFICATION

A. Manufacturer's nameplate, name, or trademark shall be permanently affixed to all equipment and material furnished under this Specification. The nameplates of the Subcontractor or Distributor are not acceptable.

2.03 EQUIPMENT IDENTIFICATION

A. Properly identify each piece of equipment with nameplates mounted on or near each operations device, including:

1. Main control and operating valves, safety devices, and hazardous units

2. Pumps, compressors, and similar motor-driven units

3. Air handling equipment, fans, coils, fancoil units, unit heaters, filters, sound attenuators, and VAV terminal units

B. Identify control panels and major control components outside panels with nameplates.

C. Identify equipment that is out of view behind access doors in unfinished rooms on face of the access door.

D. Label content:

1. Include equipment's Drawing designation or unique equipment number. Use same address nomenclature established in the energy management system.

2. Area served

3. Year installed

4. Make and model

5. Equipment size (in CFM, HP, RPM, etc.)

6. If on emergency power, indicate source of power

2.04 NAMEPLATES

A. Provide plastic labels for mechanical engraving with predrilled holes for attachment hardware.

1. Material: rigid plastic laminated impact acrylic, 2 layer, exterior grade, UV stable

2. Thickness: 3/16 inch minimum

3. Maximum label size: Length and width vary for required label content, but no less than 2 inches wide by 1 inch high.

4. Background color:

a. Normal power: Black, matte finish

b. Emergency power: Red, matte finish

5. Lettering: White, machine engraved, Futura font, 3/8 inch high, all caps

6. Maximum temperature: Able to withstand up to 160 deg. F.

7. Fasteners: Self-tapping stainless steel screws, except contact type permanent adhesive where screws cannot or should not penetrate substrate.

a. Mounting screw type to be #8- 18 x 1 /2 drilling or tapping style, 1/4 inch hex washer head, stainless steel, or similar, appropriate for material in which sign is affixed to. A bead of silicone sealer shall be applied on back of sign and at screw locations prior to affixing sign to equipment.

b. For signs larger than 3 inches by 3 inches, use a minimum of 4 mounting screws.

2.05 VALVE TAGS

A. Attached to stem of each control valve and line shutoff valve installed under Division 22, with No. 16 brass chain, color-coded plastic laminate tag. Engrave laminate tags with 1-inch designated numbers in accordance with typed schedule showing valve size, locations, service, similar to the following form:

RW: 3-inches
Shutoff, Toilets

3rd Floor
Column F-8

1. Engrave identification tags “normally open” (green) or “normally closed” (red).

2. Do not identify valves where the use is obvious, such as equipment isolation valves.

3. Tag all valves except fixture stops.

4. Label HVAC valves “HVAC” plus valve identification number.

5. Number tags to conform to directory listing number, location, and use.

B. Access panel markers: Provide manufacturer’s standard 1/16 inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8 inch center hole to allow attachment.

2.06 PIPE IDENTIFICATION

A. General requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Small pipes: For external diameters less than 6 inches (including isolation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.

2. Adhesive lap joint in pipe marker overlap.

3. Laminated or bonded application of pipe marker to pipe (or insulation).

4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inches.

D. Large pipes: For external diameters of 6 inches and larger (including isolation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:

1. Laminated or bonded application of pipe marker to pipe (or insulation).

2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 inch wide; full circle at both ends of pipe marker, tape lapped 3 inches.

3. Strapped to pipe application of semi-rigid type, with manufacturer’s standard stainless steel bands.

E. Pipe Label Contents: Include identification of piping service using piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application. Include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

F. Locate pipe markers as follows:

1. Within one foot of each valve, fitting, thermometer or gauge.

2. At each branch or riser take off.

3. At each passage through walls, floors and ceiling construction.

4. At each pipe passage to underground.

5. On all horizontal pipe runs every 20 ft, at least twice in each room and each story traversed by piping system.

6. Identify piping contents, flow direction, supply and return.

7. Where capped piing is provided for future connections, provide legible and durable tags indicating symbol identification.

8. At wall and ceiling access panels.

9. Practicable variations or changes in locations and spacing may be made with specific approval of the University's Representative to meet specific conditions.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

B. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.02 DUCTWORK INSTALLATION

A. Access doors: Provide duct markers or stenciled signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.

B. Concealed doors: Where access doors are concealed above acoustical ceilings or similar concealment, plasticized tags may be installed for identification in lieu of specified signs.

C. Access doors for fire/smoke dampers: Permanently identify on the exterior by a label with letters not less than 1/2 inch in height reading "FIRE/SMOKE DAMPER".

3.03 PIPE SYSTEM IDENTIFICATION

A. General: Provide for all systems unless indicated otherwise.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. At access doors, manholes, and similar access points that permit view of concealed piping.

2. Near major equipment items and other points of origination and termination.

3. 50 feet intervals.

C. Types: Install pipe markers of one of the following types on each system, and include arrows to show normal direction of flow:

1. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2 inches beyond ends of lettering.

2. Stenciled markers, with lettering color complying with ANSI A13.1.

3. Plastic pipe markers, with application system as indicated under "Materials" in this Section. Install on pipe insulation segment where required for hot non-insulated pipes.

4. Stenciled markers, black or white for best contrast, wherever continuous color-coded painting of piping is provided.

D. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

1. Near each valve and control device. Within one foot of each valve, fitting, thermometer or gauge.

2. At each branch or riser take off, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.

3. At each passage through walls, floors and ceiling construction, or enter non-accessible enclosures.

4. At each pipe passage to underground.

5. At access doors, manholes and similar access points which permit view of concealed piping. At wall and ceiling access panels. Practicable variations or changes in locations and spacing may be made with specific approval of the University’s Representative to meet specific conditions.

6. Near major equipment items and other points of origination and termination.

7. Spaced intermediately at maximum spacing of 50 feet (15m) along each piping run, except reduce spacing to 25 feet (8 m) in congested areas of piping and equipment.

8. On all horizontal pipe runs every 20 ft, at least twice in each room and each story traversed by piping system.

9. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

10. Where capped piping is provided for future connections, provide legible and durable tags indicating symbol identification.

11. Identify piping contents, flow direction, supply and return.

E. During back-filling/top soiling of exterior underground piping systems, install continuous underground-type plastic line marker, locate directly over buried line at 12-inches above pipe. Use metallic lined plastic line markers for non-metallic type piping.

3.04 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve cock and control device in each piping system; exclude check valves, and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.

B. Valves Concealed in Suspended Ceilings: Provide 1/4 inch high plastic tape marker identifying the valve number on the nearest ceiling grid member.

3.05 MECHANICAL EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device.

1. Signs shall be placed on the equipment in a logical location, easily visible to maintenance personnel, e.g. near control panels, disconnect switches, nameplates, on or near equipment main access doors and panels, etc. Sign and drilling locations shall be approved by the University's Representative.

B. Optional sign types: Where lettering larger than 1 inch height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, verify with University's Representative.

C. Lettering size: Minimum 1/4 inch high lettering for name of unit where viewing distances less than 24 inches, 1/2 inch high for distances up to 6 feet, and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering.

D. Plasticized tags: Where equipment to be identified is concealed above acoustical ceilings or similar concealment, use plasticized tags installed within concealed space to eliminate text in exposed sign (outside concealment). In rooms other than security area, mechanical rooms, storage, etc. use thumbtacks for exposed signs with color coded for each type of equipment. Verify with University's Representative.

3.06 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by Work of this Division or other Divisions.

B. Cleaning: Clean face of identification devices.

3.07 EXTRA STOCK

A. Furnish minimum of 5% extra stock of each mechanical identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.

1. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

END OF SECTION 230553

SECTION 230593
PLUMBING/HVAC FINAL TESTING, ADJUSTING AND BALANCING

PART I - GENERAL

1.01 WORK INCLUDED

A. Final test and balance of air distribution systems.

B. Final test and balance of hydronic distribution systems and associated equipment and apparatus of mechanical work.

C. Setting and adjusting speed and volume of systems, recording data, conducting tests, preparing and submitting reports, and recommending modifications to work as required by contract documents.

D. Component types of testing, adjusting, and balancing specified in this section includes the following as applied to mechanical equipment:

1. Fans

2. Air handling units

3. Ductwork systems

4. Coils and heat exchangers

5. Piping systems

6. Terminal units

7. Balance Valves for Plumbing systems

1.02 QUALITY ASSURANCE

A. University's Representative shall hire independent testing agency services and facilities that specializes in testing, analysis, and balancing of hydronic systems and air distribution for heating-cooling systems. Work shall be done by qualified engineering technicians and trained personnel, using instruments certified accurate to limits used in standard practice for testing and balancing of hydronic and air distribution for heating-cooling systems. Agency shall field test air and hydronic flows in accordance with methods set up by Associated Air Balance Council, National Standard Volume 1, latest edition.

B. Final testing and balancing of the HVAC systems will be contracted directly by the University. The mechanical contractor, however, will be required to coordinate with the designated test and balance contractor in all respects in a manner exactly as if he were a mechanical subcontractor. With the exception of the actual labor of the test and balance contractor, the mechanical contractor shall consider this specification section to be an inclusive part of his contract documents and shall assume necessary compliance therewith, especially substantial completion. The mechanical contractor shall execute his work in close coordination with the test and balance contractor making every effort to provide complete test and balance systems, responding expeditiously to correct any deficiencies, inadequacies, imbalances, etc. that may be evidenced by the test to those systems. In that regard, cost and labor for the installation, addition, or removal of any shims, sheaves,

or other similar items necessary for incremental adjustment of systems or equipment, in order to comply with the requirements to provide complete and balanced systems demonstrated by test and balance tests, will be considered to be part of the base scope of work of this project.

1. Balancing air quantities of supply and exhaust including existing supply and return fans and all existing zone ducts to achieve those given on drawings. Records shall be kept on all air quantities measured, including tests prior to final balance. On systems with economy cycles, measure and record air quantity of supply and return fans with outside air dampers in minimum and maximum positions. Record variations in fan static and brake horsepower. Adjust to maintain constant building pressure.

2. The use of fire dampers as balancing dampers will not be permitted.

3. Primary air balance shall be achieved using variable fan speed, branch duct dampers, and so forth. The dampers on diffusers and registers may be used only for final balance.

4. Measure and record the ampere reading of each motor input after final adjustments have been made. Record nameplate amperage of motors.

5. Tabulate magnetic starter's size, type and manufacturer with heater strip size, type and rating.

C. Reference Standards:

1. AABC - Associated Air Balance Council - A National Standard Volume 1.

2. ASHRAE - American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc.

3. NEBB - National Environmental Balance Bureau.

1.03 SUBMITTALS

A. Provide submittals to indicate the extent of work proposed. Submit certified test reports as hereinafter specified signed by Test and Balance Supervisor who performed test and balance work. Provide all submittals in both hard copy and electronic format. Compile the electronic copies entirely in Abode Acrobat complete with an interactive field linked Table of Contents (linked to the chapters and subsections within the report). Submit electronic copies on a CD (or CDs).

B. Include identification and types of instruments used and their most recent calibration date with submission of final test report.

C. Provide submittal of completed balance report prior to request for final mechanical observation of the project.

1.04 JOB CONDITIONS

D. Balance agency shall perform the following during installation phase of systems:

1. Study design specifications and engineering Drawings and prepare schedule to physically inspect mechanical equipment for hydronic and air distribution systems to be tested and balanced. Contractor shall provide balance agency with one copy of Contract Drawings and specifications, mechanical equipment submittals, and change orders necessary for proper balancing of air distribution systems.

2. Balance agency shall make field inspections prior to closing in portions of systems to be balanced. Agency shall verify to its satisfaction that all work, fittings, dampers, balancing devices, etc. are properly fabricated and installed as shown or specified and that Agency will be able to properly balance system.

3. Prepare final test and balancing schedule, test record forms, and necessary technical information about hydronic and air distribution systems for installed heating-cooling equipment.

4. Recommend adjustments and/or corrections to mechanical equipment and hydronic and air distribution systems that are necessary for proper balancing of systems.

PART II - PRODUCTS

2.01 PATCHING MATERIALS

A. Except as otherwise indicated, use same products as used by original installer for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes.

1. At tester's option, plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.

2.02 TEST INSTRUMENTS

B. Utilize test instruments and equipment for test and balance work required, of type, precision, and capacity as recommended in the following test and balance standards:

1. Comply with AABC's Manual "AABC National Standards," Volume 1.

PART III - EXECUTION

3.01 BALANCING

A. Upon completion of hydronic and air handling systems, balance agency shall complete tests, analysis, and balance of hydronic and air handling systems for heating-cooling equipment.

B. This report shall include as minimum, but not be limited to, following design and actual information:

1. Motors, Pumps, and Fans: Horsepower, brake horsepower, revolutions per minute, actual amperage, and full-load rated current.

2. Supply, Return, and Exhaust Fans: Cubic feet per minute, static pressure, and outlet velocity.

3. Pumps: Suction and discharge pressure.

4. Coils: Gallons per minute, fluid temperature, and air temperature at outlet and inlet.

5. Terminal Air Distribution Units: Cubic feet per minute and inlet static pressure.

6. Inlets, Outlets, and Main Branch Ducts: Air velocity and cubic feet per minute.

7. All Rooms: Air temperature during test.

8. Other information required to establish completely balanced systems.

3.02 BALANCE REQUIREMENTS

C. Make allowance for air filter resistance at time of tests. Balance main air supplies at design air quantities and at an air resistance across filter bank midway between design specifications for clean and dirty filters. Balance room air supply and exhaust to within 0 and plus 10% of design air quantities for rooms with an air supply, return, or exhaust under 1000 cfm and to within 0 and plus 5% in room where total is 1000 cfm or more, or in rooms with multiple outlets. In all cases, total air quantities supplied to any floor or major zone will be within 0 and plus 5% of design.

D. After final air and hydronic balance of systems, make adjustments to obtain uniform temperatures as required by actual occupancy.

E. Take static pressure readings with inclined manometer. Take air velocity readings with instruments of recent calibration. Take final velocity readings with Alnor Velometer, Anemotherm or Vane Type Anemometer, calibrated prior to test and recalibrated at end of test. Include certified correction curves for each calibration as part of record. Certify instruments accurate to standards currently used in common practice for system balance work. Use test cones for diffusers.

F. Run tests with supply, return, and exhaust systems operating and doors, windows, etc. closed or under regular traffic. If possible, make final readings with cooling coils under load to ensure that static pressures are at maximum.

G. Adjust deflection of supply outlets to ensure proper and uniform air distribution throughout area served by such outlets.

H. Work with temperature Control Subcontractor in adjustment of automatic dampers, valves, thermostats, etc. required to maintain proper temperatures in all portions of building.

I. Contractor responsible for installing heating, cooling, and ventilating equipment shall make any changes, additions, or modifications to dampers, fan drives and motor sheaves, pump impellers, motors, and other equipment necessary for proper air and hydronic balance.

J. Balance of systems shall be reviewed by University's Representative and during this review Mechanical Contractor shall furnish men, materials, ladders, etc. to enable University's Representative to take all readings as he may direct. If errors are found, Balancing Agency shall readjust system to satisfaction of University's Representative.

K. Seal shaft at openings, including openings into duct runs.

L. Determine measured leakage factor by use of hook gauge with connections across installed orifice plate. Submit leakage factor determined by these tests to Contractor for correction.

M. Submit test equipment used to University's Representative for review before beginning work.

END OF SECTION 230593

SECTION 230700
HVAC INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Insulation Materials:

a. Flexible elastomeric.

b. Mineral fiber.

2. Adhesives.

3. Mastics.

4. Factory-applied jackets.

5. Field-applied jackets.

6. Tapes.

7. Securements.

8. Corner angles.

B. Related Sections:

1. Division 21 Section "Fire-Suppression Systems Insulation."

2. Division 22 Section "Plumbing Insulation."

3. Division 23 Section "Metal Ducts" for duct liners.

4. Division 33 Section "Underground Hydronic Energy Distribution" for loose-fill pipe insulation in underground piping outside the building.

5. Division 33 Section "Underground Steam and Condensate Distribution Piping" for loose-fill pipe insulation in underground piping outside the building.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.05 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.06 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA Inc.; Aerocel.

b. Armacell LLC; AP Armaflex.

c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

d. Or approved equal.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket or III with factory-applied FSP jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corp.; Duct Wrap.

b. Johns Manville; Microlite.

c. Knauf Insulation; Duct Wrap.

d. Manson Insulation Inc.; Alley Wrap.

e. Owens Corning; All-Service Duct Wrap.

G. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Johns Manville; HTB 23 Spin-Glas.

b. Owens Corning; High Temperature Flexible Batt Insulations.

c. Or approved equal.

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corp.; Commercial Board.

b. Fibrex Insulations Inc.; FBX.

c. Johns Manville; 800 Series Spin-Glas.

d. Knauf Insulation; Insulation Board.

e. Manson Insulation Inc.; AK Board.

f. Owens Corning; Fiberglas 700 Series.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Fibrex Insulations Inc.; Coreplus 1200.

b. Johns Manville; Micro-Lok.

c. Knauf Insulation; 1000 Pipe Insulation.

d. Manson Insulation Inc.; Alley-K.

e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.02 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. When used inside the weatherproofing system of the building, use products with VOC limits less than those identified below. Meet more stringent local requirements where they exist.

1. Contact Adhesives: 80 g/L.

2. Special Purpose Contact Adhesives: 250 g/L.

3. General Purpose Mist Spray Adhesive: 65% VOCs by weight.

4. General Purpose Web Spray Adhesive: 55% VOCs by weight.

5. Special Purpose Aerosol Adhesive: 70% VOCs by weight.

C. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

D. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA Inc.; Aeroseal.

b. Armacell LCC; 520 Adhesive.

c. Foster Products Corporation, H. B. Fuller Company; 85-75.

d. RBX Corporation; Rubatex Contact Adhesive.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Dow Chemical Company (The); 739, Dow Silicone.

b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.

c. P.I.C. Plastics, Inc.; Welding Adhesive.

d. Speedline Corporation; Speedline Vinyl Adhesive.

2.03 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; CP-35.

b. Foster Products Corporation, H. B. Fuller Company; 30-90.

c. ITW TACC, Division of Illinois Tool Works; CB-50.

d. Marathon Industries, Inc.; 590.

e. Mon-Eco Industries, Inc.; 55-40.

f. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perms at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.

5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; CP-10.

b. Foster Products Corporation, H. B. Fuller Company; 35-00.

c. ITW TACC, Division of Illinois Tool Works; CB-05/15.

d. Marathon Industries, Inc.; 550.

e. Mon-Eco Industries, Inc.; 55-50.

f. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.

3. Service Temperature Range: Minus 20 to plus 200 deg F.

4. Solids Content: 63 percent by volume and 73 percent by weight.

5. Color: White.

2.04 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.05 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in interior field-applied jacket schedules.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Johns Manville; Zeston.

b. P.I.C. Plastics, Inc.; FG Series.

c. Proto PVC Corporation; LoSmoke.

d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.

3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

4. Factory-fabricated tank heads and tank side panels.

D. Exterior Metal Jacket:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; Metal Jacketing Systems.

b. PABCO Metals Corporation; Surefit.

c. RPR Products, Inc.; Insul-Mate.

d. Or approved equal.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing or Factory cut and rolled to size.

b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barriers for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper, 3-mil- thick, heat-bonded polyethylene and kraft paper, or 2.5-mil- thick Polysurlyn.

d. Moisture Barriers for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper or 2.5-mil- thick Polysurlyn.

e. Field or Factory Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.

2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.

3) Tee covers.

4) Flange and union covers.

5) End caps.

6) Beveled collars.

7) Valve covers.

8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.06 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.

b. Compac Corp.; 104 and 105.

c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.

d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.

3. Thickness: 11.5 mils.

4. Adhesion: 90 ounces force/inch in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.

7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.

b. Compac Corp.; 110 and 111.

c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.

d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.

3. Thickness: 6.5 mils.

4. Adhesion: 90 ounces force/inch in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.

7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.

b. Compac Corp.; 120.

c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.

d. Venture Tape; 3520 CW.

2. Width: 2 inches.

3. Thickness: 3.7 mils.

4. Adhesion: 100 ounces force/inch in width.

5. Elongation: 5 percent.

6. Tensile Strength: 34 lbf/inch in width.

2.07 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products; Bands.

b. PABCO Metals Corporation; Bands.

c. RPR Products, Inc.; Bands.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) AGM Industries, Inc.; CWP-1.
        2) GEMCO; CD.

        3) Midwest Fasteners, Inc.; CD.

        4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) AGM Industries, Inc.; CWP-1.

        2) GEMCO; Cupped Head Weld Pin.

        3) Midwest Fasteners, Inc.; Cupped Head.

        4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.

        2) GEMCO; Perforated Base.

        3) Midwest Fasteners, Inc.; Spindle.

    b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

    c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) GEMCO; Nylon Hangers.

      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

      3) Or approved equal.

   b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.

   c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.

   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.

      2) GEMCO; Press and Peel.

      3) Midwest Fasteners, Inc.; Self Stick.

   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

   c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

   d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; RC-150.

2) GEMCO; R-150.

3) Midwest Fasteners, Inc.; WA-150.

4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) Midwest Fasteners, Inc.

2) Or approved equal.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

2.08 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.

2. Testing agency labels and stamps.

3. Nameplates and data plates.

4. Manholes.

5. Handholes.

6. Cleanouts.

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

2. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor

insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.

2. Pipe: Install insulation continuously through floor penetrations.

3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings:

1. Install insulation over fittings, unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit.

4. Insulate flanges ~~and unions~~ using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

5. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers,

valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

3.06 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.07 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.

2. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by

insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install pre-cut fiberglass inserts, same thickness as adjacent pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct bottoms with dimensions 24 inches and larger, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

b. On duct sides with dimensions larger than 48 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

d. Do not overcompress insulation during installation.

e. Impale insulation over pins and attach speed washers.

f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct bottoms with dimensions 24 inches and larger, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

   b. On duct sides with dimensions larger than 48 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

d. Do not overcompress insulation during installation.

e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.08 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.09 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ-SSL Jacketing.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Do not field paint aluminum jackets.

3.010 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork as installed.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.011 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.

2. Indoor, exposed supply and outdoor air.

B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.

2. Factory-insulated flexible ducts.

3. Flexible connectors.

4. Vibration-control devices.

5. Factory-insulated access panels and doors.

6. Indoor, concealed and exposed return air ducts.

3.012 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: Minimum R-Value of 4.2.

B. Concealed, outdoor-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: Minimum R-Value of 4.2.

C. Exposed, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: Minimum R-Value of 4.2.

D. Exposed, outdoor-air duct insulation shall be the following:

1. Mineral-Fiber Board: Minimum R-Value of 4.2.

3.013 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

3.014 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.015 INDOOR AND OUTDOOR PIPING INSULATION SCHEDULE

A. Chilled Water:

1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:

a. Mineral-Fiber, Preformed Pipe, Type I or Pipe Insulation Wicking System: 0.5 inch thick. Mineral fiber blanket allowed at indoor fittings where conditions prohibit preformed insulation.

2. NPS 1-1/2 to NPS 12: Insulation shall be one of the following:

a. Cellular Glass: 1 inches thick.

b. Mineral-Fiber, Preformed Pipe, Type I or Pipe Insulation Wicking System: 1 inches thick. Mineral fiber blanket allowed at indoor fittings where conditions prohibit preformed insulation.

B. Heating-Hot-Water Supply and Return:

1. NPS 1 ½ to NPS 12: Insulation shall be one of the following:

a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

2. NPS 1 ¼ and smaller: Insulation shall be one of the following:

a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches thick.

END OF SECTION 230700

SECTION 230923
BUILDING AUTOMATION CONTROL SYSTEM (BACS)

PART 1 - GENERAL

1.01 WORK INCLUDED:

A. Control sequences of operation shall be as shown in Drawings or as noted herein. Drawings of systems are diagrammatic only and any apparatus not shown, such as relays, transformers, accessories, etc., but required to make system operative to complete satisfaction of University's Representative, shall be provided at no increase in contract sum.

1. Refer to Division-26 sections for power wiring to line-voltage devices and for low voltage wiring and communication wiring to such applicable devices.

2. Refer to other Division-23 sections for controls necessary for temperature control systems.

3. The BACS scope of work shall include monitoring of other systems and equipment where indicated in the contract documents.

1.02 QUALITY ASSURANCE:

A. Electrical Standards: Provide electrical products which have been tested, listed, and labeled by Underwriters Laboratories (U.L.) and comply with NEMA standards.

B. SCADA Operational Protocol: Provide system which complies with applicable sections of the “Cyber Security Procurement Language for Control Systems” as developed and published by the Department of Homeland Security (DHS) – September 2009 (http://ics-cert.us-cert.gov/sites/default/files/FINAL-Procurement_Language_Rev4_100809_0.pdf).

1.03 SUBMITTALS:

A. Product Data: Submit manufacturer's specifications for each control device furnished, including installation instructions and start-up instructions. Submit integrated wiring and electrical diagram to show complete system operation.

B. All submittals must be received and approved by the University prior to the ordering and installation of any equipment by the Contractor.

1. Provide the University with two separate Building Controls submittals. The first will occur 60 days after the contract award and the second at 90 days. The first will provide specific information concerning the actual control system hardware, the system architecture, the points log, and the peripherals that will be provided. The second submittal will include specific information illustrating the complete system wiring schematic, full color illustrations of any screen graphic to be used, detail of the software design, and a testing plan for system performance verification that is point by point. The detail of submittal requirements are described in more specifics by the design documents.

C. Maintenance Data: Submit maintenance data and spare parts lists for each type of control device. Include this data in the Operation and Maintenance manual.

1. Submit three (3) copies of completed volumes in draft form a minimum of 180 calendar days prior to substantial completion. One (1) Copy will be returned with University Representative's comments. Revise content of documents as required prior to final submittal. No later than 60 days prior to substantial completion, the final submission of 2 copies of the O & M's will be due. Submit O & M's both in an electronic form (2 copies) and in hard paper form (2 copies). Compile the electronic copies entirely in Abode Acrobat complete with an interactive field linked Table of Contents (linked to the chapters and subsections within the report). Submit electronic copies on a CD (or CD's).

1.04 PANELS:

A. Submit shop drawings showing construction and mounting details for review prior to construction. In addition, submit the following for review prior to panel and/or system fabrication and installation:

1. Field wiring diagrams showing wiring external to panel.

2. Panel internal wiring diagrams also showing panel terminal connections for external wiring, properly coordinated and keyed to external wiring diagram.

3. Designation of all switches, pilot lights, etc. and layout of instruments, switches, and nameplates of panel.

1.05 JOB CONDITIONS:

A. Coordinate the Work of this SECTION with that of other SECTIONS to ensure that the Work will be carried out in an orderly fashion. It shall be Contractor's responsibility to check the Contract Documents for possible conflicts between temperature control Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

1.06 INSTALLING CONTRACTOR QUALIFICATIONS:

A. The Building Automation System Control System contractor must have been in business, and licensed as a contractor by the State of California, installing HVAC and building automation controls, and fire/life safety systems, for a minimum of ten (10) years preceding the bid opening.

B. The Building Automation Control System contractor must have completed no less than one (1) control system installation, within twenty-four (24) months preceding the bid opening, pursuant to a single written contract, valued at no less than three hundred thousand ($300,000) dollars.

C. Within twenty-four (24) months preceding the bid opening, from the Building Automation Control System contractor’s local office that will service the UC Davis Medical Center campus, the Building Automation Control System contractor must have completed at least twelve (12) projects, each of which included the installation of not less than five hundred (500) hardware input/output (I/O) points of the manufacturer type identified in subsection 2.01, A., under PART 2 – PRODUCTS, of this section. At least two (2) of these projects must have included the installation of not less than one thousand (1,000) hardware input/output (I/O) points of the manufacturer type identified in subsection 2.01, A., under PART 2 – PRODUCTS, of this section.

D. The Building Automation Control System contractor must demonstrate that, from the local office that will service the UC Davis Medical Center campus, a one (1) hour emergency response requirement can logistically be provided. The bidder must, in the judgment of the University's Representative, be able to generally provide one (1) hour emergency response. That is, to have appropriately equipped and trained personnel on-site within one (1) hour to rectify any potential emergency situation.

E. The Building Automation Control System contractor must have been, for five (5) years preceding the bid opening, a factory branch office, or a factory authorized dealer for the product manufacturer type identified in subsection 2.01, A., under PART 2 – PRODUCTS, of this section. Factory authorized dealer means:

1. Installing Contractor has a contract directly with the factory. A contract with a distributor is not acceptable.

2. Installing Contractor has direct access to factory technical support and training.

F. The Building Automation Control System contractor must have in its employ, at the local office that will service the U.C. Davis Medical Center campus, at least one (1) full time mechanical, or electrical engineer, registered as such by the State of California, having not less than three (3) years experience with the product manufacturer type identified in subsection 2.01, A., under PART 2 – PRODUCTS, of this section.

G. The Building Automation Control System contractor must have in its employ, at the local office that will service the U.C. Davis Medical Center campus, at least one (1) full time applications engineer, having not less than five (5) years experience with the manufacturer type identified in subsection 2.01, A., under PART 2 – PRODUCTS, of this section. The applications engineer and the aforementioned registered mechanical or electrical engineer may be the same person.

H. The Building Automation Control System contractor must have in its employ, at the local office that will service the U.C. Davis Medical Center campus, at least five (5) full time control technicians. At a minimum, one (1) technician must be senior (at least 5 years experience installing products of the manufacturer type identified in subsection 2.01, A., under PART 2 – PRODUCTS, of this section); two (2) technicians must be mid-level (at least three (3) years experience installing products of the manufacturer type identified in subsection 2.01, A., under PART 2 – PRODUCTS, of this section); and two (2) can be junior level technicians (at least one (1) year experience installing products of the manufacturer type identified in subsection 2.01, A., under PART 2 – PRODUCTS, of this section).

PART 2 - PRODUCTS

2.01 GENERAL:

A. Manufacturer: The Building Automation Control System shall be provided by the following:

1. Johnson Controls, Inc., to match campus standard.

B. All components used shall be serviceable, repairable, and replaceable by qualified temperature control technicians using non-proprietary parts, tools, and instruments.

2.02 TEMPERATURE CONTROL MATERIAL:

A. Electric Damper Actuators shall be spring return electric actuators that operate on 24 VAC or VDC power. Actuators shall be available for use with on/off, floating, proportional, or

resistive controllers. The actuators may be direct or remote mounted to a damper, or mounted to a valve using a linkage kit. Actuators shall be properly sized to provide sufficient torque to position the damper through out its operating range. Actuators shall be provided and installed for equipment provided with dampers such as Air Handling Units in addition to dampers supplied and installed under this section of the specification.

B. Control Valves:

1. Control valves shall be two-way pattern as shown, constructed for tight shut-off and shall operate against system pressures and differentials. Valves with sizes up to and including 2" shall be "screwed", 2-1/2" and larger valves shall be "flanged" configuration. Control valves shall be sized for a maximum pressure drop of 4.0 psig at rated flow (except as otherwise noted).

2. Control valves for reheat coils and chilled water fan coils shall be pressure independent type, Delta-P FDP or HDP series from Flow Control Industries or equal. All control valves shall fail in the last position. Maximum pressure drop at rated flow shall be 5 psig. Maximum pressure drop at rated flow shall be 5 psig.

3. All control valves shall be electronically operated. For valves larger than 8 inch, electro-hydraulic actuators shall be used.

4. Control valves for air handling units, heating hot water, main chilled water, domestic hot water and heat recovery systems shall be Delta P pressure independent modulating type by Flow Control Industries or equal. Maximum pressure drop at rated flow shall be 5 psig.

C. Furnish temperature control panels (TCP) of NEMA code gauge steel with locking doors for mounting all devices as shown. They shall meet all applicable requirements of Title 24, California Code of Regulations. All controllers, relays, switches, etc. for equipment located in mechanical equipment rooms shall be mounted in a TCP as shown on the drawings. Temperature settings, adjustments and calibration shall be done at the TCP. Any required UCMC Campus Data networks connection for this panel shall be installed inside the panel. All electric devices within a control panel shall be factory pre-piped and wired. Provide engraved laminated plastic nameplates identifying all devices mounted on the face of the control panels. A complete set of related "as-builts" control drawings shall be furnished in each control panel.

D. Space (room) temperature sensors shall be non-occupant adjustable unless otherwise specified. Space temperature set points shall be operator adjustable through the control system operator workstation (OWS) and through operator interface devices connected to DDC network control panels.

E. Occupant temporary override switches will not be provided unless otherwise specified.

2.03 GENERAL PRODUCT DESCRIPTION:

A. The Building Automation Control System shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, and historical data collection and archiving. The system shall include: Lighting control points utilizing the Division 16 lighting control system tied to Metasys via BACNET. JCI integrator for the addition of new medical gas points to the Nellcor/Puritan Bennett medical gas system. The BACS server shall have the capability to request and successfully process electrical monitoring data on-demand from the GE PMCS host server on a peer-to-peer basis.

B. The Building Automation Control System shall consist of the following:

1. Standalone DDC panels

2. Standalone application specific controllers (ASCs)

C. System architectural design eliminates dependence upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

D. Standalone DDC panels shall be able to access any date from, or send control commands and alarm reports directly to any other DDC panel or combination of panels on the network without dependence upon a central processing device. Standalone DDC panels shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.

2.04 FMS ARCHITECTURE

A. Overall Conceptual Description

1. The FMS shall be designed entirely for use on intranets and internets. All networking technology used at the Tier 1 level shall be off the shelf, industry standard technology fully compatible with other owner provided networks in the facility.

2. All aspects of the user interface, whether to servers or to Tier 1 solid-state devices, shall be via browsers. Any PCs used as operator interface points shall not require the purchase of any special software from the manufacturer in order to provide the complete user interface as described herein.

3. The user interface will be complete as described herein, providing complete tool sets, operational features, multi- panel displays, and other display features. Systems that merely provide HTML based web pages as the operator interface will not be acceptable.

4. The primary components of the system will be the Primary Application Nodes and Servers located at the highest level of the network architecture. Both will use the same user interface and provide the same level of accessibility via the network. The only distinction between the user interface used on servers as compared to Primary Application Nodes will be select menu items used for accessing long term storage features on the servers or on their respective archive devices (CD/RW, etc.)

B. General

1. The FMS shall consist of a number of Nodes and associated equipment connected by 3industry standard network practices. All communication between Nodes shall be by digital means only.

2. The FMS network shall at minimum comprise of the following:

a. Operator PCs – fixed or portable.

b. Network processing, data storage and communication equipment including file servers.

c. Routers, bridges, switches, hubs, modems and like communications equipment.

d. Active processing Nodes including field panels.

e. Intelligent and addressable elements and end devices.

f. Third-party equipment interfaces.

g. Other components required for a complete and working FMS.

3. All FMS features shall be accessible via Enterprise Intranet and Internet browser with equivalent FMS access control for user access.

4. The FMS shall support auto-dial/auto-answer communications to allow FMS Nodes to communicate with other remote FMS Nodes via standard telephone lines. Refer to drawings for type of line to be used, DSL or voice grade. Where no preference is indicated, DSL is the preferred grade.

5. The PC Workstations, File servers and principal network equipment shall be standard products of recognized major manufacturers available through normal PC vendor channels. “Clones” are not acceptable.

6. Provide licenses for all software residing in the FMS system and transfer these licenses to the Owner prior to completion.

C. Network

1. The FMS shall incorporate a primary Tier 1 network. At the Contractor’s option, the FMS may also incorporate integrated Secondary Tier 2 and tertiary Tier 3 networks.

2. The FMS Network shall utilize an open architecture capable of all of the following:

a. Utilizing standard Ethernet communications and operate at a minimum speed of 10/100 Mb/sec

b. Connecting via BACnet at the Tier 1 level in accordance with as per ANSI/ASHRAE Standard 135-2001.

c. Connecting via the N2 Protocol at the Tier 2 level.

d. Connecting via LonMark as per ANSI/EIA 709 (LonWorks) to LonMark FTT-10 transceivers at the Tier 2 level.

3. The FMS network shall support both copper and optical fiber communication media. Fiber cable, fiber modules or other fiber equipment shall not be provided if copper is selected.

D. Third-Party Interfaces

1. FMS Contractor shall integrate real-time data from systems supplied by other trades as required.

2. The FMS system shall include necessary FMS hardware equipment and software to allow data communications between the FMS system and systems supplied by other trades.

3. The trade contractor supplying other systems will provide their necessary hardware and software and will cooperate fully with the FMS contractor in a timely manner at their cost to ensure complete data integration.

E. Uninterruptible Power Supply (UPS)

1. Where indicated for supporting operator PCs, servers, and other equipment as indicated, provide a UPS as required.

2. UPS shall be sized for 50% spare capacity. The UPS shall be complete with batteries, external bypass and line conditioning.

F. Power Fail / Auto Restart

1. Provide for the automatic orderly and predefined shutdown of parts or all of the FMS following total loss of power to parts or all of the FMS.

2. Provide for the automatic orderly and predefined startup of parts or all of the FMS following total loss of power to those parts or all of the FMS. Archive and annunciate time and details of restoration.

3. Provide for the orderly and predefined scheduling of controlled return to normal, automatically time scheduled, operation of controlled equipment as a result of the auto restart processes.

4. Maintain the FMS real-time clock operation during periods of power outage for a minimum of 72 hours.

G. Downloading and Uploading

1. Provide the capability to generate FMS software-based sequences, database items and associated operational definition information and user-required revisions to same at any Operator PC, and the means to download same to the associated Application Node.

2. Application software tool used for the generation of custom logic sequences shall be resident in both the application node and the server(s) where indicated on the drawings.

3. Provide the capability to upload FMS operating software information, database items, sequences and alarms to the designated server(s).

4. The functions of this Part shall be governed by the codes, approvals and regulations applying to each individual FMS application.

2.05 OPERATOR INTERFACE

A. General

1. The FMS Operator Interface shall be user friendly, readily understood and shall make maximum use of colors, graphics, icons, embedded images, animation, text based information and data visualization techniques to enhance and simplify the use and understanding of the FMS by authorized users at the OWS.

2. It shall be possible to designate any PC on the Tier 1 network as an Operator Interface point. No special software will need to be purchased from the FMS manufacturer for any such PC.

3. User access to the FMS shall be protected by a flexible and Owner redefinable software-based password access protection. Password protection shall be multi-level and partitionable to accommodate the varied access requirements of the different user groups. Provide the means to define unique access privileges for each individual authorized user. Also provide the means to establish general password groups to which an individual will then be assigned. Once assigned to the group each individual will assume all the capabilities and restrictions of that group. Provide the means to on-line manage password access control under the control of a Master Password.

4. The user interface shall be able to combine data from any and all of the system components in a single browser window. This shall include historical data stored on a server.

5. The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:

    a. User access for selective information retrieval and control command execution

    b. Monitoring and reporting

    c. Means for the controlled re-programming, re-configuration of FMS operation and for the manipulation of FMS database information in compliance with the prevailing codes, approvals and regulations for individual FMS applications.

6. Provide FMS reports and displays making maximized use of simple English language descriptions and readily understood acronyms, abbreviations and the like to assist user understanding and interpretation. All text naming conventions shall be consistent in their use and application throughout the FMS.

7. All PC-based configurations shall operate on Microsoft® Windows 10.

8. Each fixed and portable PC shall be on-line configurable for specific applications, functions and groups of FMS points.

B. Navigation Trees

1. The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.

2. Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree

in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.

3. The navigation trees shall be “dockable” to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.

C. Dividable display panels

1. It shall be possible for the operator to divide the display area within a single browser window into multiple display panels. The content of each display panel can be any of the standard summaries and graphics provided by the system.

2. Provide each display panel with minimize, maximize, and close icons.

D. Alarms

1. Alarms shall be routed directly from primary application nodes to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the OWS software shall, at the minimum, provide the following functions

   a. Log date and time of alarm occurrence.

   b. Generate a “Pop-Up” window, with audible alarm, informing a user that an alarm has been received.

   c. Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.

   d. Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.

   e. Provide the ability to direct alarms to an e-mail address or alpha-numeric pager. This must be provided in addition to the pop up window described above. Systems which use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.

   f. Any attribute of any object in the system may be designated to report an alarm.

2. The FMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions

3. The FMS shall annunciate application alarms at a minimum.

E. Reports

1. Reports shall be generated and directed to one or more of the following: User interface displays, printers, or archive at the user’s option. As a minimum, the system shall provide the following reports:

a. All points in the FMS.

b. All points in each FMS application.

c. All points in a specific AN.

d. All points in a user-defined group of points.

e. All points currently in alarm in an FMS application.

f. All points locked out in an FMS application.

g. All FMS schedules.

h. All user defined and adjustable variables, schedules, interlocks and the like.

i. FMS diagnostic and system status reports.

2. Provide all applicable standard reports of the FMS manufacturer.

3. Provide for the generation by the user of custom reports.

F. Dynamic Color Graphics

1. An unlimited number of graphic displays shall be able to be generated and executed.

2. Graphics shall be based on Scalar Vector Graphic (SVG) technology.

3. Values of real time attributes displayed on the graphics shall be dynamic and updated on the displays.

4. The graphic displays shall be able to display and provide animation based on real-time FMS data that is acquired, derived, or entered.

5. The user shall be able to change values (set points) and states in system controlled equipment directly from the graphic display.

6. Provide a graphic editing tool that allows for the creation and editing of graphic files. It shall be possible to edit the graphics directly while they are on line, or at an off line location for later downloading to the AN.

7. FMS system shall be provided with a complete user expandable symbol library containing all of the basic symbols used to represent components of a typical FMS system. Implementing these symbols in a graphic shall involve dragging and dropping them from the library to the graphic.

G. Schedules

1. The system shall provide multiple schedule input forms for automatic FMS time-of-day scheduling and override scheduling of FMS operations. At a minimum, the following spreadsheet types shall be accommodated:

a. Weekly schedules.

b. Temporary override schedules.

c. Special “Only Active If Today Is A Holiday” schedules.

d. Monthly schedules.

2. Schedules shall be provided for each system or sub-system in the FMS. Each schedule shall include all commandable points residing within the system. Each point may have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and control of equipment within the system. Scheduling and rescheduling of points shall be accomplished easily via the system schedule spreadsheets.

3. Monthly calendars for a 12-month period shall be provided that allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

H. Historical trending and data collection

1. Trend and store point history data for all FMS points and values as selected by the user.

2. The trend data shall be stored in a manner that allows custom queries and reports using industry-standard software tools.

3. At a minimum, provide the capability to perform statistical functions on the historical database:

a. Average.

b. Arithmetic mean.

c. Maximum/minimum values.

d. Range – difference between minimum and maximum values.

e. Standard deviation.

f. Sum of all values.

g. Variance.

I. Paging

1. Provide the means of automatic alphanumeric paging of personnel for user-defined FMS events.

a. System shall support both numeric and alpha-numeric pagers, using Alphanumeric, PET, or IXO Protocol at the owner’s option.

b. Users shall have the ability to modify the phone number or message to be displayed on the pager through the system software.

c. System shall utilize pager schedules to send pages to the personnel that are “on-call”.

d. Contractor shall be responsible for providing a modem for connection to the paging service.

2.06 APPLICATION NODES

A. Primary Application Nodes

1. The primary application node shall perform the function of monitoring all system variables, both from real hardware points, software variables, and controller parameters such as set points.

2. Application nodes shall be entirely solid state devices. No rigid disk drives will be permitted in the equipment rooms.

3. The primary application nodes shall manage and direct all information traffic on the Tier 1 network, between the Tier 1 and Tier2 networks, and to servers.

4. Any node on the Tier 1 network shall be equipped with all software necessary to drive the complete user interface including graphics on a browser connected to the node via the network or directly via a local port on the node.

5. The operating system of the application node shall support multi-user access. At minimum four users shall be able to access the same application node simultaneously.

6. Communication between nodes shall be per-to-peer via 10/100 Ethernet using the BACnet protocol.

7. The AN shall be capable of direct connection to multiple field busses using different protocols simultaneously as indicated below. Should the controller not support multiple field busses, install two primary nodes side by side.

   a. An RS-485 serial field bus such as MSTP or the manufacturer’s proprietary field bus.

   b. A LON field bus for supervision and control of LON based controllers that conform to the Lon Talk standard.

8. The primary nodes will integrate data from both field busses into a common object structure. Data from both field busses will appear in common displays throughout the user interface in exactly the same format. It shall not be possible to determine which field buss the data originated on without reviewing the system configuration data.

9. AN shall be programmable and governed by the requirements of their applicable codes, approvals and regulations.

10. The AN shall be designed, packaged, installed, programmed and commissioned in consideration of their specific service and prevailing operating conditions. They shall be proven standard product of their original manufacturer and not a custom product for this Project.

11. A failure at an AN shall not cause failures or non-normal operation at any other system AN other than the possible loss of active real-time information from the failed AN.

12. Ancillary AN equipment, including interfaces and power supplies, shall not be operated at more than 80% of their rated service capacity.

13. AN shall comply with FCC Part 15 subpart J class A emission requirements.

14. Each primary node shall be equipped with the necessary un-interruptible power such that it will not cease operation during minor power outages, including those that occur upon transfer to emergency generator or other local power source not provided by the utility.

B. HVAC Node

1. HVAC Node shall provide both standalone and networked direct digital control of HVAC systems.

2. A dedicated HVAC Node shall be configured and provided for each primary HVAC system (air handler, chiller, boiler) and each terminal HVAC system (VAV Box, Unit Heater, Fan Coil Unit, Cabinet Heater, Heat Pump, Fan Powered Box, CV Box).

3. Each HVAC Node shall retain program, control algorithms, and setpoint information in non-volatile memory in the event of a power failure, and shall return to normal operation upon restoration of power.

4. Each HVAC Node shall report its communication status to the FMS. The FMS shall provide a system advisory upon communication failure and restoration.

5. For each primary HVAC system, provide means of indication of system performance and setpoints at, or adjacent to the HVAC Node.

6. For each primary HVAC system, provide a means to adjust setpoints and start/stop equipment at, or adjacent to the HVAC Node.

7. Provide a means to prevent unauthorized personnel form accessing setpoint adjustments and equipment control functions.

8. The HVAC Node shall provide the ability to download and upload configuration data, both locally at the Node and via the FMS communications network.

9. The HVAC Node shall be provided with a permanently-mounted local graphic terminal where required in the sequences of this specification. The local graphic terminal shall provide dynamic graphical representation of the associated system status, with the ability for the operator to enter commands with proper password protection.

2.07 APPLICATION SOFTWARE

A. HVAC Application Software

1. Event Messaging: Provide for the automatic execution of user-defined messages on the occurrence of each predefined FMS real-time event including equipment/point status change, approaching limit or alarm, time of day and the

like. Direct messages to any number of operator PCs, e-mail destinations, and pagers.

2. Indoor Air Quality: Provide monitoring of outside air, return air and supply air CO2 concentration, calculate and maintain fresh air requirements. Adjust outdoor air intake to ensure return air CO2 high level limit is not exceeded.

3. Optimum Start/Stop: Provide software to start equipment on a sliding schedule based upon indoor and outdoor conditions, to determine the minimum time of HVAC system operation needed to satisfy the space environmental requirements. The program shall also determine the earliest possible time to stop the mechanical systems. The optimum start/stop program shall operate in conjunction with, and be coordinated with, the scheduled start/stop and night setback programs.

4. Auto Alarm Lockout: Provide for scheduled and automatic lockout of alarm annunciation from equipment during non-normal operating conditions including shutdown, emergency power operation, fire alarm and the like.

5. Energy monitoring: Provide software to monitor and totalize consumption as measured by pulse meters.

6. Event Initiated Programs and custom logic: Provide software to define custom logic sequences that will reside in the nodes. The definition software will also reside in the node and be accessible via the standard user interface via a browser.

7. System Restart: Upon restoration of the AC power to an HVAC Node, automatically restart all equipment and restore all loads to the state as required by the FMS. Provide appropriate time delays to prevent demand surges or overload trips.

8. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

Runtime Totalization: Automatically sample, calculate and store runtime hours for binary input and output points as listed in the point schedule of this specification.

9. Analog/Pulse Totalization: Sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

2.08 NETWORKING/COMMUNICATIONS:

A. The design of the Building Automation Control System shall network operator workstations and Standalone DDC Panels as shown on the attached system configuration drawing. Inherent in the system's design shall be the ability to expand or modify the network(s) either via the local area network, or auto-dial telephone line modem connections, or via a combination of the two networking schemes.

1. Local Area Network

a. Workstation/DDC Panel Support: Operator workstations and DDC panels shall directly reside on a local area network such that communications may be executed directly between controllers, directly between workstations, and between controllers and workstations on a peer-to-peer basis.

b. Dynamic Data Access: All operator devices, either network resident or connected via dial-up modems, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment. Access to system data shall not be restricted by the hardware configuration of the Building Automation Control System. The hardware configuration of the Building Automation Control System network shall be totally transparent to the user when accessing data or developing control programs.

c. General Network Design: Network design shall include the following provisions:

1) High-speed data transfer rates for alarm reporting, quick report generation from multiple controllers and upload/download efficiency between network devices. The minimum baud rate shall be one (1) Megabaud.

2) Support of any combination of controllers and operator workstations directly connected to the local area network. A minimum of fifty (50) devices shall be supported on a single local area network.

3) Detection and accommodation of single or multiple failures of either workstations, DDC panels or the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.

Message and alarm buffering to prevent information from being lost.

4) Error detection, correction, and retransmission to guarantee data integrity.

5) Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.

6) Commonly available, multiple sourced, networking components and protocols shall be used to allow the Building Automation Control System to coexist with other networking applications such as office automation. MAP, ETHERNET, IBM Token Ring and ARCNET are acceptable technologies.

7) Use of an industry standard IEEE 802.x protocol. Communications must be of a deterministic nature to assure calculable performance under worst-case network loading.

8) Synchronization of the real-time clocks in all DDC panels shall be provided.

2.09 STANDALONE DDC PANELS:

A. General: Standalone DDC panels shall be microprocessor based, multi-tasking, multi-user, and real-time digital control processors. Each standalone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the attached Appendix A Medical Equipment Input/Output Schedule.

B. Memory: Each DDC panel shall have sufficient memory to support its own operating system and databases including:

1. Control processes

2. Energy Management Applications

3. Alarm Management

4. Historical/Trend Data for all points

5. Maintenance Support Applications

6. Custom Processes

7. Operator I/O

8. Dial-Up Communications

9. Manual Override Monitoring

C. Point types: Each DDC panel shall support the following types of point inputs and outputs:

1. Digital Inputs for status/alarm contacts

2. Digital Outputs for on/off equipment control

3. Analog Inputs for temperature, pressure, humidity, water and air flow, and position measurements

a. Analog Outputs for valve and damper position control, and capacity control of primary equipment.

b. Pulse Inputs for pulsed contact monitoring

D. Expandability: The system shall be modular in nature, and shall permit easy expansion through the addition of software applications, workstation hardware, field controllers, sensors, and actuators.

1. The system architecture shall support 95% expansion capacity of all types of DDC panels, and all point types included in the initial installation.

E. Serial Communication Ports: Standalone DDC panels shall provide at least two (2) RS-232C serial data communication ports for simultaneous operation of multiple operator I/O devices such as industry standard printers, laptop workstations, PC workstations, and panel mounted or portable DDC panel Operator's Terminals. Standalone DDC panels shall

allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or network terminals.

F. Hardware Override Switches: As indicated in the point schedule, the operator shall have the ability to manually override automatic or centrally executed commands at the DDC panel via local, point discrete, onboard hand/off/auto operator override switches for binary control points and gradual switches for analog control type points. These override switches shall be operable whether the panel is powered or not.

G. Hardware Override Monitoring: DDC panels shall monitor the status of position of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited. DDC panels shall also collect override activity information for daily and monthly reports.

H. Local Status Indicator Lamps: The DDC panel shall provide local status indication for each binary input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.

I. Integrated On-Line Diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel, and shall not require the connection of an operator I/O device.

J. Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

K. Powerfail Restart: In the event of the loss of normal power, there shall be an orderly shut down of all standalone DDC panels to prevent the loss of database or operating system software. Non-Volatile memory shall be incorporated for all critical controller configuration data, and battery back up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention. Should DDC panel memory be lost for any reason, the user shall have the capability of reloading the DDC panel via the local area network, via the local RS-232C port, or via telephone line dial-in.

2.10 SYSTEM SOFTWARE FEATURES:

A. General

1. All necessary software to form a complete operating system as described in this specification shall be provided, including graphical system displays where specified.

2. The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher level computer for execution.

B. Control Software Description:

1. Pre-Tested Control Algorithms: The DDC panels shall have the ability to perform the following pre-tested control algorithms:

a. Two Position Control

b. Proportional Control

c. Proportional plus Integral Control

d. Proportional, Integral, plus Derivative Control

e. Automatic Control Loop Tuning.

2. Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

3. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

4. Powerfail Motor Restart: Upon the resumption of normal power, the DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

C. Energy Management Applications: DDC Panels shall have the ability to perform any or all of the following energy management routines:

1. Time of Day Scheduling

2. Calendar Based Scheduling

3. Holiday Scheduling

4. Temporary Schedule Overrides

5. Optimal Start

6. Optimal Stop

7. Night Setback Control

8. Enthalpy Switchover (Economizer)

9. Peak Demand Limiting

10. Temperature Compensated Load Rolling

11. Fan Speed/CFM Control

12. Heating/Cooling Interlock

13. Cold Deck Reset

14. Hot Deck Reset

15. Hot Water Reset

16. Chilled Water Reset

17. Condenser Water Reset

18. Chiller Sequencing

19. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Execution portion of this specification.

D. Graphical Custom Process Programming Capability: DDC panels shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

1. Process Inputs and Variables: It shall be possible to use any of the following in a custom process:

2. Any system-measured point data or status

3. Any calculated data

4. Any results from other processes

5. User-Defined Constants

6. Arithmetic functions (+,-,*,/, square root, exp, etc.)

7. Boolean logic operators (and, or, exclusive or, etc.)

8. On-delay/Off-delay/One-shot timers

9. Process Triggers: Custom processes may be triggered based on any combination of the following:

10. Time interval

11. Time of day

12. Date

13. Other processes

14. Time programming

15. Events (e.g., point alarms)

16. Dynamic Data Access: A single process shall be able to incorporate measured or calculated data from any and all other DDC panels on the local area network.

    In addition, a single process shall be able to issue commands to points in any and all other DDC panels on the local area network.

17. Advisory/Message Generation: Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to

directly send a message to a specified device, buffer the information in a follow-up file, or cause the execution to a dial-up connection to a remote device such as a printer of pager.

18. Custom Process Documentation: The custom control-programming feature shall be self-documenting. All interrelationships defined by this feature shall be documented via graphic flowcharts and English language descriptors.

E. Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each DDC panel shall perform distributed independent alarm analysis and filtering to minimize network traffic, and prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC Workstation or local I/O device, or communications with other panels on the network.

1. Point Change Report Description: All alarm or point change reports shall include the point's English language description and the time and date of occurrence.

2. Prioritization: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Each DDC panel shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.

   The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.

3. Report Routing: Alarm reports, messages, and files will be directed to a user-defined list of operator devices, or PCs used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.

4. Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 65-character alarm message to more fully describe the alarm condition or direct operator response.

   Each standalone DDC panel shall be capable of storing a library of at least 250 Alarm Messages. Each message may be assignable to any number of points in the panel.

5. Auto-Dial Alarm Management: In Dial-up applications, only critical alarms shall initiate a call to a remote operator device. In all other cases, call activity shall be minimized by time-stamping and saving reports until an operator scheduled time, a manual request, or until the buffer space is full. The alarm buffer must store a minimum of 50 alarms.

F. Historical Data and Trend Analysis: A variety of Historical data collection utilities shall be provided to automatically sample, store, and display system date in all of the following ways.

1. Continuous Point Histories: Standalone DDC panels shall store Point History Files for all analog and binary inputs and outputs.

The Point History routine shall continuously and automatically sample the value of all analog inputs at half-hour intervals. Samples for all points shall be stored for the past 24 hours to allow the user to immediately analyze equipment performance and all problem-related events for the past day. Point History Files for binary input or output points and analog output points shall include a continuous record of the last ten status changes or commands for each point.

2. Control Loop Performance Trends: Standalone DDC panels shall also provide high resolution sampling capability with an operator-adjustable resolution of 10-300 seconds in one-second increments for verification of control loop performance.

3. Extended Sample Period Trends: Measured and calculated analog and binary date shall also be assignable to user-definable trends for the purpose of collecting operator-specified performance data over extended periods of time. Sample intervals of 1 minute of 2 hours, in one-minute intervals, shall be provided. Each standalone DDC panel shall have a dedicated buffer for trend date, and shall be capable of storing a minimum of 5000 data samples.

4. Data Storage and Archiving: Trend data shall be stored at the Standalone DDC panels, and uploaded to hard disk storage when archival is desired. Uploads shall occur based upon either: user-defined intervals, manual command, or when the trend buffers become full. All trend data shall be available in disk file form for use in 3rd Party personal computer applications.

G. Runtime Totalization: Standalone DDC panels shall automatically accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this specification.

1. The Totalization routine shall have a sampling resolution of one minute or less.

2. The user shall have the ability to define a warning limit for Runtime Totalization. Unique, user-specified messages shall be generated when the limit is reached.

H. Analog/Pulse Totalization: Standalone DDC panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

1. Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. KWH, gallons, KBTU, tons, etc.).

2. The Totalization routine shall have a sampling resolution of one minute or less.

3. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

I. Event Totalization: Standalone DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.

1. The Event Totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

2. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

2.11 APPLICATION SPECIFIC CONTROLLERS - HVAC APPLICATIONS:

A. Each Standalone DDC Controller shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASCs).

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

C. Each ASC shall have sufficient memory to support its own operating system and data base including:

1. Control Processes

2. Energy Management Applications

3. Operator I/O (Portable Service Terminal)

D. The operator interface to any ASC point data or programs shall be through any network-resident PC workstation, or any PC or portable operator's terminal connected to any DDC panel in the network.

E. Application Specific Controllers shall directly support the temporary use of a portable service terminal. The capabilities of the portable service terminal shall include but not be limited to the following:

1. Display temperatures

2. Display status

3. Display setpoints

4. Display control parameters

5. Override binary output control

6. Override analog setpoints

7. Modification of gain and offset constants

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

G. Hardware Override Switches: As indicated in the point schedule, the operator shall have the ability to manually override automatic or centrally executed commands at the ASC panel via local, point discrete, onboard hand/off/auto operator override switches for binary control points and gradual switches for analog control type points. These override switches shall be operable whether the panel is powered or not.

H. Application Description:

1. Unitary Controllers:

a. Unitary Controllers shall support, but not be limited to, the following types of systems to address specific applications described in the Execution portion of this specification, and for future expansion:

    1) Fan Coils (Two-Pipe, Four-Pipe)

b. Unitary Controllers shall support the following types of point inputs and outputs:

    1) Heating and Cooling Outputs

        a) 1 to 3 Stages
        b) Analog Output with two-pipe logic
        c) Reversing valve logic for Heat Pumps

    2) Fan Output

        a) On/Off Logic Control

c. Unitary controllers shall support the following library of control strategies to address the requirements of the sequences described in the Execution portion of this specification, and for future expansion:

    1) Daily/Weekly Schedules

    2) Comfort/Occupancy Mode

    3) Economy Mode

        a) Standby Mode/Economizer Available

        b) Unoccupied/Economizer Not Available

        c) Shutdown

    4) Temporary Override Mode

        a) Temporary Comfort Mode (Occupancy-Based Control)

        b) Boost (Occupant Warmer/Cooler Control)

d. Occupancy-Based Standby/Comfort Mode Control: Each Unitary Controller shall have a provision for occupancy sensing overrides. Based upon the contact status of either a manual wall switch or an occupancy sensing device, the Unitary Controller shall automatically select either Standby or Comfort mode to minimize the heating and cooling requirements while satisfying comfort conditions.

e. Continuous Zone Temperature Histories: Each Unitary Controller shall automatically and continuously, maintain a history of the associated zone temperature to allow users to quickly analyze space comfort and equipment performance for the past 24 hours. A minimum of two samples per hour shall be stored.

f. Alarm Management: Each Unitary Controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

I. Wireless Monitoring

1. This Section shall provide wireless interfaces on systems and medical equipment where indicated in the contract documents

2. The wireless technology shall be compatible with all other wireless technologies employed in the hospital and shall be submitted for review and approval. The wireless technology shall also operate over the UCDMC data network wireless access points installed throughout the hospital by the UCDMC IT department.

3. Coordinate monitoring requirements and installation details for the medical equipment with the University equipment planner.

PART 3 - **EXECUTION**

3.01 GENERAL:

A. Furnish all labor, materials, equipment, and service necessary for a complete and operating Direct Digital Control Building Automation Control System, as shown on the drawings and described herein.

B. All labor, material, equipment, and software necessary to meet the functional intent of the Building Automation Control System as specified herein and as shown on the drawings shall be included.

C. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein, or on the plans, that are required to meet the functional intent of the Building Automation Control System, shall be provided without additional cost to the University.

D. Equipment furnished by Electrical and/or Mechanical Contractor that is normally wired before installation shall be furnished completely wired. Wiring normally performed in field shall be furnished and installed by the Building Automation Control System contractor.

E. Control equipment having electrical connections only, which are furnished under this work, shall be installed and connected by the Building Automation Control System contractor. Electrical devices requiring wet side piping connections shall be installed by the Mechanical Contractor.

F. Clearly identify and label equipment and controls, such as starters, switches, relays, as to function and position with permanently engraved plastic nameplates.

G. Wiring of control equipment in accordance with wiring diagrams and functional operation of the control system shall be the responsibility of the Building Automation Control System contractor.

H. Final Adjustment of Equipment: After completion of installation, adjust temperature sensors, control valves, actuators, motors, and similar equipment provided under the scope of work of this section. Cooperate with the air balance contractor as required.

I. Perform final adjustment by specially trained personnel in direct employ by the manufacturer of the primary Building Automation Control System.

J. Connect control valves with threaded connections with sufficient unions to permit valves to be readily removed from their installed locations for servicing, without disturbing adjacent piping. In no case shall this be less than three unions for three-way valves and one union for two-way valves.

K. Wiring and raceways in the BACS scope of works includes but is not limited to the following:

1. Power wiring for all controllers, sensors, relays and other equipment shall be taken from the local HVAC controls panels except equipment provided with dedicated supplies provided by Division 16.

2. Controls wiring shall be routed from the local HVAC controls panels.

3. Conduit shall be used for the following:

a. All power wiring.

b. All exposed and concealed low voltage wiring in all areas below 8 feet above floor level.

c. All mechanical and equipment rooms, exterior locations and any other areas where physical protection and/or access is required as defined elsewhere in the contract documents.

d. All in-wall drops to equipment monitoring and/or control points including but not limited to medical equipment, kitchen service equipment, elevator sump and other moisture sensors, water flow meters, equipment mounted alarms, etc.

e. All areas where specifically indicated on the Drawings.

4. J-Hooks and or designated low voltage raceway shall be used for the following:

a. All low voltage wiring above 8 feet above floor level in open and accessible areas where conduit is not required, to cable trays or other conduits.

b. All areas where specifically indicated on the Drawings.

5. Conduit, wiring, J-Hook materials and installation requirements shall comply with the applicable sections of Division 16 unless specifically indicated otherwise on the Drawings.

3.02 WARRANTY:

A. The Building Automation Control System contractor shall provide a one-year warranty covering the Building Automation Control System, and all associated components installed by the Building Automation Control System contractor. Any manufacturing or installation defects arising during this warranty period shall be corrected without cost to the University. The Building Automation Control System contractor shall respond to the job site within a one (1) hour period for any emergency relating to the control system and associated components installed by the Building Automation Control System contractor. Warranty period shall commence after all operator instruction is completed and the entire system has been accepted by University.

3.03 CARE AND CLEANING:

A. Repair or replace broken, damaged, or otherwise defective parts, materials, and work. Leave entire work in condition satisfactory to University's Representative. At completion, carefully clean and adjust equipment, fixtures, and trim installed as part of this work. Leave systems and equipment in satisfactory operating condition.

3.04 OPERATION TEST/SYSTEM COMMISSIONING:

A. Each piece of equipment shall be tested by the Building Automation Control System contractor to show that it will operate in accordance with designed requirements, and provide written documentation of this test. Control system commissioning shall consist of a point per point conformation and system operational demonstration conducted jointly by the Building Automation Control System contractor and the University's Representative.

B. The mechanical contractor and BACS contractor/vendor will conduct two levels of Quality Assurance to verify that the required installation and performance of the Building Automation Control System as been met.

1. Static Commissioning:

a. A point to point examination and documentation of the successful installation of the BACS system and its components in its entirety.

b. The start up of all HVAC equipment and associated systems will not commence until this work has been completed and the documentation received by the University.

2. Dynamic Commissioning:

a. A point by point demonstration and documentation of the successful performance of the BACS system and its components in its entirety.

b. The verification demonstrations of all HVAC equipment and associated systems will not commence until this work has been completed and the documentation received by the University.

C. In General the Commissioning process will comprise the following:

1. Review of points list and documentation.

2. Installation compliance with project plans and specifications.

3. Point-to-point check.

4. Control devices calibration and operation.

5. System programming and documentation.

6. System endurance test.

7. Control loop trends.

8. Reports and alarms.

9. Analog input calibration.

10. Analog output check and spring ranges.

11. Digital input range set points.

12. Digital output in autolog.

13. Point by point performance verification.

14. O & M training and documentation.

15. Opposite season verification and documentation.

16. Review and document system architecture.

3.05 OPERATOR INSTRUCTION:

A. During system commissioning and at such time acceptable performance of the Building Automation Control System hardware and software has been established, the Control Contractor shall schedule with the University’s Representative and provide forty (40) hours of on site, or off site, operator instruction to the University's operating personnel. Operator instruction during normal working hours shall be performed by a competent representative familiar with the systems hardware, software, and accessories.

END OF SECTION 230923

SECTION 233113
METAL DUCTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.

2. Single-wall round and flat-oval ducts and fittings.

3. Sheet metal materials.

4. Sealants and gaskets.

5. Hangers and supports.

6. Seismic-restraint devices.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.

2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule"

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in ASCE 7 Section 13.6 as modified by the CBC 2019 Section 1617A. For structurally braced supports systems, refer to Mason West, Inc. Seismic Restraint Guidelines for Suspended Distribution Systems, OPM-0043-13.

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.

2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.

3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.04 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.

2. Sealants and gaskets.

3. Seismic-restraint devices.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.

2. Factory- and shop-fabricated ducts and fittings.

3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.

4. Elevation of top of ducts.

5. Dimensions of main duct runs from building grid lines.

6. Fittings.

7. Reinforcement and spacing.

8. Seam and joint construction.

9. Penetrations through fire-rated and other partitions.

10. Equipment installation based on equipment being used on Project.

11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.

2. Suspended ceiling components.

3. Structural members to which duct will be attached.

4. Size and location of initial access modules for acoustical tile.

5. Penetrations of smoke barriers and fire-rated construction.

6. Items penetrating finished ceiling including the following:

   a. Lighting fixtures.

   b. Air outlets and inlets.

   c. Speakers.

   d. Sprinklers.

   e. Access panels.

   f. Perimeter moldings.

   g.

D. Welding certificates.

E. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports, AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.02 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Lindab Inc.

b. McGill AirFlow LLC.

c. SEMCO Incorporated.

d. Sheet Metal Connectors, Inc.

e. Spiral Manufacturing Co., Inc.

f. Or approved equal.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.03 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.

2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.04 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

2. Tape Width: 4 inches.

3. Sealant: Modified styrene acrylic.

4. Water resistant.

5. Mold and mildew resistant.

6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.

7. Service: Indoor and outdoor.

8. Service Temperature: Minus 40 to plus 200 deg F.

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.

2. Solids Content: Minimum 65 percent.

3. Shore A Hardness: Minimum 20.

4. Water resistant.

5. Mold and mildew resistant.

6. For indoor applications, sealant shall have a VOC content of 250 g/l or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.

8. Service: Indoor or outdoor.

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.

2. Base: Synthetic rubber resin.

3. Solvent: Toluene and heptane.

4. Solids Content: Minimum 60 percent.

5. Shore A Hardness: Minimum 60.

6. Water resistant.

7. Mold and mildew resistant.

8. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

9. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers".

10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.

11. Service: Indoor or outdoor.

12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.

2. Type: S.

3. Grade: NS.

4. Class: 25.

5. Use: O.

6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.

2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.05 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes:

1. For gravity, non-structural supports: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

2. For structurally braced supports systems, refer to Mason West, Inc. Seismic Restraint Guidelines for Suspended Distribution Systems, OPM-0043-13.

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.06 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper B-Line, Inc.; a division of Cooper Industries.

2. Ductmate Industries, Inc.

3. Hilti Corp.

4. Kinetics Noise Control.

5. Loos & Co.; Cableware Division.

6. Mason Industries.

7. TOLCO; a brand of NIBCO INC.

8. Unistrut Corporation; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by the Office of Statewide Health Planning and Development for the State of California.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A 603, galvanized or ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.02 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2. Outdoor, Supply-Air Ducts: Seal Class A.

3. Outdoor, Exhaust Ducts: Seal Class C.

4. Outdoor, Return-Air Ducts: Seal Class C.

5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.

6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.

7. Unconditioned Space, Exhaust Ducts: Seal Class C.

8. Unconditioned Space, Return-Air Ducts: Seal Class B.

9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.

10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.

11. Conditioned Space, Exhaust Ducts: Seal Class B.

12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.04 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.

2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with ASCE/SEI 7.

B. Select seismic-restraint devices with capacities adequate to carry present static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by the Office of Statewide Health Planning and Development for the State of California.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Set anchors to manufacturer's recommended torque, using a torque wrench.

5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.06 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.07 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.08 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.

2. Test the following systems - Supply duct mains prior to CAV/VAV branches, as well as all ducts in shafts or where duct will be inaccessible:

a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections, selected by Construction Manager from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.

b. Supply Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections, selected by Construction Manager from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.

c. Return Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections, selected by Construction Manager from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.

d. Exhaust Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections, selected by Construction Manager from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.

e. Outdoor Air Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections, selected by Construction Manager from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

4. Test for leaks before applying external insulation.

5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.

6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests: Note – Ducts shall be shop fabricated with sealed ends installed after shop cleaning. Ducts shall be installed on site with ends sealed daily and all open ends closed including registers until construction is complete. A visual inspection and cleaning shall be required if damage is found or suspected during field installation.

1. Visually inspect duct system to ensure that no visible contaminants are present.

2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.09 DUCT CLEANING

A. Cleaning shall be required only for duct sections that has been found or suspected to be damaged during installation.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.

2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.

3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.

2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.

4. Coils and related components.

5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.

6. Supply-air ducts, dampers, actuators, and turning vanes.

7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.

4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.010 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.011 DUCT SCHEDULE

A. Supply Ducts:

1. Ducts Connected to Variable-Volume Air-Handling Units:

a. Pressure Class: Positive 3-inch wg.

b. Minimum SMACNA Seal Class: B.

c. SMACNA Leakage Class for Rectangular: 12.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

B. Return Ducts:

1. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 3-inch wg.

b. Minimum SMACNA Seal Class: B.

c. SMACNA Leakage Class for Rectangular: 12.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

C. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative 2-inch wg.

b. Minimum SMACNA Seal Class: C if negative pressure, and A if positive pressure.

c. SMACNA Leakage Class for Rectangular: 24.

d. SMACNA Leakage Class for Round and Flat Oval: 12.

D. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.

E. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.

2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.

2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.

3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.

2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.

c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

F. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

a. Rectangular Main to Rectangular Branch: 45-degree entry.

b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.

b. Velocity 1000 to 1500 fpm: Conical tap.

c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Ceiling dampers.
7. Smoke dampers.
8. Combination fire and smoke dampers.
9. Corridor dampers.
10. Flange connectors.
11. Duct silencers.
12. Turning vanes.
13. Remote damper operators.
14. Duct-mounted access doors.
15. Flexible connectors.
16. Flexible ducts.
17. Duct security bars.
18. Duct accessory hardware.

B. Related Sections:

1. Division 28 Section "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.

b. Manual volume damper installations.

c. Control damper installations.

d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.

e. Duct security bars.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

D. Source quality-control reports.

E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

1.05 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless

otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.

2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and a No. 1 finish for exposed ducts.

D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.02 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Greenheck Fan Corporation.

2. Nailor Industries Inc.

3. Pottorff; a division of PCI Industries, Inc.

4. Ruskin Company.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 1-inch wg.

E. Frame: 0.052-inch- thick, galvanized sheet steel, with welded corners and mounting flange unless otherwise noted in equipment schedules.

F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Extruded vinyl, mechanically locked.

I. Blade Axles:

1. Material: Stainless steel.

2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: Galvanized steel.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball or synthetic pivot bushings.

M. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.

2. Counterweights and spring-assist kits for vertical airflow installations.

3. Electric actuators.

4. Chain pulls.

5. Screen Mounting: Front mounted in sleeve.

a. Sleeve Thickness: 20-gage minimum.

b. Sleeve Length: 6 inches minimum.

6. Screen Mounting: Rear mounted.

7. Screen Material: Galvanized steel.

8. Screen Type: Insect.

9. 90-degree stops.

2.03 BAROMETRIC RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Greenheck Fan Corporation.

2. Nailor Industries Inc.

3. Pottorff; a division of PCI Industries, Inc.

4. Ruskin Company.

B. Suitable for horizontal or vertical mounting.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 2-inch wg.

E. Frame: 0.064-inch- thick, galvanized sheet steel, with welded corners and mounting flange.

F. Blades:

1. Multiple, 0.025-inch- thick, roll-formed aluminum.

2. Maximum Width: 6 inches.

3. Action: Parallel.

4. Balance: Gravity.

5. Eccentrically pivoted.

G. Blade Seals: Vinyl.

H. Blade Axles: Galvanized steel.

I. Tie Bars and Brackets:

1. Material: Aluminum.

2. Rattle free with 90-degree stop.

J. Return Spring: Adjustable tension.

K. Bearings: Synthetic.

L. Accessories:

1. Flange on intake.

2. Adjustment device to permit setting for varying differential static pressures.

2.04 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. METALAIRE, Inc.

b. Nailor Industries Inc.

c. Pottorff; a division of PCI Industries, Inc.

d. Ruskin Company.

2. Standard leakage rating, with linkage outside airstream.

3. Suitable for horizontal or vertical applications.

4. Frames:

a. Hat-shaped, galvanized or stainless-steel channels, 0.064-inch minimum thickness.

b. Mitered and welded corners.

c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

a. Multiple or single blade.

b. Parallel- or opposed-blade design.

c. Stiffen damper blades for stability.

d. Galvanized-steel, 0.064 inch thick.

6. Blade Axles: Stainless steel.

7. Bearings:

a. Molded synthetic.

b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

B. Low-Leakage, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. METALAIRE, Inc.

b. Nailor Industries Inc.

c. Pottorff; a division of PCI Industries, Inc.

d. Ruskin Company.

2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

3. Suitable for horizontal or vertical applications.

4. Frames:

a. Hat shaped.

b. Galvanized or Stainless-steel channels, 0.064 inch thick.

c. Mitered and welded corners.

d. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

a. Multiple or single blade.

b. Parallel- or opposed-blade design.

c. Stiffen damper blades for stability.

d. Galvanized, roll-formed steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel.

7. Bearings:

a. Molded synthetic.

b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Blade Seals: Vinyl.

9. Jamb Seals: Cambered stainless steel.

10. Tie Bars and Brackets: Galvanized steel.

11. Accessories:

a. Include locking device to hold single-blade dampers in a fixed position without vibration.

2.05 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Greenheck Fan Corporation.

2. METALAIRE, Inc.

3. Nailor Industries Inc.

4. Ruskin Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:

1. Hat shaped.

2. Galvanized or Stainless-steel channels, 0.064 inch thick.

3. Mitered and welded corners.

D. Blades:

1. Multiple blades with maximum blade width of 8 inches.

2. Parallel- and opposed-blade design.

3. Galvanized or Stainless steel.

4. 0.064 inch thick.

5. Blade Edging: Closed-cell neoprene edging.

6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

E. Blade Axles: 1/2-inch- diameter; stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:

1. Molded synthetic.

2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

3. Thrust bearings at each end of every blade.

2.06 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Greenheck Fan Corporation.

2. METALAIRE, Inc.

3. Nailor Industries Inc.

4. Pottorff; a division of PCI Industries, Inc.

5. Ruskin Company.

B. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating: 1-1/2 and 3 hours.

E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138-inch-thick, as indicated, and of length to suit application.

2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.07 CEILING DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. METALAIRE, Inc.

2. Nailor Industries Inc.

3. Prefco; Perfect Air Control, Inc.

4. Ruskin Company.

B. General Requirements:

1. Labeled according to UL 555C by an NRTL.

2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.

E. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

F. Fire Rating: 2 hours.

2.08 SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ruskin Company.

2. Greenheck Fan Corporation.

3. Nailor Industries Inc.

4. PHL, Inc.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Damper Actuation: Damper actuation shall be in accordance with Sections 716.3.3.1 through 716.3.3.4 of the 2010 California Building Code as applicable.

D. Frame: Frame shall be a minimum of 0.125 inch aluminum formed into a structural hat channel shape with corner braces for reinforcement.

E. Blades: Blades shall be aluminum airfoil shaped single piece construction. Standard blade action shall be parallel.

F. Blade Edge Seals: Blade edge seals shall be silicone rubber designed to withstand 450 ° F and jamb seals shall be aluminum flexible metal compression type.

G. Bearings: Bearings shall be stainless steel sleeve turning in an extruded hole in the frame.

H. Leakage: Class I (4 CFM/sq. ft. at 1.0 inch w.g.).

I. Rated pressure and velocity: As part of the UL qualification, damper shall have demonstrated a capacity to operate (to open and close) under HVAC system operating conditions, with pressures up to 4 inch w.g. in the closed position, and 4,000 fpm air velocity in the open position.

J. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

K. Damper Motors: Modulating or two-position action.

L. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC" and Division 26 Sections.

3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.

4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.

6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.

7. Electrical Connection: 115 V, single phase, 60 Hz.

M. Accessories:

1. Each smoke damper shall be equipped with Ruskin SP100 Switch Package or equal. The Switch Package shall include two position indicator switches linked directly to the damper blade to provide the capacity of remotely indicating blade position.

2.09 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ruskin Company.

2. Air Balance Inc.; a division of Mestek, Inc.

3. Cesco Products; a division of Mestek, Inc.

4. Greenheck Fan Corporation.

5. Nailor Industries Inc.

B. Type: Static and dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Damper Actuation: Damper actuation shall be in accordance with Sections 716.3.3.1 through 716.3.3.4 of the 2010 California Building Code as applicable.

D. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

E. Fire Rating: 1-1/2 and 3 hours.

F. Frame: Frame shall be a minimum of 16-gauge galvanized steel formed into a structural hat channel reinforced at corners for added strength.

G. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.

H. Blades: Blades shall be airfoil shaped double skin construction with 14-gauge equivalent thickness.

I. Bearings: Bearings shall be stainless steel turning in an extruded hole in the frame.

J. Blade Edge Seals: Blade edge seals shall be silicone rubber and galvanized steel mechanically locked into blade edge and shall withstand a minimum of 450 ° F.

K. Jamb Seals: Jamb seals shall be non-corrosive stainless-steel flexible metal compression type.

L. Leakage: Class I (4 cfm/sq. ft. at 1-inch w.g. and 8 cfm/sq. ft. at 4 inch w.g.).

M. Rated pressure and velocity: As part of the UL qualification, dampers shall have demonstrated a capacity to operate (to open and close) under HVAC system operating conditions, with pressures of at least 4 inches w.g. in the closed position and up to 4,000 fpm air velocity in the open position.

N. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

O. Master control panel for use in dynamic smoke-management systems.

P. Damper Motors: Modulating or two-position action.

Q. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC" and Division 26 Sections.

3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.

4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.

6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.

7. Electrical Connection: 115 V, single phase, 60 Hz.

R. Accessories:

1. Each smoke damper shall be equipped with Ruskin SP100 Switch Package or equal. The Switch Package shall include two position indicator switches linked directly to the damper blade to provide the capacity of remotely indicating blade position.

2.010 CEILING DIFFUSER COMBINATION FIRE SMOKE RADIATION DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ruskin Company.

2. Air Balance Inc.; a division of Mestek, Inc.

3. Cesco Products; a division of Mestek, Inc.

4. Nailor Industries Inc.

B. General Requirements:

1. Label combination fire and smoke dampers according to UL 555 for 1-1/2-hour rating by an NRTL.

2. Label combination fire and smoke dampers according to UL 555S for smoke damper rating by an NRTL and label Leakage Class I.

3. Label combination fire and smoke dampers according to UL 555C as a ceiling damper.

4. California State Fire Marshall Listed.

C. Controlled Closure Device (Heat Activated): 165° F standard. Electric EFL standard with electric actuator.

D. Frame: 20-gauge galvanized steel, 10-inch depth.

E. Blades: 20-gauge galvanized steel.

F. Bearings: Stainless steel sleeve, pressed into frame.

G. Blade Seal: Silicone edge type for smoke seal to 450° F.

H. Axles: ½ inch plated steel.

I. Damper Finish: Mill galvanized.

J. Diffuser Finish: Standard white.

K. Thermal Blanket Insulation: Mineral wool standard.

L. Mounting: Horizontal in T-bar or rigid (gypboard) ceiling.

M. Diffuser Type and Size: Perforated surface mount. 24” x 24” nominal. 22-gauge steel.

2.011 CORRIDOR DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Air Balance Inc.; a division of Mestek, Inc.

2. Cesco Products; a division of Mestek, Inc.

3. Nailor Industries Inc.

4. Ruskin Company.

B. General Requirements: Label combination fire and smoke dampers according to UL 555 for 1-1/2-hour rating by an NRTL.

C. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.

D. Frame: Frame shall be a minimum of 16 gauge galvanized steel formed into a structural hat channel reinforced at corners for added strength.

E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

F. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.

G. Damper Motors: Modulating or two-position action.

H. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC." And Division 26 Sections.

3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.

4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.

6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.

7. Electrical Connection: 115 V, single phase, 60 Hz.

2.012 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ductmate Industries, Inc.

2. Nexus PDQ; Division of Shilco Holdings Inc.

3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

4. Or approved equal.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.013 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ductmate Industries, Inc.

2. Duro Dyne Inc.

3. METALAIRE, Inc.

4. SEMCO Incorporated.

5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

D. Vane Construction: Double wall.

2.014 REMOTE DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Pottorff; a division of PCI Industries, Inc.

2. Ventfabrics, Inc.

3. Young Regulator Company.

4. Or approved equal..

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass.

D. Cable: Stainless steel.

E. Wall-Box Mounting: Recessed, 2 inches deep.

F. Wall-Box Cover-Plate Material: Stainless steel.

2.015 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ductmate Industries, Inc.

2. Flexmaster U.S.A., Inc.

3. Greenheck Fan Corporation.

4. Nailor Industries Inc.

5. Pottorff; a division of PCI Industries, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

1. Door:

a. Double wall, rectangular.

b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.

c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.

d. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.

b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.

c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.

d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.

2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.

3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.

4. Factory set at 10-inch wg.

5. Doors close when pressures are within set-point range.

6. Hinge: Continuous piano.

7. Latches: Cam.

8. Seal: Neoprene or foam rubber.

9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.016 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ductmate Industries, Inc.

2. Duro Dyne Inc.

3. Ventfabrics, Inc.

4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

1. Provide coatings and adhesives for use inside the weatherproofing system that comply with the limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24) identified in Section 018113.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..

2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.

3. Service Temperature: Minus 40 to plus 200 deg F.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..

2. Minimum Tensile Strength: 500 lbf/inch in the warp and 440 lbf/inch in the filling.

3. Service Temperature: Minus 50 to plus 250 deg F.

G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.

1. Minimum Weight: 16 oz./sq. yd..

2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.

3. Service Temperature: Minus 67 to plus 500 deg F.

H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.

1. Minimum Weight: 14 oz./sq. yd..

2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.

3. Service Temperature: Minus 67 to plus 500 deg F.

I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.

2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.017 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Flexmaster U.S.A., Inc.

2. McGill AirFlow LLC.

3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

4. Alco Rubber Products.

5. Or approved equal.

B. Noninsulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire.

1. Pressure Rating: 10-inch wg positive per UL-181 and 0.75-inch wg negative.

2. Maximum Air Velocity: 4000 fpm.

3. Temperature Range: Minus 20 to plus 250 deg F Intermittent (@ ½ inch positive w.g. max); Minus 20 to 180 deg F Continuous (@ 2 inch positive w.g. max); Minus 20 to 140 deg F Continuous (@ maximum pressure).

C. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wg positive per UL-181 and 0.75 -inch wg negative.

2. Maximum Air Velocity: 4000 fpm.

3. Temperature Range: Minus 20 to plus 250 deg F Intermittent (@ ½ inch positive w.g. max); Minus 20 to 180 deg F Continuous (@ 2 inch positive w.g. max); Minus 20 to 140 deg F Continuous (@ maximum pressure).

4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.

D. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

2.018 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft or control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.

2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Connect ducts to duct silencers with flexible duct connectors.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On upstream side of duct coils.

2. At drain pans and seals.

3. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.

4. Control devices requiring inspection.

5. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.

2. Two-Hand Access: 12 by 6 inches.

3. Head and Hand Access: 18 by 10 inches.

4. Head and Shoulders Access: 21 by 14 inches.

5. Body Access: 25 by 14 inches.

6. Body plus Ladder Access: 25 by 17 inches.

L. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

P. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

Q. Connect flexible ducts to metal ducts with draw bands.

R. Install duct test holes where required for testing and balancing purposes.

3.02 FIELD QUALITY CONTROL

A. Tests and Inspections: Contractor to coordinate testing and inspections with the commissioning requirements identified in Section 230800 “Commissioning of HVAC”. Test and Inspections (EXCEPT FOR FSD’s) can be performed at time of installation.

1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that purpose of access door can be performed.

3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.

4. Inspect turning vanes for proper and secure installation.

5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233713
DIFFUSERS, REGISTERS, & GRILLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Rectangular and square ceiling diffusers.

2. Perforated diffusers.

B. Related Sections:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.

2. Method of attaching hangers to building structure.

3. Size and location of initial access modules for acoustical tile.

4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.01 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Nailor Industries Inc.

b. Price Industries.

c. Titus.

d. Tuttle & Bailey.

e. Or approved equal

2. Devices shall be specifically designed for variable-air-volume flows.

3. Material: Steel

4. Finish: Baked enamel, white

5. Face Size: 24 by 24 inches

6. Face Style: Modular core, 4-way discharge

7. Mounting: T-bar

8. Pattern: Adjustable

B. Perforated Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Nailor Industries Inc.

b. Price Industries.

c. Titus.

d. Tuttle & Bailey.

e. Or approved equal

2. Devices shall be specifically designed for variable-air-volume flows.

3. Material: Steel backpan and pattern controllers, with steel face.

4. Finish: Baked enamel.

5. Face Size: 24 by 24 inches

6. Duct Inlet: Square

7. Mounting: T-bar

2.02 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.03 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 255500
GENERAL PROVISIONS FOR BUILDING AUTOMATION SYSYTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work included in this Section:

1. The Building Automation System (BAS) manufacturer shall provide the Building Automation System as specified herein in its entirety.

2. The Building Automation System Contractor shall provide the systems covered by this section and have full responsibility for the entire BAS including complete and seamless integration into the UC Davis Medical Center's Johnson Controls, JCI, application data servers over the campus network.

3. It is the intent of this specification for the BAS to be installed as a complete package by the Building Automation System Contractor. The system shall include all necessary and required software and hardware including but not limited to operator interfaces, input/output devices and sensors, controllers, communication equipment and IT infrastructure. Installation, supervision and project management are included as well.

4. The backbone BAS IT infrastructure consisting of CAT6A, patch panels, core switches, switches and media converters will be provided and installed by the University. Devices required to connect to the owner's network will be provided by the BAS contractor. Local switches in each room/panel shall be DIN-rail mountable type.

5. The BAS is a building wide system that incorporates other sub systems, such as HVAC systems direct digital control, DDC, building lighting control interface, energy metering, and packaged equipment controller interface as indicated

6. Control systems using wireless technology and / or cloud base data gathering are not acceptable.

7. All BAS control setpoints shall be accessible by campus JCI servers.

8. Control sequences of operation shall be as shown in Drawings or as noted herein. Drawings of systems are diagrammatic only and any apparatus not shown, such as relays, transformers, accessories, etc., but required to make system operative to complete satisfaction of University's Representative, shall be provided at no increase in contract sum.

B. Major Items of Work

1. Section 25 55 00 – General Provisions for Building Automation System

2. Section 25 55 20 – Direct Digital Control System and User Interface

3. Section 25 55 30 – Electronic Sensors, Devices and Field Hardware

C. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions, applicable portions of Division 1, Division 22, 23 and 26 – Basic Materials and Methods, apply to this Section.

2. Refer to Division-26 sections for power wiring to line-voltage devices and for low voltage wiring and communication wiring to such applicable devices

3. Provide BAS connections to packaged controllers for equipment under Divisions 22 and 23

4. Lighting control integration for new buildings and additions: The BAS scope of work shall include all labor to interface with the Automatic Lighting Controls System provided in Division 26. Refer to Division 26 for complete description of requirements for the Automatic Lighting Control System which shall include hardware gateways BACnetIP or MSTP to communicate to the BAS.

    a. Lighting-control contractor shall provide naming matrix, connecting BACnet information/nomenclature to lighting-zone information

5. The BAS scope of work shall include monitoring of other systems and equipment where indicated in the contract documents

1.02 QUALITY ASSURANCE

A. Manufacturer Qualifications: Building Automation System shall be as manufactured by Johnson Controls and shall carry UL 864 Listing, UUKL classification for smoke control if smoke control is specified.

B. Electrical Standards: Provide electrical products which have been tested, listed, and labeled by Underwriters Laboratories (U.L.) and comply with NEMA standards.

C. Installing Contractor Qualifications:

1. Bids by wholesalers, franchised dealers or any firm whose principal business is not that of manufacturing, developing and installing Building Automation Systems is not acceptable. Bidder must be factory authorized with the product they are proposing.

2. Firms specializing and experienced in control system installations for not less than 10 years. Firms with experience in DDC installation projects with point counts equal to this project and systems of the same character as this project.

3. The Building Automation System contractor must demonstrate that, from the local office that will service the UC Davis Medical Center campus, a one (1) hour emergency response requirement can logistically be provided. The bidder must, in the judgment of the University's Representative, be able to generally provide one (1) hour emergency response. That is, to have appropriately equipped and trained personnel on-site within one (1) hour to rectify any potential emergency situation

4. Installing firms submitting as an “approved equal” to JCI Metasys must get pre-approved prior to bid and gain owners acceptance on the following functionality per the Div01 substitution requirement, prior to project bid:

a. Installing firm must demonstrate that all BACnet objects are readable from the existing JCI Metasys Building Automation System. Readable BACnet objects include but not limited to all binary inputs, binary values, binary outputs, analog inputs, analog values, analog outputs, point descriptions, multi-state inputs, multi-state values, multi-state outputs, schedules, trendlogs and alarms.

b. Installing firm must demonstrate that all BACnet objects are writable from the existing JCI Building Automation System. Writable BACnet objects include but not limited to all binary values, binary outputs, analog values, analog outputs, point descriptions, multi-state values, multi-state outputs, schedules, trendlogs and alarms.

c. Installing firm must demonstrate program loaded into any application specific or general-purpose controller must be viewable to the existing Integrated Development Environment (IDE). Firm to demonstrate the ability to upload, edit, save and download programming through the existing JCI system.

d. Installing firm must demonstrate that the existing software toolset at the UCDMC servers can make changes to the new application specific controllers. New software will not be allowed.

5. For each point listed above demonstrate that a change in value at the building can be seen by the JCI servers. This change in value must be seen within 30 seconds of value change. There is no exception for this specification requirement. No subsequent BAS submittal packages will be reviewed or accepted until the demonstration is satisfactorily completed with Unive`rsity consent.

6. The Building Automation System contractor must have been, for five (5) years preceding the bid opening, a factory branch office, or a factory authorized dealer for the product manufacturer type identified in subsection 2.01, A., under PART 2 – PRODUCTS, of this section. Factory authorized dealer means:

   a. Installing Contractor has a contract directly with the factory. A contract with a distributor is not acceptable.

   b. Installing Contractor has direct access to factory technical support and training

   c. Installing contractor develops controller hardware and software

7. Any cost impact to the project as a result of the approval process will be the sole responsibility of the installing firm seeking approval. In the event approval is not received installing firm is responsible for any additional costs incurred if an alternate firm is requested to submit.

8. The Building Automation Control System contractor must have in its employ, at the local office that will service the U.C. Davis Medical Center campus, at least five (5) full time control technicians. At a minimum, one (1) technician must be senior (at least 5 years experience installing products of the manufacturer type identified in subsection 2.01, A., under PART 2 – PRODUCTS, of this section); two (2) technicians must be mid-level (at least three (3) years experience installing products of the manufacturer type identified in subsection 2.01, A.,

under PART 2 – PRODUCTS, of this section); and two (2) can be junior level technicians (at least one (1) year experience installing products of the manufacturer type identified in subsection 2.01, A., under PART 2 – PRODUCTS, of this section).

D. Installer's Experience with Proposed Product Line:

1. Firms shall have specialized in and be experienced with the installation of the proposed product line, Metasys for not less than ten years from date of completion on at least three projects of similar size and complexity.

E. Installer's Field Coordinator and Sequence Programmer Qualifications:

1. Individual(s) shall specialize in and be experienced with control system installation for not less than 5 years. Proposed field coordinator shall have experience with the installation of the proposed product line for not less than three projects of similar size and complexity. Installer shall submit the names of the proposed individual and at least one alternate for each duty. Submittals shall document this experience with references. The proposed individuals must show proof of the following training:

a. Product Line Training: Individuals overseeing the installation and configuration of the proposed product line must provide evidence of the most advanced training offered by the Manufacturer on that product line for installation and configuration

b. Programming Training: Individuals involved with programming the site-specific sequences shall provide evidence of the most advanced programming training offered by the vendor of the programming application offered by the Manufacturer.

c. BACnet Training: The BACnet BAS shall be furnished, engineered and installed by individuals who have completed the BACnet Network Design, Installation and Maintenance Training Program. Certifications shall be provided.

F. Installer's Service Qualifications:

1. The installer must be experienced in control system operation, maintenance and service. Installer must document a minimum 5 year history of servicing installations of similar [size] and complexity. Installer must also document at least a one year history of servicing the proposed product line.

G. Installer's Response Time and Proximity

1. Installer must maintain a fully capable service facility within a 45 mile radius of the project site. Service facility shall manage the emergency service dispatches and maintain the inventory of spare parts.

1.03 STANDARDS AND CERTIFICATIONS

A. Sections 25 55 00 to 25 55 60 shall be provided and installed by the same Subcontractor.

B. The entire Building Automation System shall be:

1. Approved and listed by Underwriters Laboratories, Inc. (UL).

2. Listed by State Fire Marshall as an approved Smoke Management System if smoke control is specified.

3. Approved by California Energy Commission as an approved Control and Energy Management System in compliance with California Energy Conservation Code Title 24 requirements.

4. Approved and Listed by the California Energy Commission as an Economizer Fault Detection and Diagnostic (FDD) System.

C. Listings, Codes and Standards compliance shall include, but not be limited to, the following:

1. Underwriters Laboratories (UL)

   a. Building Automation System (UL 864 UDTZ).

   b. Process Management System (UL 864 QUAX).

   c. Smoke Control Systems Equipment (UL 864 UUKL).

   d. Energy Management Equipment (UL 916 PAZX).

2. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

3. National Fire Protection Association (NFPA)

   a. NFPA 90A

   b. NFPA 70 (NEC)

   c. NFPA 92A & 92B

4. National Electrical Manufacturers Association (NEMA)

   a. NEMA 250 Enclosure for Electrical Equipment

   b. NEMA ICS 1: General Standards for Industrial Controls

5. Electronics Industry Alliance (EIA)

6. Institute of Electrical and Electronics Engineers (IEEE): IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems

7. FCC Part 15, Sub-Part B, Class A

8. CE Electromagnetic Compatibility

9. Be registered as meeting appropriate radiated and conducted interference levels from a Class “A” computing device.

D. Equipment and devices employed in the system shall bear the appropriate UL listing mark to ensure compliance.

E. The Drawings and specifications are complementary to one another – meaning that what is called for on one is to be considered called for in both. Where conflicts exist between the specification sections or between the specifications and the drawings, the more stringent requirements shall apply.

F. Where two or more codes conflict, the most restrictive shall apply. Nothing in this specification or related documentation shall be construed to permit work not conforming to applicable codes.

G. Specification requirements may exceed any code requirements. Where specifications and code differ or conflict, the most stringent requirement shall apply.

1.04 SUBMITTALS

A. General

1. Conform to requirements of Division 1 and requirements stated herein.

2. Shop drawings and submittals, giving full fitness and other pertinent facts, shall be submitted and approval secured before apparatus in question is ordered, built or installed. The BAS contractor shall be solely responsible for the removal and replacement of any item not in compliance with the contract documents at no cost to the Owner.

3. Shop drawings shall be presented in a manner to facilitate easy visualization of the systems installation and operation.

4. Shop drawings shall be submitted with the following four sections:

a. Equipment data sheets and equipment matrix. Valves data sheets and valve selection matrix.

b. System architecture, P&I diagrams, wiring and interface diagrams.

c. Sequence of operations.

d. System Graphics

5. The contractor shall allow a minimum of four weeks of submittal review time by the Architect's for each submittal or re-submittal.

6. The Architect's review of the submittals shall be for general arrangement only and shall not be construed as a complete check or constitute a waiver of the requirements of the Contract Documents.

B. Product Data Sheets

1. Devices and equipment catalogue cuts including specifications and installation instructions for all devices used by the BAS and specified in this division including devices furnished and installed by other Divisions. Indicate proposed application for each device referenced to the applicable specification section.

2. Range and scale information for all transmitters and sensors. Indicate all applicable options and where more than one device is to be used on one sheet, submit a separate, individually marked sheet for each device.

3. Submit a summary matrix listing the following information:

    a. Rows: Each device

    b. Columns: Tab#, specification section, part number, description, manufacturer, application, range or span and expected setpoint or operating range.

4. Valve, damper, well and tap schedules showing sizes, configuration, characteristics, capacity, location, tag and part number.

5. Control valve schedules shall be submitted in a spreadsheet format and shall include a separate line for each valve and a separate column for each valve attribute. The attributes shall include the valve tag number, the system served, the pipe size, close off pressure, body rating, target C_v, actual C_v, target pressure drop, actual pressure drop, fail safe position and actuator information.

C. Equipment Layout Shop Drawings:

1. The Contractor shall submit shop drawings (floor plans) showing proposed layout and installation of all network and power equipment (panels and devices) and the relationship to other divisions. The drawings shall be drawn to a suitable scale. Show plan and elevation views and adequately indicate service space requirements, mounting, electrical connections, concrete work as required to completely coordinate the installation with other trades.

D. Control System Drawings

1. System Architecture:

    a. BAS riser diagram showing all DDC controllers, operator workstations, network controller, repeaters, bridges, switches, gateways and network wiring and how these devices will interface to the existing campus JCI System.

    b. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. Indicate media, protocol, baud rate, and type of each LAN. All repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the diagram.

2. Panels and controllers layout and point list including device tag number, point type, system name, object name, expanded id, display units, address, cable destination etc.

3. Wiring diagrams, including wiring between panels and between panels and devices. Diagrams shall show, in addition to the automatic control system installation, the wiring required to interface with the self-contained equipment and motor control circuitry, all of which interfaces with and controlled by the BAS. Data shall be derived from and submitted with approved diagrams from the

manufacturer. The required data shall be submitted as an integral part of the BAS submittal even if the required data is submitted under a separate cover by another discipline.

4. Project specific manufacturer shop drawings where applicable (Custom control panels, sensor/transmitter pairs etc.)

5. Schematic flow diagram of each air and water system (Process and Instrumentation Diagrams) showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. All physical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table.

6. Software submittals shall contain narrative descriptions of sequence of operations and programming flow charts. The sequence of operations shall be fully developed and referenced to the devices used identified by tag numbers as shown on the P&I (Process & Instrumentation diagrams). Show all calculations and set points. In a matrix format, show alarms, alarm thresholds and settings.

7. Any additional details required by the AE (Architect/Engineer) to demonstrate that the system shall function as intended.

E. Graphics: Graphics proposed for all systems including but not limited to: Floor plans, AHU systems, chilled water and hot water systems, steam systems (when provided), room terminal unit systems and miscellaneous mechanical, electrical and plumbing systems. Also include floor plan graphics with room sensor locations with current values, locations of panels and examples of trending and custom reports.

F. Sequence of Operations: See drawings.

G. All drawings and diagrams shall be generated using the Visio Professional or AutoCAD release 2014 or higher and shall be a minimum size of 11 x 17. The Architect will furnish architectural floor plans backgrounds on floppy discs, Zip discs or CD-ROM or post on an FTP site.

H. The Contractor shall clearly identify variations from the Contract Documents, if any, and document the reason for such variation.

I. No material or equipment shall be installed before its product data has been submitted, reviewed and returned to the Contractor with the note “NO EXCEPTIONS TAKEN”, or the note, “MAKE CORRECTIONS NOTED” marked thereon. In the event of the latter note, the correction noted shall be made and noted in the as-built set. Materials installed or work performed without the review of drawings and/or review of software flow diagrams is subject to rejection.

J. Digital copies (unless more required by Division 1) of product data for materials and equipment covered by each Section of this Division shall be submitted for review.

1. Materials and equipment covered by an individual section shall be bound together and submitted as one package along with a summary spread sheet listing the various components submitted and their intended use and application.

2. The Contractor shall submit the required data in a timely manner and shall allow reasonable time for review and processing. The Contractor shall assume full responsibility for delays incurred due to rejected items.

3. Non-rejection of an item shall in no way obviate compliance with the Contract Documents.

4. The Contractor must certify and sign each section of the submittal stating that he has reviewed all of the materials included in the submittal and the submittal is in compliance with the contract documents.

1.05 OPERATION MANUALS

A. Provide complete operation and maintenance manuals, as required in Section 01700, for all systems. Manuals shall be contained in suitable loose-leaf binders with project identification on the cover and sections separated by individual tabs.

B. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS and all associated field devices. This documentation shall include specific part numbers, software versions, data and configuration files. A complete recommended spare parts inventory list shall be included with procurement lead time and expected frequency of use of each part clearly identified.

C. Workstation User's Manual shall contain the following information as a minimum:

1. System overview and networking concepts

2. Login and navigation through various menus

3. Establish and modify set points and schedules

4. Upload and download software, set points, schedules, operating parameters and status to and from the operator workstation and field hardware.

5. Collect trend data and generate trend plots

6. Enable and disable alarms and messages

7. Generate Report.

8. Backing up software and data files

9. Using the operator workstation with 'third party' software

D. Project Engineering Manual shall contain as a minimum:

1. System architecture overview

2. Hardware cut-sheets and descriptions of installed products and accessories, including Installation, mounting and connection details.

3. Wiring diagrams for all controllers and field hardware

4. Complete parts list and maintenance instructions for all installed products.

5. Commissioning, setup and backup procedures for all software and field controllers, workstation and devices.

6. Listing and description of basic terminology, alarms, messages and frequently used commands or shortcuts.

E. Software Documentation shall contain as a minimum:

1. Graphical representation of all control algorithms for every piece of mechanical equipment controlled on the project, together with a glossary or icon symbol library detailing the function of each graphical icon. 'Line by line' computer program documentation is unacceptable.

2. Detailed description of control sequences used to achieve the specified sequences.

3. Graphical representation of the mechanical equipment hierarchy for the project including all equipment controlled by the BAS. I.e. a VAV terminal box may be the source for increased cooling demand and requires the primary VAV AHU to operate which requires the chillers to operate.

4. Detailed listing of all specified alarm and event messages programmed for designated mechanical/electrical equipment and required operator action.

5. Documented listing of all system software, including the operating system and the system application programs. Listing shall include sufficient information to allow a person familiar with the programming language, but unfamiliar with the program, to understand it.

6. Graphic flow diagrams "Flow charts" of all software programs used on this project.

F. Manuals shall also contain the following information:

1. All information required by and specified in the "Submittals" section of these Specification in its final as-built form incorporating all revisions made as a result of the submittal process, during the installation, start-up or acceptance portion of the project.

2. CAD generated sketches of system graphics showing all monitored systems, data (measured and calculated), point addresses, and operator instructions.

3. As-built wiring diagrams of the complete system, all its components and devices.

G. In addition to the drawings included in the Operation Manuals, provide one digital set

H. For systems requiring a dedicated control panel (AHU's, CHW and HW systems, etc. the BAS contractor shall leave a printed copy of that particular systems flow diagram, SOO, wiring diagram and bill of material inside the controls enclosure.

1.06 INSTALLATION

A. The installation shall include: Hardware installation, programming and supervision, checkout, adjusting and validating, necessary for a complete fully operational system.

B. The BAS Subcontractor shall furnish and install all necessary conduits, control wiring, low voltage power wiring and conduit to control panels and field devices and all interlock wire

and conduit as shown on the drawings, stated in the sequence of operation and listed on point list and necessary for the proper operation of all specified systems.

C. Power supply, conduit and wiring from distribution panels to BAS field panels and devices, such as, but not limited to, valve actuators, terminal box controllers, damper actuators, , are a part of the work of this Section. Power supply shall be from emergency power source for all equipment connected to emergency power and/or used for Fire Life Safety operation.

D. Control wiring and conduit to automation field panels and devices, such as, but not limited to, valve actuators, terminal box controllers, damper actuators, , are a part of the work of this Section.

E. All wiring to outdoor panels and devices shall be arranged so that the conduits enter the panels and devices from the bottom in order to minimize the risk of water leaks. All conduit entries into outdoor panels and devices must be made with special weatherproof fittings.

F. Disconnects as required by the UMC 2013 section 308.0 “Means of Disconnect”, are a part of the work of this Section.

G. Wiring

1. All wiring performed by the BAS Subcontractor shall be installed in accordance with the requirements of Division 26 as well as all current and applicable local and national codes including but not limited to:

    a. NEC (NFPA 70) – National Electrical Code

    b. CMC – California Mechanical Code

    c. CFC – California Fire Code

    d. CBC – California Building Code

2. Except for Smoke Control systems, and unless required by Division 26 specifications, plenum-rated low voltage wiring may be installed without conduits in accessible, concealed spaces above ceiling plenums, if installed in a neat workmanlike manner, suspended from the structure on hangers and not touching any hot surfaces (coils). Laying bare wires and cables on the ceiling grid is prohibited.

3. For Smoke Control systems, and if required by Division 26 specifications, in addition to meeting the requirements of the electrical codes, all wiring, regardless of voltage, shall be fully enclosed within continuous raceways (conduit).

4. Concealed wiring within partition wall to temperature sensors needs to be in conduit to 8ft AFF.

5. All wiring must be color-coded and all terminations shall be numbered in accordance with applicable wiring standards and Division 26 requirements.

H. Dampers

1. All modulating and two position automatic control dampers, combination fire/smoke dampers and smoke dampers, whether shown on drawings or not, are included under work of Division 23. Any additional dampers not shown on the Drawings, but required to complete the work of Sections 25 55 00 through 25 55 60, shall be selected under the work of Section 25 55 30, but furnished and installed under Section 23 33 00.

2. Damper actuators for all modulating and two position dampers, furnished under Section 23 33 00, shall be furnished and installed under this Section. Provide all additional relays, control wiring and end switches for monitoring the status and controlling these dampers as required by the sequence of operation. Actuators for Smoke and Combination Fire/Smoke dampers shall be furnished with end switches integral with the dampers as a complete UL listed assembly under the work of Section 23 33 00.

3. Provide and install disconnects as required by the UMC 2001 section 309.0 “Means of Disconnect”.

I. BAS contractor shall label all wiring and identify power supply circuit numbers and source panels as required.

J. Provide minimum 15 minutes UPS power modules for all control devices requiring uninterruptible power to meet the smoke control system requirements if Smoke Control is part of the scope of work or if equipment controlled by the BAS will operate on Standby or Emergency Power.

1.07 STARTUP AND COMMISSIONING SERVICES

A. The BAS contractor shall participate in the Start-up procedures of all equipment and systems, such as the chilled water, hot water and steam systems, air handling systems, electrical, plumbing and Fire Life safety systems in the presence of the equipment manufacturer’s representatives, Commissioning Authority or the Owner’s representative as applicable.

B. Upon completion of the installation and after a complete point-to-point check of the system, the BAS contractor shall load the system software and perform a safe system start-up following the procedures outlined in the various Division 23 sections. The BAS Contractor shall perform all necessary calibration, testing and debugging and perform all required operational checks to insure that the system is functioning in full accordance with these Specifications

C. Each point in the system shall be tested for both hardware and software functionality. Provide a point to point test plan and test report to the commissioning agent.

D. Each system under control of the BAS shall be tested against the approved sequence of operations per functional test procedures developed by the commissioning agent. The commissioning’s agents report shall be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.

E. The Contractor in the presence of the Owner’s representative shall perform an acceptance test for all the system and train all the Owner’s designated employees in accordance with the provisions herein and the Commissioning specifications issued by the Commissioning Authority.

1.08 DEMONSTRATION AND ACCEPTANCE TESTING (FUNCTIONAL PERFORMANCE TESTING)

A. Refer to Commissioning specifications provided by Commissioning Authority

1.09 OPERATOR INSTRUCTIONS

A. If installing JCI Metasys – the BMS contractor is to provide 24 hours of owner training.

B. Alternate manufacture requirements:The system supplier shall conduct operator training on the system at acceptance time. Training shall be performed for three operator levels, and shall include the following, with a minimum of 16 hours for level 1, 24 hours for level 2 and 40 hours for level 3 of dedicated instructor time.

1. Level 1: Two persons on basic data display and interpretation of graphics, addresses, and alarm and to interpret all alarm displays and printouts, to request all data displays.

2. Level 2: Two persons (included in Level 1 class) on intermediate command and program change operations. This level of operators shall be trained to execute all manual commands (Start/Stop, Secure/Access), request all logs and change time based On/Off program times and load assignments.

3. Level 3: One-person (included in Level 1 and Level 2 classes) on total system programming. This level of operators shall be trained to install all other programs and program changes specified herein to be keyboard programmable. This training shall include complete understanding of all application packages, the custom written data file and user programs, and the ability to write and change new and existing specified programs. Trainer shall review and use documentation specified.

C. During system commissioning and prior to the guarantee period, the BAS Contractor shall provide hands-on maintenance and operation training to the Owner’s personnel. Training shall be performed for all the electrical and mechanical components of the BAS using a submitted and approved O & M manual prepared specifically for this project.

D. The system supplier shall offer retraining of the Owner’s personnel at the Owner’s expense. Supplier shall furnish a syllabus of all training courses offered, and shall maintain a published schedule of training classes and a schedule of fees for classes.

E. The training sessions shall be videotaped by the contractor and copy of the videotape handed to the Owner.

1.010 SYSTEM ACCEPTANCE

A. Satisfactory completion is when the BAS contractor has performed successfully all the required testing by the Authorities Having Jurisdiction, the Commissioning Authority and by the specifications and demonstrated performance and compliance with all Contract Documents. System acceptance shall be contingent upon completion and review of the corrected deficiencies issued by all parties.

B. Request a final review prior to system acceptance after completion of the following:

1. Installation of all systems required by the Contract Documents.

2. Satisfactory operation of all systems for a period of two weeks.

3. Tagging and Identification of all equipment as required.

4. Cleaning and painting if required.

5. Submission and acceptance of submitted maintenance and service manuals.

6. Submission of as built record drawings.

7. Satisfactory completion of training programs.

8. Delivery of maintenance tools and spare parts.

1.011 WARRANTY

A. Refer to Division 01 Warranties

B. The BAS contractor shall warrant the system (equipment, materials, programming and workmanship) for 12 months labor and 3 year parts after system commissioning acceptance and beneficial use by the owner. During the entire warranty period and at no additional cost to the owner, the BAS contractor shall maintain and update all software and firmware versions with the most current revisions issued by the system and/or product manufacturer. Also during the warranty period and at no extra cost to the owner, the BAS contractor shall provide all necessary adjustments and modifications required for a workable system consistent with the letter and intent of the Sequence of Operation of this specification

C. Within this period, upon notice by the Owner, any defects due to faulty materials, methods of installation or workmanship shall be promptly (no later than 48 hours after receipt of notice) repaired or replaced under the work of this section at no expense to the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. Manufacturer: The Building Automation Control System shall be provided by the following:

1. Johnson Controls, Inc. Metasys to match campus standard

B. Installer: Johnson Controls, Inc. direct factory branch located in Folsom, CA.

2.02 MATERIALS & PRODUCTS

A. Comply with individual Sections of this Division.

B. As a minimum, the Building Automation System shall consist of the following:

1. Network Control Units, Operator Workstations and File Servers

2. Standalone General Purpose/Multiple Application DDC Controllers.

3. Standalone General Purpose/Single Application DDC Controllers.

4. Application specific controllers.

5. Interfaces and gateways to third party controllers.

6. Floor network controllers and expansion modules.

7. Air and Hydronic Terminal equipment controllers

8. Sensors, devices, valves and actuator, etc.

C. The Building Automation Control System shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, and historical data collection and archiving.

2.03 USER INTERFACE

A. Comply with the individual sections of this Division

PART 3 - EXECUTION

3.01 CONFERENCE

A. Upon award of the Contract, before submittals are prepared and any work is started, arrange a meeting with the Commissioning agent, Engineer and Owner or their representatives to discuss the work in this Division.

3.02 BAS SYSTEM PROJECT MANAGER

A. Have present at the project site, a project manager who shall, as a part of his duties, be responsible for the following activities:

1. Coordination and interface between this Subcontractor and all other trades, Owner, local authorities, and design team.

2. Attendance at meetings as requested by the owner and the commissioning agent

3. Supervision of field technicians and coordination of all activities between his subcontractors.

4. Scheduling of work progress, manpower loading, material delivery, equipment installation and checkout.

5. Coordination of all drawings and submittals between consultants, engineers other sub-trades and his subcontractors.

6. Programming and commissioning of control system

7. Engineering submittals

3.03 DRAWINGS

A. The contract drawings are diagrammatic. Size and location of equipment is drawn to scale wherever possible. The contractor shall make use of all data included in all of the Contract Documents bust must verify this information on site.

3.04 COORDINATION WITH OTHER TRADES

A. The BAS Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall have a trained technician available on request during the balancing of the systems. The BAS Contractor shall coordinate all requirements to provide a complete air and water balance with the Balancing Contractor and shall include all labor and materials in his scope of work.

B. Review the Contract Documents for the work performed by others in order to establish grade lines and eliminate interference.

1. Work, which interferes with the work of other trades, shall be removed and rerouted at the discretion of the Architect.

2. No additional funds will be allowed for changes made necessary by interference with the work of other trades.

C. When not shown on drawing, controls contractor shall generate floor drawing showing required locations for 120V power to transformers provided and installed by the controls contractor. Div 26 to provide 120V power as required

D. Owner IT Network coordination: During system commissioning controls contractor to request IP address for new network level controllers. Patch cable to network engine is provided by others.

3.05 COMMISSIONING

A. In coordination with Division 22, 23 and 26 contractors and the Owner’s representatives, provide services and manpower necessary for commissioning of the system as required by the Commissioning Specifications.

3.06 ACCESSIBILITY

A. The installation of valves, dampers, thermometers, gauges, traps, clean-outs, control devices or other specialties requiring reading, adjustment, inspection, repairs, removal or replacement shall be conveniently and accessibly located with reference to the finished building. Refer to Division 15 sections.

3.07 PROTECTION

A. Provide adequate protection for all finished work against physical damage from whatever cause during the progress of the work and until completion. During construction, properly cap all ducts, pipes and equipment to prevent the entrance of sand and dirt. Protect equipment against moisture, plaster, cement, paint or other hazards by covering with polyethylene sheets.

B. All device locations shall be safe from water damage. No control devices shall be mounted under piping, valves or wall penetrations where water leakage may occur.

3.08 CLEANING

A. After installation is complete, clean all systems as indicated below.

1. During work in progress: Carefully clean the premises and keep all portions of the building free of debris.

2. Chrome or nickel-plated work: Thoroughly polish.

3. Factory finished items: Remove grease and oil and leave surfaces clean and polished.

3.09 WIRE LABELS/ DEVICE TAGGING

A. Comply with the requirements of Division 23, Division 26 sections and the following:

1. Controller Identification:

a. A nameplate securely fastened to the outside of the controller enclosure shall identify all controllers. Minimum size of letters shall be 1”.

2. Panel Identification:

a. A nameplate securely fastened to the outside of the controller enclosure shall identify all local control panels. Minimum size of letters shall be 1”.

3. Field Devices:

a. All field devices shall be identified by a typed (not handwritten) securely attached tag label. Each tag will consist of a stainless steel wire and stainless steel tag. The device name will match the object name on the control drawings. One tag will be provided for every valve, sensor, etc. Minimum size of letters shall be 1/2”.

4. Panel Devices:

a. A typed label shall identify all panel devices. Each tag shall consist of a black plastic tag with white lettering. Device names will match object on control drawings. One tag will be provided for every panel mounted device (transformers, controllers, etc.) Tags will be securely fixed to panel device with sticky back tape.

5. Wire Identification:

a. All low and line voltage control wiring shall be identified as referenced to the associated control diagram, at each end of the conductor or cable. Identification shall be permanently secured to the conductor or cable and shall be typed.

END OF SECTION 255500

SECTION 255520
DIRECT DIGITAL CONTROL SYSTEM AND USER INTERFACE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, applicable portions of Division 1, Division 22, 23 and 26 – Basic Materials and Methods, apply to this Section.

1.02 DESCRIPTION

A. General: Provide Direct Digital Control (DDC) system, complete, as shown, specified or required per Contract Documents.

B. Work Included in this Section: Principal items of work include, but are not limited to, the following:

1. General Purpose/Multiple Application DCC controllers.

2. Single/Application Specific DDC Controllers.

3. Single/Application Specific Controllers – Terminal Unit Controllers.

4. System Software

5. User Interface

C. Related Work Not Included in This Section: Other Division 25 sections.

1.03 DESIGN INTENT

A. The primary goals of the Building Automation System (BAS) are to maintain an environment automating and facilitating the technical operation of the facility, maximize the effectiveness of operations and maintenance personnel, and manage energy consumption, maintain IAQ and occupants comfort. As a result the BAS shall communicate with the JCI Metasys system on campus.

1.04 GENERAL REQUIREMENTS

A. Requirements of Section 25 55 00 govern the work of this Section.

B. Each system shall be provided with its own dedicated direct digital controller or application specific controller. Mechanical systems such as Air handling units, Air Terminal Units & Fan coil units or packaged systems shall not be controlled by more than one specific application controller. The intent of this section is to ensure stand-alone control for all major HVAC equipment that will require Proportional (P) Proportional & Integral (PI) or Proportional, Integral & Derivative (PID) control processes.

C. Fans, dampers, sensors and devices included as part of a “system” (example: a relief fan associated with an air handler) shall be controlled and wired to the same controller and directly controlled by the same CPU.

D. Provide 10% spare slots in all DCC panels for future expansion and addition of point modules.

E. Furnish temperature control panels (TCP) of NEMA code gauge steel with locking doors for mounting all devices. They shall meet all applicable requirements of Title 24, California Code of Regulations. All controllers, relays, switches, etc. for equipment located in mechanical equipment rooms shall be mounted in a TCP. Temperature settings, adjustments and calibration shall be done at the TCP. Any required UCMC Campus Data networks connection for this panel shall be installed inside the panel. All electric devices within a control panel shall be factory pre-piped and wired. Provide engraved laminated plastic nameplates identifying all devices mounted on the face of the control panels. A complete set of related "as-built" control drawings shall be furnished in each control panel.

1.05 GENERAL SYSTEM REQUIREMENTS

A. The Direct Digital Control (DDC) system shall be an integral part of Building Automation System (BAS). The system shall be modular in nature permitting expansion of both capacity and functionality through the addition of sensors, actuators, network controllers and operator devices.

B. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices

C. Standalone DDC panels shall be able to access any data from, or send control commands and alarm reports directly to any other DDC panel or combination of panels on the network without dependence upon a central processing device. Standalone DDC panels shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device. Systems, which do not meet this requirement, are not acceptable.

D. Provide all of the required FDD system status' and faults of each HVAC package unit economizer within the BACnet Temperature Control System graphics. FDD controller must be manufactured by the DDC supplier and approved and listed on CEC website under Fault Detection Diagnostic System Declaration List (no exceptions). Third party FDD controllers are not acceptable.

E. Where indicated by the University, provide Automatic Demand Shed Controls as required by the Building Energy Efficiency Standards - Title 24. Provide each HVAC system with Automated Demand Response (ADR) control and programming to change setpoints, reset setpoints, adjustable rate of change for setpoint change, ability to disable and allow manual control.

1. System functionality shall be demonstrated and confirmed during system start-up regardless of presence of ADR signal generator. If ADR signal is not required per project documents signal shall be simulated in software to prove complete operation.

2. Provide project names and a customer references of two projects that controls contractor has successfully implemented Automated Demand Response.

1.06 SYSTEM INTEGRATION

A. Neutral Protocol: The neutral Protocol used between systems will be BACnet over Ethernet and shall comply with the ASHRAE BACnet standard. The BACnet system integrator shall allow bi-directional communications between the host system and BACnet system over an Ethernet network.

B. BACnet integration into the Metasys network must respect existing BACnet devices and operational configurations. Failure to do so will cause outages ranging from individual devices to the entire downtown campus. BAS manufacturer must be able to utilize all of the range BACnet addresses so that any new building does not use any duplicate addresses. All costs impacts to state entity, including building tenant evacuation resulting from system outage, will be passed along to installing contractor.

C. Direct Protocol

1. The BAS shall include appropriate hardware equipment and software to allow bi-directional data communications between the BAS and third party manufactures' control panels. The BAS shall receive, react to and return information from multiple building systems including but not limited to chillers, boilers, variable frequency drives, power monitoring and metering systems, lighting systems and fire life safety systems. Integration shall be via RS-232 or RS-485 technologies.

2. All data required by the application shall be mapped into the Network controller database and shall be transparent to the operator. Point inputs and outputs from the third party controllers shall have real time interoperability with the BAS software features

D. Third party controllers shall communicate via BACnet MS/TP or IP. The manufacture of the equipment is responsible for providing and commissioning this gateway for use by the BAS system. The BMS contractor will only be responsible for integration gateways for 3rd party controllers with MODBUS.

1.07 SYSTEM ARCHITECTURE

A. First Tier or Level 1 Network – BACnet IP

1. The first tier or Level 1 network is the main backbone of the system and shall be based on an industry standard Ethernet TCP/IP.

2. Network Control Units, Operator Workstations and File Servers shall reside on the first tier network without the need of gateway devices. PC Workstation shall connect to the campus network. Network engine controllers shall live on the tier 1 network. Air Handler controllers and central plant controllers shall reside on the first tier or Level 1 Ethernet network or the Level 2 MS/TP network..

3. The first tier shall be connected to the facility wide network by way of standard network practices.

4. The system architecture shall support 100% expansion capacity of all types of DDC panels, and all point types included in the initial installation.

B. Second Tier or Level 2 Network; shall be BACnet MS/TP at 78,600 baud

C. Dynamic Data Access: All operator devices, either network resident, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment.

1.08 NETWORK DESIGN GENERAL REQUIREMENTS

A. Network design shall include the following provisions:

1. Detection and accommodation of single or multiple failures of workstations, DDC panels or the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.

2. Message and alarm buffering to prevent information from being lost.

3. Error detection, correction and re-transmission to guarantee data integrity.

4. Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event that an operator device does not respond.

5. Synchronization of the real-time clocks in all DDC panels.

1.09 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Where indicated for supporting operator PCs, servers, and other equipment as indicated, provide a UPS as required

PART 2 - PRODUCTS

2.01 STANDALONE GENERAL PURPOSE/MULTIPLE APPLICATION DDC CONTROLLERS

A. General: Standalone DDC panels shall be microprocessor based, multi-tasking, multi-user, and real-time digital control processors.

B. Each standalone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the attached point list.

C. Each General Purpose/Multiple Application Controller must be capable of standalone direct digital operation utilizing its own 10 bit processor, non-volatile flash memory, input/output, 12 bit A to D conversion, hardware clock/calendar and voltage transient and lightning protection devices. All non-volatile flash memory shall have a battery backup of at least five years. Firmware revisions to the module should be able to be made from the local workstation, portable operator terminals or from remote locations over LANs.

D. The General Purpose/Multiple Application Controllers shall be expandable to the specified I/O point requirements. Each controller shall accommodate multiple I/O Expander Modules via a designated expansion I/O bus port. These expander modules shall expand the total point capacity of each controller. The controller, in conjunction with the expansion modules, shall act as one standalone controller.

E. All communication and input/output signals shall be hardwired (wireless technology is not acceptable).

F. Memory: Each DDC panel shall have sufficient memory to support its own operating system and databases including.

1. Operator I/O.

2. Control processes.

3. Custom processes.

4. Support applications.

5. Alarm management.

6. Dial-Up communications.

7. Manual override monitoring.

8. Energy management applications.

9. Historical/trend data for all points maintenance.

G. Each General Purpose/Multiple Application Controller shall execute application programs, calculations, and commands via a 10-bit microcomputer resident in the controller. All operating parameters for application programs residing in each controller shall be stored in read/writable nonvolatile flash memory within the controller and will be able to upload/download to/from the operator workstation.

H. All point data; algorithms and application software within a controller shall be custom programmable from the operator workstation.

I. Each General Purpose/Multiple Application Controller shall contain both software and firmware to perform full DDC PID control loops.

J. Local Override Switches: Provide local override switches where shown on drawings. If required, the override switches will manually override automatic or centrally executed commands at the DDC panel via local manual switches. Provide operator override switches for binary output control points and gradual positioning switches for analog output control points as indicated in the point schedule. Local override switches are not required when the override function can be achieved at the output device (starter, valve, damper, etc.) and the device is located in sight of the DDC panel.

K. Hardware Override Monitoring: Monitor the override status and position of each override as a discrete condition in addition to point status and alarm condition. Include this information in logs and summaries to inform the operator that automatic control has been inhibited. DDC panels shall also collect override activity information for daily and monthly reports.

L. Integrated On-Line Diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel.

M. Surge and Transient Protection: Provide isolation consistent with IEEE Standard 587-1980 at all networks terminations, and all field point terminations to suppress induced voltage transients.

N. Power Fail Restart: In the event of loss of normal power, there shall be an orderly shutdown of all standalone DDC panels to prevent the loss of database or operating system software.

O. Economizer Fault Detection and Diagnostics (FDD) as required by the CEC Building Energy Efficiency Standards - Title 24. Controller shall be approved and listed on the CEC website under Fault Detection Diagnostic System Declaration List.

2.02 STANDALONE GENERAL PURPOSE / SINGLE APPLICATION DDC CONTROLLERS

A. The standalone DDC controller capacity shall be capable of being extended through the use of remote Single/Specific Application Controllers (SAC).

B. Provide a minimum of one controller per air handler

C. All communication and input/output signals shall be hardwired (wireless technology is not acceptable).

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

E. Each SAC shall have sufficient memory to support its own operating system and databases including:

1. Control processes.

2. Energy management applications.

3. Operator I/O (portable service terminal).

F. Each General Purpose/Single Application Controller shall execute application programs, calculations, and commands via a 10-bit microcomputer resident in the controller. All operating parameters for application programs residing in each controller shall be stored in read/writable nonvolatile flash memory within the controller and will be able to upload/download to/from the operator workstation.

G. Each General Purpose/Single Application Controller must be capable of standalone direct digital operation utilizing its own 10-bit processor, non-volatile flash memory, input/output, 10 bit A to D conversion, hardware clock/calendar and voltage transient and lightning protection devices. All non-volatile flash memory shall have a battery backup of at least five years. Firmware revisions to the module should be able to be made from the local workstation, portable operator terminals or from remote locations over modems or LANs.

H. All point data, algorithms and application software within a controller shall be custom programmable from the operator workstation.

I. Each General Purpose / Single Application Controller shall contain both software and firmware to perform full DDC PID control loops.

J. The operator shall be able to access any SAC point data or program through the network resident PC workstation or any PC or portable operator's terminal connected to any DDC panel in the network.

K. Integrated on-line diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel.

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

M. Air Handling Unit (AHU) Controllers: AHU controllers shall support, but not be limited to, the following configurations of systems to address current requirements as described in the Sequence of Operation portion of this specification, and for future expansion.

1. Large Air Handling Units: Mixed Air - Single Path; Mixed Air - Dual Path; 100% Single Path; 100% Dual Path.

2. AHU Controllers shall support all the necessary point inputs and outputs to perform the specified control sequences in a completely standalone fashion including but not limited to all associated dampers, sensors and actuators.

3. AHU controllers shall have a library of control routines and program logic to perform the sequence of operation as specified in the Sequence of Operation portion of this specification.

4. Continuous Zone Temperature Histories: Each AHU controller shall automatically and continuously, maintain a history of the associated zone temperature to allow users to quickly analyze space comfort and equipment performance for the past 24 hours. A minimum of one sample every 15 minutes shall be stored.

5. Alarm Management: Each AHU controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

2.03 APPLICATION SPECIFIC CONTROLLERS - TERMINAL UNIT CONTROLLERS

A. Each terminal unit controller shall provide both standalone and networked direct digital control of pressure independent constant and variable volume terminal boxes. Each controller shall contain both software and hardware to perform full DDC P, PI and PID loop control and able to operate as a standalone controller and maintain the assigned space temperature in the event of a loss of communication with the network. Each controller shall execute application programs, calculations and commands via a 10-bit microprocessor resident within the controller. All communication and input/output signals shall be hardwired (wireless technology is not acceptable).

B. The controller shall determine airflow by dynamic pressure measurement using a dead-ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters. Each controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.

C. When continuous operation at occupied flow is required, provide an “Autozero” module in order to provide periodic recalibration of the air velocity transducer without changing the air volume being delivered.

D. The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops and shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. This feature will reduce commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes. The controller shall be able to support various types of zone temperature sensors with all options listed in the specifications.

E. The controller shall provide the ability to download and upload configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.

F. All operating parameters for application programs residing in each controller shall be stored in the controller’s non-volatile memory. Setpoint changes initiated over the network shall be written to the controller’s non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.

G. Firmware or application programs, stored in the controller memory shall conform to the sequence of operation specified in Section 25 55 50. Controllers with manufacturer-preprogrammed sequences (configurable controllers) are unacceptable. Controllers shall be fully programmable and able to be reprogrammed in accordance with the specified sequences in section 25 50 50. Firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.

H. The portable operator interface shall provide the user with the following functionality as a minimum:

1. Display system status (heating, cooling, etc.)

2. Display and change all point and set points

3. Set and change heating/cooling dead bands

4. Set and change PI loop gains

5. Set and change system mode (occupied/unoccupied)

6. Set and change system schedule

7. Override all set points

8. Override all digital and analog outputs

9. Command all digital and analog outputs

10. Select application mode

11. Assign controller address

I. The controllers shall have LED indication for visual status of communication, power and all outputs

J. Inputs

1. Analog inputs shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:

    a. 0-10 VDC Sensors

    b. 10,000Ω Type II Thermistors

    c. 4-20 ma sensors

    d. 0-5 VDC sensors

2. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input “bouncing.”

3. For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.

K. Outputs

1. Analog outputs shall provide the following: 0-10 VDC (4-20 mA) outputs

2. Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.

3. For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.

4. Each controller shall provide modulating control 0-10 VDC (4-20 mA) to reheat valves. Floating Point Control is not acceptable.

L. The controller’s performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop’s sample interval, which may be used to continuously monitor and document system performance. The air-terminal controller, VAV, CAV and other types shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the air-terminals.

1. Absolute temperature loop error

2. Signed temperature loop error

3. Absolute airflow loop error

4. Signed airflow loop error

5. Average damper actuator duty cycle.

M. The controller shall detect system error conditions to assist in managing the zones. The error conditions shall consist of:

1. Unreliable space temperature sensor

2. Unreliable differential pressure sensor

3. Starved box

4. Insufficient cooling

5. Insufficient heating

N. Provide an electronic damper actuator with modulating control. Obtain damper torque ratings from the terminal box manufacturer and size the actuator accordingly. Actuator shall have a minimum of 35 in-lb. of torque and be protected against overload. Mount actuator on damper shaft without the need for additional linkage. A visual pointer shall indicate the position of the actuator. The damper actuator shall be capable of stroking 90 degrees in 95 seconds for damper positioning to speed commissioning and troubleshooting tasks.

O. Terminal Unit Controllers shall carry the following listings: UL 916 and UL 864, UUKL classification (if part of a Smoke Control system) and FCC compliance.

2.04 SYSTEM SOFTWARE

A. General

1. The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher-level computer for execution.

2. Software shall be modular in design to provide maximum flexibility, expansion and future revision of the system. All functionality described herein shall be regarded as a minimum.

3. The system software shall include the following as a minimum:

a. Complete database entry.

b. Configuration of all controller and operator workstation application programs to provide the sequence of operation indicated.

c. Graphics of each system as shown in the I/O Summary Tables.

d. Report generation, configuration of reports and point summaries.

e. Event / alarms comprised of priority alarms, alarms, and messages.

4. The system software shall be comprised of the following elements:

a. Graphical User Interface.

b. System Configuration Utilities.

c. Graphical Programming.

d. Direct digital control software.

e. Application software.

B. Control Software Description

1. Pre-Tested Control Algorithms: The DDC panels shall have the ability to perform the following pre-tested control algorithms.

a. Two-position control.

b. Proportional control.

c. Proportional plus integral control.

d. Proportional, integral, plus derivative control.

e. Automatic control loop tuning.

2. Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

3. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during normal start-up and also restart after power restoration periods by automatically introducing time delays between successive start commands to heavy electrical loads.

4. Energy Management Applications: DDC panels shall have the ability to perform any or all of the following energy management routines:

a. Time of day scheduling.

b. Calendar based scheduling.

c. Holiday scheduling.

d. Temporary schedule overrides.

e. Optimal start.

f. Optimal stop.

g. Night setback control.

h. Enthalpy switchover (Economizer).

i. Peak demand limiting.

j. Temperature compensated load rolling.

k. Fan speed/CFM control.

l. Heating/cooling interlock.

m. Cold deck reset.

n. Hot deck reset.

o. Hot water reset.

p. Chilled water reset.

q. Condenser water reset.

r. Chiller, boiler and heat exchanger sequencing.

5. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user to customize. Programs shall be applied to building equipment as described in the Sequence of Operations.

6. Custom Process Programming Capability: DDC panels shall be able to execute custom, project specific processes defined by the user, to automatically perform calculations and special control routines.

7. Process Inputs and Variables: It shall be possible to use any of the following in a custom process.

a. Any system measured point data or status.

b. Any calculated data.

c. Any results from other processes.

d. User defined constants.

e. Arithmetic functions (+,-,*,/, square root, exp, etc.).

f. Boolean logic operators (and, or, exclusive or, etc.).

g. On-delay/off-delay/one-shot timers.

8. Process Triggers: Custom processes may be triggered based on any combination of the following:

a. Time interval.

b. Time of day.

c. Date.

d. Other processes.

e. Time programming.

f. Events (e.g., point alarms).

C. Dynamic Data Access

1. A single process shall be able to incorporate measured or calculated data from any and all other DDC panels on the local area network. All hardware and

communications cabling necessary to enable any point in any process to be global shall be furnished, such that any existing or any spare point can be designated as a global point in software.

2. In addition, a single process shall be able to issue commands to points in any and all other DDC panels on the local area network.

3. Advisory/Message Generation: Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote device such as a printer or pager.

4. Custom Process Documentation: The custom control programming feature shall be self documenting. All interrelationships defined by this feature shall be documented via graphical flow charts and English language descriptors.

D. Historical Data and Trend Analysis: A variety of historical data collection utilities shall be provided to automatically sample, store, and display system data in all of the following ways.

1. Continuous Point Histories: Standalone DDC panels shall store Point History files for all analog and binary inputs and outputs.

   a. The point history routine shall continuously and automatically sample the value of all analog inputs at half-hour intervals. Samples for all points shall be stored for the past 24 hours to allow the user to immediately analyze equipment performance and all problem related events for the past day.

   b. Point history files for binary input or output points and analog output points shall include a continuous record of the last ten status changes or commands for each point.

2. Control Loop Performance Trends: Standalone DDC panels shall also provide high resolution sampling capability with an operator adjustable resolution of 10-300 seconds in one second increments for verification of control loop performance.

3. Extended Sample Period Trends

   a. Measured and calculated analog and binary data shall also be assigned to user definable trends for the purpose of collecting operator specified performance data over extended periods of time. Sample intervals of 1 minute to 2 hours, in one-minute intervals, shall be provided.

   b. Each standalone DDC panel shall have a dedicated buffer for trend data, and shall be provided with sufficient memory to store a minimum of 5000 data samples.

E. Data Storage and Archiving

1. Trend data shall be stored at the standalone DDC panels. Provide sufficient memory at the standalone DDC panels to store the trend data to be uploaded to hard disk storage when archival is desired.

2. Uploads shall occur based upon user defined interval, manual command, or when the trend buffers become full. All trend data shall be available in disk file form for use in 3rd Party personal computer applications.

F. Runtime Totalization: Standalone DDC panels shall automatically accumulate and store runtime hours for binary input and output points as specified in the Point List portion of this Specification.

1. The totalization routine shall have a sampling resolution of one minute or less.

2. The user shall have the ability to define a warning limit for runtime totalization. Unique, user specified messages shall be generated when the limit is reached.

3. Analog/Pulse Totalization

a. Standalone DDC panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user selected analog and binary pulse input type points.

b. Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g., kWh, gallons, kBtu, tons, etc.).

c. The totalization routine shall have a sampling resolution of one minute or less.

d. The user shall have the ability to define a warning limit. Unique, user specified messages shall be generated when the limit is reached.

G. Event Totalization: Standalone DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.

1. The event totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

2. The user shall have the ability to define a warning limit. Unique, user specified messages shall be generated when the limit is reached.

2.05 USER INTERFACE

A. Mobile, Web Based, User Interface (MUI)

1. General

a. The Mobile, Web Based, User Interface shall be HTML5-compliant and provide device-agnostic access to the system from smartphones, tablets, portable and desktop computers. User Interfaces that require software installation on the client device (ex. Java, MicrosoftSilverlight®, Adobe® Flash®), or software downloads from an online app store shall not be acceptable for these purposes.

b. The MUI shall provide system operators with a simple location-based navigation approach to finding information, including the ability to search for any location by name and to bookmark a location in a standard browser.

c. The same user interface elements shall be accessible from any type of personal computer or mobile device running any type of operating system supported (ex. iOS, Android, Windows). It shall automatically adapt and optimize the display for the screen size and touch screen navigation.

d. The user interface shall provide support for up to 50 concurrent users from individuals with defined access to the system.

2. Navigation Trees

a. A dedicated location based navigation tree shall be provided as part of the UI in order to navigate to specific places within the facility on a hierarchical basis (typ. Facility, Building, Wing, Floor, Room)

b. The location-based tree shall use place names familiar to the operator without training or familiarization regarding special codes and conventions utilized in the generation of the BMS.

c. Clicking or tapping on a location name in the tree shall display the home page associated with the space and simultaneously expand the tree to display the next level of spaces below the one selected.

3. Dashboard Displays

a. The user interface shall provide the ability to view equipment visualizations, floor plans, and/or other graphics on mobile or desktop client devices in a browser environment, without the need for additional plugins or software. Graphics shall be accessible via a space (for floorplans, campus maps, etc.) or equipment dashboard.

b. Standard dashboards shall be configured for each defined space including one of the following predefined or custom elements:

c. Equipment Serving Space

d. Potential Problem Areas

e. Equipment Summary

f. Graphic Display (if specified)

g. Schedule

h. Standard dashboards shall be configured for each system or device (typ. mechanical or electrical equipment) including the following predefined or custom elements:

i. Trend

j. Equipment Activity Summary

k. Equipment Relationships Summary

l. Equipment Data

m. Graphic Display (if specified)

n. Schedule

o. Users with appropriate permissions shall have access to a Dashboards Manager that can change the display order of Summaries and Data elements, add or remove elements and apply custom dashboards layouts to equipment and space by type.

p. Dashboard Manager shall apply dashboards to spaces or equipment based on the viewing platform (Desktop/Tablet or Phone) in order to tailor the user experience to the needs of the specific user base.

q. Default dashboard displays by space and equipment type shall be created per the guidelines in this specification or by mutual agreement with the owner's representative.

4. Alarm Management

a. The user interface shall provide a single display of all potential issues in a facility including items currently in alarm, warning, override, out-of-service and offline.

b. The user interface shall provide notification of new alarms, visually and audibly.

c. The user interface shall provide the ability to view a summary of alarms, including a chart of the number of alarms in each of the defined alarm priority ranges. The priority ranges should be filterable.

d. The user interface shall provide the capability to view multiple occurrences of the same alarm, ultimately providing the ability to acknowledge or discard all occurrences of the alarm in a single action.

e. The user interface shall provide the capability to view, and filter on, all alarms present in a well-defined mechanical system using the equipment serving equipment relationships.

f. The user interface shall provide the capability to acknowledge and discard all occurrences of at least 1000 alarms in one operation

g. The user interface shall provide the user with the understanding of what physical space is being affected when an alarm occurs. The user interface shall provide the ability to filter alarms by physical space affected when the alarm occurred.

h. The user interface shall provide the capability to monitor alarms 24/7 without requiring an active login to the system, accessible via segregated web page. The user interface shall provide the capability to enabled or disable the 24/7 alarm monitor mode if desired.

5. Equipment Activity Summary

a. The user interface shall provide a filterable, single display, of all activity related to a specific piece of equipment including user changes,

discarded user changes, pending alarms, discarded alarms, and acknowledged alarms for at least one year of historical data.

b. Filters shall allow only specific activities for specific data points occurring within a specific time and date window to be displayed.

c. It shall be possible to export a .csv copy of the currently displayed summary by clicking or tapping on the export icon.

d. Clicking on the information icon in front of any displayed activity listed in the summary shall expand the display to include the name of the user, server time, value prior to the activity, the ability to annotate the activity and a user selectable icon for displaying a trend graph of the point.

6. Equipment Relationships Summary

a. The user interface shall provide a summary of all equipment and spaces related to the operation of the system or device currently selected for viewing.

b. Include the capability to navigate to the home page of any related piece of equipment or space with a single click or tap on the desired element.

7. Equipment Data Summary

a. The user interface shall provide a summary of all data pertaining to a particular piece of mechanical or electrical equipment in a tabular format.

b. Clicking or tapping on any value in the summary shall display a related command panel allowing the user to command, override, or change service condition of the point selected and to annotate such actions for future reference

c. It shall be possible to export a .pdf copy of the report with a single click on the associated export icon.

8. Equipment Serving Space Summary

a. The user interface shall provide a summary of all mechanical and electrical equipment as defined in the points list that serves a selected space from the navigation tree.

b. The summary shall be capable of including a subset of the viewable points for each system representing the key elements of interest to operators without subjecting them to long lists of points irrelevant to basic operation.

9. Potential Problem Areas

a. The user interface shall provide a summary of all points in the system related to the space that are not operating correctly (e.g. alarm, off normal or not communicating correctly) in order to provide the operator with a quick update on current conditions.

b. The information shall include

1) Point status (via color

2) Point name

3) Value of the point when the summary was taken

4) Equipment that contains the offending point

5) Space that is served by that equipment

10. Equipment Summary

    a. The UI shall provide a summary that allows the user to compare all similar equipment that serves the space as well as downstream (child) spaces in order to evaluate conditions quickly and determine patterns for troubleshooting purposes.

    b. Each unique equipment type shall be selectable and display a representative set of values along with the space(s) being served by the device. Equipment types can be selected from a dropdown menu in the summary.

11. User Defined Summaries

    a. Provide the capability to view, command, and modify large quantities of similar data in summaries without the use of a secondary application (e.g. a spreadsheet). These summaries shall be generated automatically or user defined. User defined summaries shall allow up to seven user defined columns describing attributes to be displayed including custom column labels with up to 100 rows per summary.

12. Trend

    a. The user interface shall provide the capability to view historical trend data from multiple pieces of equipment in both bar and line formats.

    b. The user shall have the ability to navigate to a selection list of frequently viewed trends.

13. Graphics

    a. The user interface shall display an equipment visualization or graphic within the context of its associated space (building, floor, room, etc.) or equipment dashboard.

    b. Graphics shall include the ability to define individual information layers for operator selection in order to clarify systems status and simplify operation on mobile devices. Where desired a master layer may be defined to include important information about the facility on all graphic screens.

    c. Graphics shall support the use of photo-realistic symbols as well as color change and animation to match the status of the related system control point.

d. It shall be possible to export a time stamped .pdf file of the graphic being viewed in order to communicate the current conditions in the space or the equipment being viewed and to provide a historic record.

e. An integral graphic manager shall be provided including the following features and capabilities:

1) Creation and modification of graphics from any HTML5 capable browser without the need for additional plug-ins or software packages

2) Access to a full suite of pre-defined templates for air and water sourced HVAC applications as well as the ability to add custom templates as created for other use. Pre-aliased graphic templates may be defined and saved for repetitive representations of common mechanical and electrical equipment.

3) A full suite of pre-defined three dimensional symbols for mechanical and electrical systems as well as all line, text and shape tools required for integration into a graphic with zoom and pan capabilities on multiple platforms and in multiple browsers.

4) The ability to search and replace items in multiple graphics with a single command

5) The ability to import and insert photos and images into the graphic

f. The ability of the graphics manager to create and edit graphics including the ability to bind graphic elements to the values and conditions of system points in both an on-line and off-line mode.

g. As required, the BMS Contractor shall provide software licenses in the name of the owner for programming, configuration and graphics building tools to allow designated representatives to make changes, modifications or additions to the system. While future updates or revisions may require and update fee, the owner shall incur no additional cost if they choose not to update. Systems that require any annual or time-limited licensing fees shall not be permitted.

14. Scheduling

a. The user interface shall provide the capability to display, in a singular view, all of the effective schedules in the context of the space (building/floor/room, etc.) or equipment that the schedule effects. The software should have the ability to display an effective schedule, for the present, or a future date.

b. The user interface shall provide a report of all schedules affecting a space or equipment. The report shall provide the user details of events that comprise the weekly schedule and exception schedule(s). The report shall provide a means of viewing individual breakout scheduling elements for Weekly Schedule, Exceptions and Default Commands

c. The user interface shall provide the capability to efficiently change or modify schedules in mass quantities. This includes the capability to add, in bulk, exceptions to schedules, in addition to assigning, in bulk, weekly schedules.

15. Command and Control

a. It shall be possible to command system analog and binary points via a dropdown menu accessed by clicking or tapping on the value shown in any equipment summary or graphic display and completing the task in the resultant menu including an optional annotation.

b. Commanding multiple points shall be possible on displays where multiple like system elements can be chosen.

16. Search

a. Typing a text string in the Search box shall display a list of all occurrences of that string in the MUI. When a string is represented in the description of a space or network element, selecting it shall display its default dashboard.

17. Offline Operation

a. The Mobile UI shall have the ability to operate in an offline mode in order to create or edit graphics and dashboard elements.

B. Site Management Portal and Associated Application Components

1. General – The Site Management Portal and its user interface shall serve as the primary tool for engineering personnel for the maintenance of the BMS

2. All features and functions of the Site Manager and associated user Interface defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.

3. The software shall run be accessible and operational on a Microsoft Internet Explorer (11.0 or higher) browser and support the following functions:

a. Configuration

b. Commissioning

c. Data Archiving

d. Monitoring

e. Commanding

f. System Diagnostics

4. Operator Interface

a. An integrated browser based client application shall be provided as the user interface program for operators familiar with the detailed operation of the Building Management System and charged with the maintenance and optimization of the mechanical/electrical systems in the facility.

b. All Inputs, Outputs, Setpoints, and all other parameters as defined shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.

c. The user interface software shall provide help menus and instructions for each operation and/or application.

d. The system shall support customization of the UI configuration and a home page display for each operator.

e. All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.

5. Navigation Trees

a. The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum, provide a tree that identifies all systems on the networks.

b. Provide the ability for the operator to add custom trees.

6. Alarms

a. Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:

7. Reports and Summaries

a. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:

1) All points in the BMS

2) All points in each BMS application

3) All points in a specific controller

4) All points in a user-defined group of points

5) All points currently in alarm

6) All points locked out

7) All user defined and adjustable variables, schedules, interlocks and the like.

b. Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.

8. Schedules

a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:

1) Weekly schedules

2) Exception Schedules

3) Monthly calendars

b. It shall be possible to define one or more exception schedules for each schedule including references to calendars

c. Changes to schedules made from the User Interface shall directly modify the schedule database stored in an engine or server.

9. Security/Passwords

a. Multiple-level passwords access protection shall be provided via roles and permissions. The feature will allow the system to base access on a user's job title or role and allow the user/manager access interface control, display, and database manipulation capabilities based on an assigned password.

b. Each user shall have the following: a user account name a complex password or passphrase

c. The system shall allow each user to change his or her password at will.

d. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.

e. Each login attempt is recorded in the system Audit Log with the option to record the IP address of the PC that made the login.

10. Historical trending and data collection

a. Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:

1) Any point, physical or calculated, may be designated for trending. Two methods of collection shall be allowed:

2) Defined time interval

3) Upon a change of value

4) Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.

b. Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time-scheduled basis.

11. Trend data viewing and analysis

a. Provide a trend viewing utility that shall have access to all database points.

C. Mobile Access Portal Gateway

1. General: The Mobile Access Portal (MAP) Gateway shall provide a complementary extension to the DDC system user interface requirements previously described in these specifications. The MAP Gateway shall provide an HTML5 browser interface between mobile devices and DDC controllers without the requirement for operational engines or servers. A task specific mobile application shall not be required to use the MAP Gateway.

a. The MAP Gateway shall be a hardware/software device which consists of a combination WiFi Access Point hotspot and user interface web server, with BACnet MS/TP RS-485 connectivity, and optional Ethernet IP connectivity.

b. When not connected via the Ethernet IP port, the MAP Gateway shall provide a secure, isolated connection to controllers on the BACnet MS/TP field bus with no opportunities to "jump off", or bridge over, to the site's IT infrastructure.

c. The MAP Gateway shall not require the user to purchase or install any software or applications on the user's smart phone, tablet, PC, or smart device.

d. The MAP Gateway shall include the following pre-configured user interface web pages linked to real-time data in the field controllers:

1) Device List Page

2) Device Home Page

3) Device Alarm Page

4) Point View/ Edit Page

e. Airflow Balancing: The gateway shall provide a tool for VAV box commissioning and air balancing for controllers provided under this specification. Connectivity to the individual boxes will not require connection to each controller but rather a connection to a single device on the MS/TP network within WiFi range.

f. The MAP Gateway shall include an RS-485 Port configured as BACnet MS/TP Master.

PART 3 - EXECUTION

3.01 INSPECTION OF CONDITIONS

A. Examine all related work and surfaces before starting work of this Section. Report to the Architect, in writing, conditions, which will prevent proper provision of this work. Beginning of work of this Section without reporting unsuitable conditions to the Architect constitutes acceptance of conditions. Perform any required removal, repair or replacement of this work caused by unsuitable conditions at no additional cost to the Owner.

3.02 INSTALLATION OF CONTROL PANELS

A. All DDC panels shall be installed in a neat workmanlike manner, in a convenient accessible location. Do not install any panel to be in a location where it may be subject to accidental damage or malfunction due to elements or vibrations from equipment, piping or ductwork.

B. All panels shall be located indoors. No outdoors DDC panels on this project.

C. Installation of Digital Terminal Unit Controllers

1. Terminal Controller, airflow transducer, damper actuator shall be shipped to the Terminal Box manufacturer for factory mounting. Factory mounting shall be the responsibility of the box manufacturer. Terminal box manufacturer to provide control transformer and all necessary fuses and disconnects required.

2. Terminal Box manufacturer shall factory install and wire the Terminal Controller, airflow transducer, damper actuator in a NEMA 1 UL listed enclosure. The terminal boxes shall arrive on site, pre-wired using screw connections and terminal blocks, so that connection of room temperature sensor, communications trunk, reheat valve and power shall complete the installation.

3. When terminal box is being fed from multiple power sources:

a. Separate each power source in accordance with NEC (Emergency power and Normal power)

b. Separate each power type in accordance with NEC (Low and High voltage)

c. Use a separate, local disconnect for each power source (Provided by terminal box manufacturer).

d. Clearly identify the different power sources and post a warning indicating that the terminal box is fed from multiple power sources.

4. All cost associated with shipping the Terminal Unit Controllers, actuators and transducers, furnished under this section, to the terminal unit manufacturer shall be borne by the BAS contractor.

5. Installation of Terminal Unit Controllers, actuators and transducers by terminal unit manufacturer will be at terminal unit manufacturer's cost.

3.03 INTEGRATION OF SYSTEM

A. The Building Automation System Contractor must provide a list of all the mechanical equipment and other Building Automation Systems that their system is capable of seamlessly interfacing with as part of their proposal along with a list of projects as reference to validate their claim.

B. At a minimum, the Building Automation System must be able to communicate through data lines, with the chillers, boilers, VFDs, lighting, fire alarm system and water treatment system for monitoring and control. Refer to other specification sections and/or Notice to Bidders for specific manufacturers on this project.

C. Complete all inter-wiring between panels, operator terminals, field devices such as sensors, operators, etc. as required, in a workmanlike manner.

END OF SECTION 255500

SECTION 255530
ELECTRONIC SENSORS, DEVICES AND FIELD HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Controllers, electronic sensors, devices, instrumentation and field hardware, complete, as shown on the plans, specified in the point list, and required by the sequence of operations for a complete and functional control system.

a. Temperature sensors & transmitters

b. Relative humidity sensors and transmitters:

c. Air quality measurement

d. Water flow measurements

e. Hydraulic pressure and differential pressure transmitters

f. Water flow and level sensors and switches

g. Air pressure sensors and switches

h. Airflow measuring stations

i. Electrical power switches and sensors

j. Control devices

k. Automatic control valves

l. Damper actuators

m. Enclosures

n. Pressure monitoring systems (TSI)

B. Related Work:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions, applicable portions of Division 1, Section 23 05 00 – General Provisions and applicable Division 22, 23 and Division 26 sections.

C. Conditions:

1. Requirements of Section 25 55 00 govern the work of this Section.

1.02 SUBMITTALS

A. Comply with the requirements of Division 1 and Section 25 55 00.

1.03 QUALITY ASURANCE

A. General: Materials, equipment and installation shall comply with all applicable building laws and published standards as described in Section 17000. In addition, comply with the following standards:

1. UL

2. NEC

3. ANSI

4. OSHA

5. ASHRAE

6. SMACNA

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide field devices for input and output of digital (binary) and analog signals into DDC hardware. Provide signal conditioning for all field devices as recommended by field device manufacturers, and as required for proper operation in the system.

B. It is the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.

C. Unless otherwise mentioned in this section, field devices specified herein are generally ‘two-wire’ type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, or is not designed to work with ‘two-wire’ type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide ‘four-wire’ type equal transmitter and necessary regulated DC power supply as required.

D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.

E. Accuracy: As used in this Section, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis. Sensor accuracies specified below shall be minimum accuracy requirements.

F. Mount all sensors and transmitters in a convenient location, visible and accessible for maintenance. For duct mount sensors, a neoprene grommet (sealtite fitting and mounting plate) shall be used on the sensor to prevent air leaks.

2.02 TEMPERATURE SENSORS & TRANSMITTERS

A. Duct Temperature Sensors:

1. Provide 10,000Ω Type II Thermistors sensing element. The system error (sensor and transmitter) shall not exceed ±0.5°F over the specified range.

B. Flexible Averaging Sensors:

1. Provide up to 25' continuous resistance element averaging sensor when sensing temperature in mixed air applications or where stratified conditions occur or when large quantities of air are being measured.

2. Also provide flexible averaging sensors when measuring temperatures downstream of a heating or cooling coil.

3. Position the sensor as close to the coil as possible to avoid any "hunting" of the valve and not too close in order to avoid any radiation. Install sensor in a crisscross pattern across the duct and provide temperature averaging over the entire length of the probe.

C. Rigid Averaging Sensors:

1. Provide sensors of the rigid averaging type downstream of air handlers and when duct size exceeds 12" in width. Probe length shall be equal or close to the duct width.

D. Single Point Sensors:

1. Single point sensors shall be allowed in branch duct. Single point sensors can also be used to measure return air temperatures.

E. General Space Temperature Sensors

1. Definition

a. General space temperature sensors/transmitters are defined as sensors connected to and used by air-terminal box controller to control a room temperature.

2. Requirements

a. Provide a 10K or 100KΩ thermistor type-sensing element with accuracy equal to or better than +/- 0.36°F at 77°F. Sensor to be factory calibrated and matched with specified controller.

b. Space (room) temperature sensors shall be occupant warm cool adjustable, with override button and no display unless otherwise indicated. Space temperature, humidity and CO2 sensor shall be readable and setpoints adjustable by the BAS system operator through devices connected to the DDC system panels and operator workstations

c. Provide the following additional features where indicated:

1) For LCD zone temperature sensors provide at a minimum four (4) color indicators (blue, red, amber and green) that will cast a glow onto the wall below the sensor to be used as visual indicator to the occupants of the condition of the system. The color and on/off state of the Status Light indicator shall be fully programmable.

a) Red LED shall be used to locally identify Economizer Fault Detection and Diagnostics (FDD) fault as required by Building Energy Efficiency Standards - Title 24.

2) Digital room temperature and set point display where required.

F. Specific Application Space Temperature Sensors

1. For special applications, procedure rooms and sensitive spaces and/or where humidity control is required, provide a space temperature sensor consisting of a 100Ω Platinum RTD with a TCR of 0.000385 Ω/Ω/°C. The temperature sensor and transmitter shall be matched and factory calibrated to eliminate sensor tolerance from system accuracy. The system error (sensor and transmitter) shall not exceed ±0.5°F over the specified range.

G. Fluid Temperature Sensors - Immersion Probes

1. Provide,10,000 OHM Type II Thermistor sensing element with temperature coefficient of 0.000385 Ω/Ω/°C. The system error (sensor and transmitter) shall not exceed ±1°F over the specified range.

2. Provide sensing element in temperature conductive compound in sealed moisture/waterproof stainless steel tube with a threaded fitting. Install in an appropriate matching stainless steel thermowell pressure rated and constructed in accordance with the system working pressure.

3. Fill the thermowell with a thermal-conducting compound. The sensor and the well shall be supplied as a complete assembly including wellhead Greenfield fitting. Mount the thermowell in an elbow of the pipe facing the direction of flow.

4. Sensors used in BTU or process calculations shall be matched and accurate to ±0.1°F over the process temperature range. Submit a manufacturer's calibration report indicating the calibration certification traceable to the National Bureau of Standards (NBS).

2.03 RELATIVE HUMIDITY SENSORS AND TRANSMITTERS:

A. Fast response relative humidity transmitters with the following features

1. Range: 0-100% RH and accuracy better than ± 3% and ± 1.7%.

2. Operating range of 23°F to 131°F.

3. Output signal 4 to 20 mA or 0-10V with screw terminals for wire connections.

4. Two point field calibration of transmitter.

5. Filter for sensor protection.

B. General

1. When sensing mediums below the ambient dew point, provide a suitable case insulator to prevent internal condensation and moisture on the sensor and transmitter.

2. Provide an NIST traceable calibration certificate with each sensor/transmitter where required.

C. Acceptable Manufacturers

1. Vaisala Veris Dwyer ACI JCI

2.04 OUTSIDE AIR SENSORS (IF REQUIRED)

A. General:

1. Sensors shall be mounted on the roof in an appropriate housing designed to withstand the environmental conditions to which they will be exposed.

2. The sensors shall be located so they shall not be affected by exhaust air, solar effect (except for solar compensator) or cooling tower air circulation. The sensors shall be located where they can be serviced without the need of a ladder or lift equipment.

3. For Outside Air Temperature, provide a Dwyer TE-RND-B outside air temperature sensor with sun shield.

4. For Outside Air Temperature and Humidity, provide a Dwyer RHP-3R3B combo outside air temperature sensor and humidity sensor with sun shield.

2.05 AIR QUALITY MEASUREMENTS

A. Duct Mounted CO_2 Sensors and Transmitters:

1. Provide a self-compensating, return air duct mounted CO_2 transmitter with an industry standard, 4-20 ma output signal. Measurement range shall be 0 to 2000 ppm with an Accuracy (including repeatability, non-linearity and calibration uncertainty) ± (2 % of range + 2% of reading). Long-term stability <±5 % of range /5 years and a Response time (63%) of 1 minute.

2. Locate the sensors to be as shown on the drawings.

3. Transmitter shall be by Vaisala , Veris, Dwyer, Setra or ACI, JCI

B. Wall mounted CO_2 Sensors and Transmitters

1. CO2 sensor shall have an accuracy of +/- 30 ppm over the range of 0–2000 ppm or better.

2. CO2 sensor shall utilize Automatic Baseline Correction to maintain sensor calibration without the need for manual calibration.

C. CO Sensors and Transmitters

1. Sensor shall utilize state of the art enhanced MOS sensor technology microprocessor controlled and compensated for temperature and humidity. Unit shall not require field calibration. The sensor shall output a 4 –20mA and can be mounted up to 5,000 ft from the BAS panel. Additional RS 485 interface shall be provided for optional direct connection to a BAS.

2. The monitor unit shall have discrete LEDs to indicate Warning, Alarm and Sensor status. Auxiliary relays shall also be provided for remote indication

3. Transmitter shall be by MSA model TGM or equal

D. Refrigerant Monitoring:

1. The Refrigerant Monitor shall The Chillgard RT Monitor utilizes stable and selective photoacoustic infrared (IR) technology to sense refrigerant gases at levels as low as 1 part-per million and can be configured to monitor from up to eight remote areas. The Refrigerant Monitor shall be capable of being configured to detect a specific refrigerant or a group of refrigerants.

2. The analyzer shall be capable of monitoring over a range of 0-1000 ppm with a sensitivity of 1 ppm in the 0-100 ppm range and +10% of reading in the 100-1000 ppm range.

3. Three separate alarm set point levels shall be provided. The set points shall be independently adjustable for any value for a given range. The set points shall provide drive signals to user interface relays. The alarm set points shall have the capability of providing the user a selection of latching or non-latching.

4. The system shall be capable of supplying a 4-20 mA isolated sourcing signal and 0-10 VDC, signal representing the gas concentration being sampled.

5. Refrigerant Monitor shall be Chillguard RT by MSA or equal.

2.06 WATER FLOW MEASUREMENTS

A. General

1. Install flow sensor as shown on the P&ID and locate in pipe runs in accordance with manufacturer instructions and specifications for length of straight pipe runs required before and after the device to ensure accuracy.

2. Provide an integral Stainless Steel Three-Valve manifold for isolation of transmitter without depressurizing the lines.

3. Sensor and transmitter (specified hereunder) shall be sent to a certified laboratory for an NIST traceable calibration in order to achieve better than +/- 0.5% measurement accuracy. Provide and submit all flow calibration reports.

B. Magnetic Flow Meter – Chilled, Domestic and Hot water

1. Provide a magnetic flow meter with and accuracy up to ±0.15% of volumetric flow rate accuracy over 13:1 flow turndowns, ±0.25% over 40:1 flow turndown.

2. The magnetic Flow Meter shall be Rosemont , Onicon or equal.

3. If meter is installed higher than 4' AFF, a remote display must be provided.

C. Differential Pressure Flow Meter:

1. Where straight pipe required for Magnetic Flow Meter cannot be provided, provide a differential pressure type flow meter. Construction material shall be 316 Stainless steel with flanged end fittings.

2.07 STEAM MEASUREMENTS

A. Vortex Shedding Meter

1. Provide Rosemont or equal Vortex Shedding flow meter with integral temperature sensor and reducer (if needed). Sensor accuracy shall be 1.35% of rate

2. Wetted material shall be 316 SS. Transmitter shall be remote mounted or integral mounted (depending on accessibility) on flow tube with integral configuration/display module. Transmitter shall be capable of 4-20mA and HART Protocol.

3. Mount the meter horizontally. Avoid mounting transducers downstream of modulating valves or butterfly valves. Upstream Straight Run should be 20 Diameters upstream, and 10 diameters downstream. Straight runs can be reduced with filed adjustments.

4. Model number: 8800D-R-060-S-A3-N-1-D-1-MTA-M5-RXX-Q4. Consult factory to confirm sizing for specific flow conditions.

2.08 HYDRAULIC PRESSURE AND DIFFERENTIAL PRESSURE TRANSMITTERS:

A. Provide standard 4-20mA output. Incorporate a temperature measurement to compensate for thermal effects and provide transient protection. Accuracy shall be +/- 0.075% of span or better.

B. Provide transmitter with a LCD display and failure mode alarm capabilities.

C. Wetted parts of the sensor and electronic housing shall be 316L stainless steel.

D. Differential Pressure Transmitter shall be Rosemount model 3051CD with LCD display and integral mount 3-valve manifold. Pressure Transmitters shall be Rosemount , Veris, Setra, ACI or equal.

2.09 WATER FLOW AND LEVEL SENSORS AND SWITCHES

A. Water Flow Switches:

1. Provide differential pressure type flow switch with adjustable sensitivity and setpoint. When a differential pressure is exerted upon the sensing elements a

single pole, double throw (form "C" contact) will be operated. Switch shall be PENN model P74 for 150 psig system and “Mercoid” DP series for 300 psig systems or equal.

B. Liquid Level Switches:

1. Provide 2-position level switches where required or shown. Floating mercury switch type, completely sealed against moisture and corrosion. Mount where accessible for maintenance and inspection. Switch contact “make” and “break” set point shall be adjustable. Switch shall be Weil 8230 Series or equal.

C. Liquid Level Sensors and Transmitters

1. Kele or equal. Type depends on application.

2.010 AIR PRESSURE SENSORS AND SWITCHES

A. Differential Pressure Switches

1. Pressure switches shall have a repetitive accuracy of ±1% of their operating range and shall withstand up to 150% of rated pressure. Sensors shall be diaphragm or Bourbon tube. Actuation shall be adjustable over the operating pressure range.

2. The switch output shall be a SPDT snap switch rated for the application. Provide the switch complete with mounting brackets sensing tips and electrical screw type connections.

3. High and low differential pressure cut off switches shall be of the manual reset type for equipment or personnel protection. Switch to be UL Listed.

B. Differential Pressure Transmitter

1. Sensor shall have no moving parts and shall include NIST standards certification. Provide a standard 4-20mA analog output signal with an accuracy of +/- 0.25% of full span. Connections shall be barbed fittings for tubing and screw type for electrical connections.

2. Differential pressure transmitters for duct static pressure shall have a range of 0”-2.5” w.g. For differential pressure across pre-filters the transmitter shall have a range of 0”-1” for final filters, a range of 0”-2.5” w.g. maximum or as scheduled on the drawings.

3. Manufacturer and Model Number: Setra with LCD Display or equal.

C. Shielded Room, Plenum and Space Static Pressure Probes (SAP)

1. Provide for each room or space, a shielded static pressure probe suitable for surface mount (SAP/1), recessed flush (SAP/3) or suspended (SAP/2) mounting, complete with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, and 1/8" FPT (3/4" FPT (for S.A.P./2)) takeoff fitting, all contained in an aluminum (316 stainless steel) casing, with brushed finish on exposed surfaces.

2. The probes shall be capable of sensing the static pressure in the proximity of the sensor to within 1% of the actual pressure value while being subjected to a maximum airflow of 1000 FPM from a radial source.

3. The shielded room or space static pressure sensors shall be the SAP/1/2/3 shielded static air probes as manufactured by Air Monitor Corporation or equal.

4. The shielded plenum static pressure sensors shall be the SAP/3 shielded static air probes as manufactured by Air Monitor Corporation or equal.

5. For room sensing the range shall be bidirectional ± .1 or .25” w.g. (Setra 2641-0R1WB or Dwyer 607-0B) or equal.

D. Static Outside Air Probe (SOAP)

1. Provide for the room or space static pressure indicating or controlling systems an outdoor static pressure sensor constructed of 10 gage Type 316 stainless steel with a 2" diameter FPT connection.

2. The outdoor air probe shall be capable of sensing the outside atmospheric air pressure to within 2% of the actual value when subjected to radial wind velocities up to 40 miles per hour with approach angles up to 30º to the horizontal.

3. The static outside air probe shall be the SOAP as manufactured by Air Monitor Corporation or equal.

E. General Requirements for Pressure Switches and Transmitters

1. Select sensor with appropriate range for the application so that normal operation will occur at mid range of the sensor span.

2. Duct sensing pressure applications where the velocity exceeds 1500 fpm shall utilize a static pressure traverse probe.

3. Mount Pressure Switches and Transmitters outside of the Air Handler Enclosure. High and Low static pressure switches shall be installed in a lockable and labeled enclosure.

2.011 AIRFLOW MEASURING STATIONS

A. General

1. Application: For pressurization control using the fan tracking method, for air flow measurements and minimum outside air measurement and control.

2. The Air Flow Measuring Station shall consist of an airflow measuring sensor(s) and matched transmitter.

3. Fan Air Flow Measuring Stations shall be out of the air stream type (piezo ring) provided and installed by the Air Handler manufacturer. The Transmitters shall be calibrated and programmed by the Air Handler manufacturer.

4. The manufacturer shall produce and submit a report containing all formulas, values and calibration data for verification and record.

5. For duct mounted and for OA measurements when air velocities less than 400 fpm are anticipated, a thermal dispersion type flow meter shall be provided.

B. Air Flow Traverse Probe Stations

1. Airflow traverse probes shall be of the insertion type, capable of continuously measuring air volume in the duct served.

2. Each airflow traverse probe mounted within the station shall contain multiple total and static pressure sensors located along its exterior surface, and internally connected to their respective averaging manifolds.

3. The flow sensors shall not protrude beyond the surface of the probe(s), and shall be the offset (Fechheimer) type for static pressure and the chamfered impact type for total pressure measurement. The airflow station's measured accuracy shall not be affected by directional flow having yaw and/or pitch angles up to 30º.

4. Stations shall be AMCA certified and be capable of measuring the airflow rates within an accuracy of ±2% without the use of correction factors over a velocity range of 400 to 4000 FPM. (For velocities less than 400 fpm use the Thermal Dispersion type)

5. Airflow measuring station shall be Air Monitor “VOLU-probe/VS” or FAN-E for locations with limited straight duct runs.

6. Installation: For duct mounting follow the manufacturer installation instructions for location and quantity of required sensors. For outdoor installations provide the transmitter in a NEMA 4 enclosure

7. The transmitter shall be: Air Monitor Corporation or Ebtron or JCI. The transmitter shall have and accuracy of 0.25% of natural span including non-linearity, hysteresis and repeatability. The transmitter shall be provided with an automatic zeroing circuit.

C. Thermal Dispersion Type

1. Sensors: Sensors shall use thermal dispersion technology with two “bead in glass,” hermetically sealed thermistor probes at each measurement point. The system shall be factory calibrated to NIST traceable standards and not require calibration or adjustment over the life of the equipment. Each sensor probe shall be provided with a UL plenum rated cable with terminal connectors and gold plated contacts.

2. Transmitter: The transmitter shall be microprocessor based and capable of processing up to 16 independent sensing points per location. The transmitter shall have 16-character alphanumeric display for airflow and diagnostics. The output shall be 0-10VDC or 4-20 mA selectable. The transmitter shall be capable of indicating individual sensor airflow and ignore any malfunctioning sensors.

3. Installation: For duct mounting follow the manufacturer installation instructions for location and quantity of required sensors. For outdoor installations provide the transmitter in a NEMA 4 enclosure.

4. Airflow measuring station and transmitter shall be Ebtron Gold series model GTA116-PC or JCI equal.

2.012 ELECTRICAL POWER SWITCHES AND SENSORS

A. Current Switches

1. For 1/5 to 30 HP motors, provide self powered precision solid-state switches; UL listed with direct input to the BAS for general status and proof-of-performance monitoring. Provide switch with adjustable set point, “Trip” and “Power” LED indicators. Provide screw type terminations. Switch to by Veris Industries model H-608 (Split Core).

2. For 35 HP and above, provide self powered precision solid-state switches; UL listed with direct input to the BAS for general status and proof-of-performance monitoring. Provide switch with adjustable set point, “Trip” and “Power” LED indicators. Provide screw type terminations. Switch to by Veris Industries model H-908 (Split Core).

3. For use with Variable Frequency Drives, use Neilsen-Kuljian, Inc., SENTRY 250 series or equal. The switch shall be split core, with adjustable set point, and a frequency operating range of 6 to 100Hz and LED indication.

4. For fractional horsepower 120 V motors, use” Veris” Industries model Hawkeye 500 series. Provide Switch with adjustable set point (if amp draw is 0.5 and above), HOA switch, relay power LED and sensor calibration LED (if amp draw is 0.5 and above).

B. Current Transducers:

1. Provide a UL listed current transducer with a 4-20mA linear output proportional to the current being measured with an accuracy of $\pm$ 0.5% or better. Transducer will have reverse polarity protection. Transducer shall be Kele model 4CMA or equal. For currents above 20 Amps, use model SA series – Split core.

2.013 CONTROL DEVICES

A. Control Relays

1. Relays used for interposing or isolation duty shall be of the plug-in environmentally sealed three poles, double throw (3PDT) type with indicator light. Provide one relay type for interchangeability site wide.

2. The relay coil operating voltage shall be that required for the intended duty up to and including 240 V AC and 110V DC at 2 VA. Contact shall be UL rated for 10 amps. Relay shall be Potter & Brumfield Model KUP-14*3 or equal.

3. Suitable plug-in socket shall be of the 11-tab insertion type suitable for 10-amp service. Socket assembly shall have barriered screw terminals and mounting holes.

4. Socket shall have edge tabs for use with a track mounting system. Relays shall be mounted using a track mounting system. Socket shall be Potter & Brumfield Model 27E121 or equal.

B. Timing Relays

1. Time delay relays shall be UL listed, plug-in environmentally sealed with base. The relay coil and timer circuit voltage shall be that required for the intended duty.

2. Time delays both on energizing and/or de-energizing shall be adjustable and required. Furnish each timing relay with LCD status indicator.

3. For delay break types, indicator shall be off after time out, flashing while timing, and on when output is energized. Timing relays shall be function programmable by pin jumper selections assuming voltages are compatible. Furnish compatible plug-in socket as specified for control relays above.

4. Timing relays shall be OMROM Tateisi Electronics Company solid state timer Model H3CA or equal.

C. Pilot Lights:

1. Provide where required by Sequence of Operation for indication light emitting diodes (LED's). Red, green, blue and yellow LED's shall be used where pilot indicators are required.

2. Assemblies shall be complete to mount in 5/16" diameter holds with locking speed nut. Extended leads as required and external limiting resistor for 120V AC operation. External resistor shall be factory furnished, integrally fastened and secured to wire lead.

D. Potentiometers

1. Provide panel mounted carbon core or plastic film type potentiometers with 4-20mA transmitters where shown or required for manual override control. Wire wound types shall be unacceptable.

2. Product: Allen Bradley 800T or equal.

E. Power Supply:

1. Provide where shown or required DC power supplied with isolated outputs, fold back current limiting and precision regulations. Power supply shall be sized for 200% of the connected load.

F. Air Solenoid (E.P. Valves):

1. Solenoid air valves shall be 2-position electric to pneumatic devices capable of feeding a pneumatic signal through a common port from either a normally closed or normally open port. Select coil voltage as appropriate.

2. Provide Landis & Gyr Model EP265 or an approved equal where capacities are less than 0.3 CFM at 1-psi pressure drop. Provide ASCO Model 8320 for higher flow rates.

2.014 AUTOMATIC CONTROL VALVES

A. General

1. Control valves shall be selected and sized by the BAS manufacturer based on the requirements of this section and the Authority method as described in ASHRAE Handbook (Fundamentals, HVAC Applications and HVAC Systems and Equipment).

2. The valves shall comply with specification section 255500 and 255520 and design drawings for rating and construction.

3. Close-off (Differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following close off pressure requirements:

   a. Two-Way Water Valves: 150% of total system (pump) head at the valve location.

   b. Three-Way Water Valves: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.

   c. Steam Valves: 150% of operating (inlet) pressure.

4. Valve body rating shall be equal to the system rating as specified in Division 15.

5. Select control valves for branch design flow and location on hydronic distribution network. Valves shall be selected, when at design flow, to provide pressure drop of at least 25% of the branch circuit from supply line to the return line. Select valves to be within their range of controllability for each circuit. Valves nearer to pumps on direct return systems will be smaller than line size and provide more system dynamic pressure drop than valves far from the pumps. Obtain campus distribution flow model from the University to confirm system differential pressure available at the building. Submit selected valves in a schedule showing actuator and C_V rating, as well as flow rate, pressure drop, duty, accessories and part numbers for approval.

6. Control valves and actuators shall be covered by a 5-year manufacturer warranty.

B. Quality Assurance

1. Belimo shall manufacture valves and actuators unless a required valve is not available from Belimo. Danfoss valves and actuators are accepted as or equal to Belimo

2. Reheat zone valves shall be “Belimo” Stainless Steel Ball Valves.

3. Air handler coil valves shall be “Belimo” Stainless Steel Ball Valves.

4. Bypass valves shall be “Belimo” electronic globe valves with linear characteristics.

5. Isolation valves shall be “Belimo” electronic butterfly or ball valves 2” to 14” with Belimo or MAR actuators

C. Cooling and heating coil control shall be fully proportioning throttling type with modulating plugs or characterization discs for equal percentage flow characteristics.

D. Cooling coil control valves shall be spring return open “NO” and heating coil control valves shall be spring return closed “NC”. Other applications shall be as scheduled.

E. Isolation Valves: ON/OFF, two position control valves shall be line size “Butterfly” or ball type.

F. Modulating valves (other than heating or cooling coil flow control control) shall be “Globe” or ball type with linear characteristics.

G. Globe Valves

1. Valves ½" through 1" shall be constructed with a brass body and screwed ends. Trim (seat, stem and plug) shall consist of a removable cage providing valve plug guiding throughout entire travel range. A stainless steel trim shall be provided. Operator, stem and plug assembly shall be removable for servicing.

2. Valves 1-1/2" through 2" shall be constructed with a brass body and screwed ends. For special duty, valves may be selected to have bronze or cast iron bodies with screwed or flanged ends. A stainless steel trim (seat, stem and plug) shall be provided.

3. Valves 2-1/2" and above shall be constructed with a cast iron body and have flanged connections. A stainless steel trim (seat, stem and plug) shall be provided.

H. Electronic characterized control valves

1. Electronic characterized control valves shall have a TEFZEL flow characterization disk installed at the inlet of the valve. The valve trim, shall utilize a stainless steel ball and stem. Valve body shall be chrome plated forged brass with female NPT threads. Bodies to 1-1/4” shall be rated at 600 PSI and from 1-1/2’ to 3” at 400 PSI.

2. The valves shall have a self –aligning blowout proof stem with dual EPDM O-rings packing design. Fiberglass reinforced Teflon seats shall be used. The valve shall have a four bolt mounting flange to provide a four position, field changeable electronic actuator mounting arrangement.

3. A non metallic coupling, constructed of high temperature, continual use material shall provide a direct, mechanical connection between the valve body and the actuator. The coupling shall be designed to provide thermal isolation and eliminate lateral and rotational stem forces. Vent hole shall be provided to reduce condensation build-up.

I. Butterfly valves shall have a cast iron lug body, 304 stainless steel disk, 416 stainless steel shaft, EPDM O-ring, and RPTFE bushings.

J. Automatic Control Valve Actuators - Belimo

1. The actuator manufacturer shall have ISO 90001 certification and the actuator shall be UL listed under standard 873.

2. The actuator shall have NEMA type 2 housing and shall be applied in accordance with the manufacturer instructions.

3. Electric actuators shall consist of a high torque, reversible electric motor coupled through a permanently lubricated reduction gearbox directly to a valve stem coupling. The valve actuator shall provide the maximum torque required for valve close off for the required application

4. Provide adjustable end of travel switches; one for "OPEN" and one for "CLOSED" which will stop the motor at set valve stem positions.

5. The actuator shall be modulating with spring return, or two position with spring return as called out in this section, sequence of operation and/or point list.

6. Cooling coil control valves shall be provided with spring return open “NO” actuators and heating coil control valves shall be provided with spring return closed “NC” actuators. Other applications shall be as scheduled.

7. Upon loss of power or signal the actuator shall close or open under the power of the spring.

8. Provide a manual de-clutching override to allow manual valve operation without electric power.

9. Provide integral end (auxiliary) switches to indicate the required position of the valve where required. End (auxiliary) switches shall be “Form C” contacts, enclosed in a watertight housing. If integral ends switches are not available, provide switches as an “add-on” accessory.

10. All modulating valves shall have a positive feedback signal corresponding to the actual valve position, which can be wired back to the control system.

11. Each actuator shall have current limiting circuitry or microprocessor overload protection incorporated in its design to prevent damage to the actuator.

12. Provide a visual position indicator and an attached 3’ cable for easy installation to a junction box.

K. Pressure Gauge Fittings:

1. Provide test gauge ports suitable for the attachment of Schrader fittings. The ports shall be mounted in line together on the back plane of control panel and labeled as to source.

2. Gauges required by BAS contractor shall be installed only at a test gauge port location by removing the Schrader fitting and installing the gauge. Provide one high accuracy test gauge with 5’ of flexible connection tube and connector per control pane to be left in the panels for operator use.

2.015 DAMPER ACTUATORS

A. Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association C22.2 No. 24 certified as meeting correct safety requirements and recognized industry standards and shall be approved for installations in air plenums.

B. Electronic damper actuators for dampers that are part of a smoke evacuation/pressurization scheme must comply with the requirements of UBC 905.14 “Response Time.”

C. Where smoke control dampers do double duty, i.e. are used for controlling floor static pressures with modulating actuators, provide UL listed actuator with spring return complying with the requirements of UBC 905.14 “Response Time.”

D. Additional Requirements

1. The actuator shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp shall be of a "V" bolt design with associated "V" shaped, toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a "V" clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or setscrew type fasteners are not acceptable.

2. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.

3. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe are not acceptable.

4. All spring return actuators shall be capable of both clockwise and counterclockwise spring return operation by simple changing the mounting orientation.

5. Proportional actuators shall accept a 0-10 VDC or 0-20 mA control signal and provide a 2-10 VDC or 4-20 mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable.

6. All 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 watts for DC applications. Actuators operating on 120 VAC power shall not require more than 10 VA. Actuators operating on 230 VAC power shall not require more than 11 VA.

7. All proportional actuators shall have an external, built-in switch to allow the reversing of direction of rotation.

8. Actuators shall be provided with a conduit fitting and a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of operating the actuator housing to make electrical connections.

9. Actuators shall be design for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 5-year manufacturer's warranty, starting from the date on installation. The manufacturer shall be ISO9001 certified.

10. Electronic damper actuators shall be as manufactured by Belimo or JCI.

2.016 ENCLOSURES

A. Enclosures shall be rated and comply with the standards of The National Electrical Manufacturers Association (NEMA) as specified herein:

1. NEMA 1 – General Indoor Location

2. NEMA 3 - Outdoor

3. NEMA 4 – Wet locations (Central Plant, pump rooms…)

4. NEMA 12 – Plenums

2.017 TSI PRESSURE MONITOR & SENSOR

A. The room pressure monitor system shall be completely independent for each individual patient room. The room pressure monitor system shall not depend on measurements from other patient room monitor systems.

B. The room pressure monitor system shall measure the pressure differential between the patient room and reference space. The room pressure sensor shall have a resolution of 5% of the measured value and shall detect any change in the room pressure within 0.1 second, with a minimum reading of 0.00001 inches H2O.

C. The room pressure monitor system shall accept one to three pressure sensor input. The primary sensor shall measure the pressure differential between the patient room and corridor.

D. Each monitor shall have a full color touch screen interface with a minimum touchscreen size of 4.3 inches. Screen shall be capable of displaying multiple colors at one time. The monitor shall be capable of displaying room mode, alarm status, user-configurable room label and all measurements connected on a single screen without scrolling. Displays that change the backlighting color or external LEDs to indicate alarm status are not acceptable. Monitors that use keypads are not acceptable.

E. Local audible and visual alarms and relay contacts shall be enabled whenever either measured room pressure differential falls below its user configurable low alarm set point or rises above its user configurable high alarm set point, after a configurable delay. The pressure sensor shall have individual alarm set points for high and low alarms. A mute function shall temporarily silence the audible alarm for a user configured delay. Manual or automatic reset of the alarms shall be configurable.

F. The room pressure monitor will use the flow station to calculate the Air Changes per Hour ventilation rate for the patient room. Local audible and visual alarms shall be enabled whenever the measured air volume falls below its configurable low alarm set point, after a configurable delay. Supply and exhaust flows shall have individual alarm set points. The audible alarm shall have a mute function to temporarily silence the alarm for a user-configured delay. Manual or automatic reset of the alarms shall be configurable.

G. The room pressure monitor system shall have Positive Mode, Negative Mode and No Isolation Mode. Users can change room mode either with an input from a keyswitch or through the touchscreen without accessing the full menu system. The keyswitch or touchscreen shall change the room mode from Positive Mode or Negative Mode to No

Isolation Mode (and back), allowing the room to be used for standard patient care. In No Isolation Mode, the room pressure monitor will disable all alarms.

H. Calibration of room pressure differential and air flow shall be done electronically through the use of the integral keypad. Calibration shall consist of adjusting the sensor zero point and sensor span to match a reference measurement. Password protection of the calibration items shall limit unauthorized access. Neither remote calibration nor calibrating through the use of potentiometers is acceptable.

I. The room pressure monitor shall have the ability to communicate with a building automation system (BMS) via Modbus, BACnet® MS/TP communication protocols.

J. The room pressure sensor shall be bi-directional with an accuracy of 10% of reading. The sensor shall be capable of being mounted in the corridor (reference space) or the patient room (controlled space). The room pressure sensor shall use two in-line ceramic coated RTDs to measure the pressure differential. The room pressure sensor shall be temperature compensated over a range of 55°F to 95°F. Sensors employing a thermistor-based sensor or that cannot differentiate between positive and negative pressures are not allowed. Field-calibration of the sensor shall be performed through the touchscreen on the room pressure controller.

K. Acceptable manufactures: TSI, JCI

2.018 INCIDENTAL WORK

A. The BAS installer shall inspect the installation of the following equipment and devices provided under other sections.

1. Work included as part of Sections Sections 230523 and 232113:

a. Installation of automatic valves, separable wells specified to be supplied by the BAS manufacturer.

b. All necessary pressure taps, drain and overflow connections, piping, tubing and valves related to BAS instrumentation and devices.

2. Work included as part of Sections 233300 and 233400:

a. Furnish and install all automatic dampers and provide necessary blank off plates or transitions required for dampers that are smaller than duct size.

b. Assemble multiple section dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.

c. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation and fix seal permanently in place only after stratification problems have been eliminated.

d. Provide access doors or other approved means of access through ducts for service to equipment.

B. Air Handler Devices: Installation of control devices associated with air handlers including but not limited to damper actuators, temperature and pressure sensors shall be provided for mounting at the air handler unit factory where applicable. All cost associated with shipping the devices furnished under this section, to the air handler unit manufacturer shall be borne by the BAS contractor.

C. Interface with Chiller Controls

1. Refrigeration chillers are furnished with integral translator panels for direct interface with BAS.

2. Chiller Start/Stop, Status, Temperature reset and demand-limiting functions shall be accomplished using hardwired points directly from the BAS to the chiller interface control panel. All other functions shall be via the data link (BACnet). Coordinate with chiller manufacturer all the hardware and software requirements for a complete interface as specified.

2.019 INSPECTION OF CONDITIONS

A. Examine all related work and surfaces before starting work of this Section. Report to the Architect, in writing, conditions which will prevent proper installation of this work. Beginning of work of this section without reporting unsuitable conditions to the Architect constitutes acceptance of conditions. Perform any required removal, repair or replacement of this work caused by unsuitable conditions at no cost to the Owner.

END OF SECTION 255530

SECTION 255500
GENERAL PROVISIONS FOR BUILDING AUTOMATION SYSYTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work included in this Section:

1. The Building Automation System (BAS) manufacturer shall provide the Building Automation System as specified herein in its entirety.

2. The Building Automation System Contractor shall provide the systems covered by this section and have full responsibility for the entire BAS including complete and seamless integration into the UC Davis Medical Center's Johnson Controls, JCI, application data servers over the campus network.

3. It is the intent of this specification for the BAS to be installed as a complete package by the Building Automation System Contractor. The system shall include all necessary and required software and hardware including but not limited to operator interfaces, input/output devices and sensors, controllers, communication equipment and IT infrastructure. Installation, supervision and project management are included as well.

4. The backbone BAS IT infrastructure consisting of CAT6A, patch panels, core switches, switches and media converters will be provided and installed by the University. Devices required to connect to the owner's network will be provided by the BAS contractor. Local switches in each room/panel shall be DIN-rail mountable type.

5. The BAS is a building wide system that incorporates other sub systems, such as HVAC systems direct digital control, DDC, building lighting control interface, energy metering, and packaged equipment controller interface as indicated

6. Control systems using wireless technology and / or cloud base data gathering are not acceptable.

7. All BAS control setpoints shall be accessible by campus JCI servers.

8. Control sequences of operation shall be as shown in Drawings or as noted herein. Drawings of systems are diagrammatic only and any apparatus not shown, such as relays, transformers, accessories, etc., but required to make system operative to complete satisfaction of University's Representative, shall be provided at no increase in contract sum.

B. Major Items of Work

1. Section 25 55 00 – General Provisions for Building Automation System

2. Section 25 55 20 – Direct Digital Control System and User Interface

3. Section 25 55 30 – Electronic Sensors, Devices and Field Hardware

C. Related Documents:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions, applicable portions of Division 1, Division 22, 23 and 26 – Basic Materials and Methods, apply to this Section.

2. Refer to Division-26 sections for power wiring to line-voltage devices and for low voltage wiring and communication wiring to such applicable devices

3. Provide BAS connections to packaged controllers for equipment under Divisions 22 and 23

4. Lighting control integration for new buildings and additions: The BAS scope of work shall include all labor to interface with the Automatic Lighting Controls System provided in Division 26. Refer to Division 26 for complete description of requirements for the Automatic Lighting Control System which shall include hardware gateways BACnetIP or MSTP to communicate to the BAS.

    a. Lighting-control contractor shall provide naming matrix, connecting BACnet information/nomenclature to lighting-zone information

5. The BAS scope of work shall include monitoring of other systems and equipment where indicated in the contract documents

1.02 QUALITY ASSURANCE

A. Manufacturer Qualifications: Building Automation System shall be as manufactured by Johnson Controls and shall carry UL 864 Listing, UUKL classification for smoke control if smoke control is specified.

B. Electrical Standards: Provide electrical products which have been tested, listed, and labeled by Underwriters Laboratories (U.L.) and comply with NEMA standards.

C. Installing Contractor Qualifications:

1. Bids by wholesalers, franchised dealers or any firm whose principal business is not that of manufacturing, developing and installing Building Automation Systems is not acceptable. Bidder must be factory authorized with the product they are proposing.

2. Firms specializing and experienced in control system installations for not less than 10 years. Firms with experience in DDC installation projects with point counts equal to this project and systems of the same character as this project.

3. The Building Automation System contractor must demonstrate that, from the local office that will service the UC Davis Medical Center campus, a one (1) hour emergency response requirement can logistically be provided. The bidder must, in the judgment of the University's Representative, be able to generally provide one (1) hour emergency response. That is, to have appropriately equipped and trained personnel on-site within one (1) hour to rectify any potential emergency situation

4. Installing firms submitting as an “approved equal” to JCI Metasys must get pre-approved prior to bid and gain owners acceptance on the following functionality per the Div01 substitution requirement, prior to project bid:

a. Installing firm must demonstrate that all BACnet objects are readable from the existing JCI Metasys Building Automation System. Readable BACnet objects include but not limited to all binary inputs, binary values, binary outputs, analog inputs, analog values, analog outputs, point descriptions, multi-state inputs, multi-state values, multi-state outputs, schedules, trendlogs and alarms.

b. Installing firm must demonstrate that all BACnet objects are writable from the existing JCI Building Automation System. Writable BACnet objects include but not limited to all binary values, binary outputs, analog values, analog outputs, point descriptions, multi-state values, multi-state outputs, schedules, trendlogs and alarms.

c. Installing firm must demonstrate program loaded into any application specific or general-purpose controller must be viewable to the existing Integrated Development Environment (IDE). Firm to demonstrate the ability to upload, edit, save and download programming through the existing JCI system.

d. Installing firm must demonstrate that the existing software toolset at the UCDMC servers can make changes to the new application specific controllers. New software will not be allowed.

5. For each point listed above demonstrate that a change in value at the building can be seen by the JCI servers. This change in value must be seen within 30 seconds of value change. There is no exception for this specification requirement. No subsequent BAS submittal packages will be reviewed or accepted until the demonstration is satisfactorily completed with Unive`rsity consent.

6. The Building Automation System contractor must have been, for five (5) years preceding the bid opening, a factory branch office, or a factory authorized dealer for the product manufacturer type identified in subsection 2.01, A., under PART 2 – PRODUCTS, of this section. Factory authorized dealer means:

   a. Installing Contractor has a contract directly with the factory. A contract with a distributor is not acceptable.

   b. Installing Contractor has direct access to factory technical support and training

   c. Installing contractor develops controller hardware and software

7. Any cost impact to the project as a result of the approval process will be the sole responsibility of the installing firm seeking approval. In the event approval is not received installing firm is responsible for any additional costs incurred if an alternate firm is requested to submit.

8. The Building Automation Control System contractor must have in its employ, at the local office that will service the U.C. Davis Medical Center campus, at least five (5) full time control technicians. At a minimum, one (1) technician must be senior (at least 5 years experience installing products of the manufacturer type identified in subsection 2.01, A., under PART 2 – PRODUCTS, of this section); two (2) technicians must be mid-level (at least three (3) years experience installing products of the manufacturer type identified in subsection 2.01, A.,

under PART 2 – PRODUCTS, of this section); and two (2) can be junior level technicians (at least one (1) year experience installing products of the manufacturer type identified in subsection 2.01, A., under PART 2 – PRODUCTS, of this section).

D. Installer's Experience with Proposed Product Line:

1. Firms shall have specialized in and be experienced with the installation of the proposed product line, Metasys for not less than ten years from date of completion on at least three projects of similar size and complexity.

E. Installer's Field Coordinator and Sequence Programmer Qualifications:

1. Individual(s) shall specialize in and be experienced with control system installation for not less than 5 years. Proposed field coordinator shall have experience with the installation of the proposed product line for not less than three projects of similar size and complexity. Installer shall submit the names of the proposed individual and at least one alternate for each duty. Submittals shall document this experience with references. The proposed individuals must show proof of the following training:

a. Product Line Training: Individuals overseeing the installation and configuration of the proposed product line must provide evidence of the most advanced training offered by the Manufacturer on that product line for installation and configuration

b. Programming Training: Individuals involved with programming the site-specific sequences shall provide evidence of the most advanced programming training offered by the vendor of the programming application offered by the Manufacturer.

c. BACnet Training: The BACnet BAS shall be furnished, engineered and installed by individuals who have completed the BACnet Network Design, Installation and Maintenance Training Program. Certifications shall be provided.

F. Installer's Service Qualifications:

1. The installer must be experienced in control system operation, maintenance and service. Installer must document a minimum 5 year history of servicing installations of similar [size] and complexity. Installer must also document at least a one year history of servicing the proposed product line.

G. Installer's Response Time and Proximity

1. Installer must maintain a fully capable service facility within a 45 mile radius of the project site. Service facility shall manage the emergency service dispatches and maintain the inventory of spare parts.

1.03 STANDARDS AND CERTIFICATIONS

A. Sections 25 55 00 to 25 55 60 shall be provided and installed by the same Subcontractor.

B. The entire Building Automation System shall be:

1. Approved and listed by Underwriters Laboratories, Inc. (UL).

2. Listed by State Fire Marshall as an approved Smoke Management System if smoke control is specified.

3. Approved by California Energy Commission as an approved Control and Energy Management System in compliance with California Energy Conservation Code Title 24 requirements.

4. Approved and Listed by the California Energy Commission as an Economizer Fault Detection and Diagnostic (FDD) System.

C. Listings, Codes and Standards compliance shall include, but not be limited to, the following:

1. Underwriters Laboratories (UL)

   a. Building Automation System (UL 864 UDTZ).

   b. Process Management System (UL 864 QUAX).

   c. Smoke Control Systems Equipment (UL 864 UUKL).

   d. Energy Management Equipment (UL 916 PAZX).

2. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

3. National Fire Protection Association (NFPA)

   a. NFPA 90A

   b. NFPA 70 (NEC)

   c. NFPA 92A & 92B

4. National Electrical Manufacturers Association (NEMA)

   a. NEMA 250 Enclosure for Electrical Equipment

   b. NEMA ICS 1: General Standards for Industrial Controls

5. Electronics Industry Alliance (EIA)

6. Institute of Electrical and Electronics Engineers (IEEE): IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems

7. FCC Part 15, Sub-Part B, Class A

8. CE Electromagnetic Compatibility

9. Be registered as meeting appropriate radiated and conducted interference levels from a Class “A” computing device.

D. Equipment and devices employed in the system shall bear the appropriate UL listing mark to ensure compliance.

E. The Drawings and specifications are complementary to one another – meaning that what is called for on one is to be considered called for in both. Where conflicts exist between the specification sections or between the specifications and the drawings, the more stringent requirements shall apply.

F. Where two or more codes conflict, the most restrictive shall apply. Nothing in this specification or related documentation shall be construed to permit work not conforming to applicable codes.

G. Specification requirements may exceed any code requirements. Where specifications and code differ or conflict, the most stringent requirement shall apply.

1.04 SUBMITTALS

A. General

1. Conform to requirements of Division 1 and requirements stated herein.

2. Shop drawings and submittals, giving full fitness and other pertinent facts, shall be submitted and approval secured before apparatus in question is ordered, built or installed. The BAS contractor shall be solely responsible for the removal and replacement of any item not in compliance with the contract documents at no cost to the Owner.

3. Shop drawings shall be presented in a manner to facilitate easy visualization of the systems installation and operation.

4. Shop drawings shall be submitted with the following four sections:

a. Equipment data sheets and equipment matrix. Valves data sheets and valve selection matrix.

b. System architecture, P&I diagrams, wiring and interface diagrams.

c. Sequence of operations.

d. System Graphics

5. The contractor shall allow a minimum of four weeks of submittal review time by the Architect’s for each submittal or re-submittal.

6. The Architect’s review of the submittals shall be for general arrangement only and shall not be construed as a complete check or constitute a waiver of the requirements of the Contract Documents.

B. Product Data Sheets

1. Devices and equipment catalogue cuts including specifications and installation instructions for all devices used by the BAS and specified in this division including devices furnished and installed by other Divisions. Indicate proposed application for each device referenced to the applicable specification section.

2. Range and scale information for all transmitters and sensors. Indicate all applicable options and where more than one device is to be used on one sheet, submit a separate, individually marked sheet for each device.

3. Submit a summary matrix listing the following information:

    a. Rows: Each device

    b. Columns: Tab#, specification section, part number, description, manufacturer, application, range or span and expected setpoint or operating range.

4. Valve, damper, well and tap schedules showing sizes, configuration, characteristics, capacity, location, tag and part number.

5. Control valve schedules shall be submitted in a spreadsheet format and shall include a separate line for each valve and a separate column for each valve attribute. The attributes shall include the valve tag number, the system served, the pipe size, close off pressure, body rating, target C_v, actual C_v, target pressure drop, actual pressure drop, fail safe position and actuator information.

C. Equipment Layout Shop Drawings:

1. The Contractor shall submit shop drawings (floor plans) showing proposed layout and installation of all network and power equipment (panels and devices) and the relationship to other divisions. The drawings shall be drawn to a suitable scale. Show plan and elevation views and adequately indicate service space requirements, mounting, electrical connections, concrete work as required to completely coordinate the installation with other trades.

D. Control System Drawings

1. System Architecture:

    a. BAS riser diagram showing all DDC controllers, operator workstations, network controller, repeaters, bridges, switches, gateways and network wiring and how these devices will interface to the existing campus JCI System.

    b. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. Indicate media, protocol, baud rate, and type of each LAN. All repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the diagram.

2. Panels and controllers layout and point list including device tag number, point type, system name, object name, expanded id, display units, address, cable destination etc.

3. Wiring diagrams, including wiring between panels and between panels and devices. Diagrams shall show, in addition to the automatic control system installation, the wiring required to interface with the self-contained equipment and motor control circuitry, all of which interfaces with and controlled by the BAS. Data shall be derived from and submitted with approved diagrams from the

manufacturer. The required data shall be submitted as an integral part of the BAS submittal even if the required data is submitted under a separate cover by another discipline.

4. Project specific manufacturer shop drawings where applicable (Custom control panels, sensor/transmitter pairs etc.)

5. Schematic flow diagram of each air and water system (Process and Instrumentation Diagrams) showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. All physical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table.

6. Software submittals shall contain narrative descriptions of sequence of operations and programming flow charts. The sequence of operations shall be fully developed and referenced to the devices used identified by tag numbers as shown on the P&I (Process & Instrumentation diagrams). Show all calculations and set points. In a matrix format, show alarms, alarm thresholds and settings.

7. Any additional details required by the AE (Architect/Engineer) to demonstrate that the system shall function as intended.

E. Graphics: Graphics proposed for all systems including but not limited to: Floor plans, AHU systems, chilled water and hot water systems, steam systems (when provided), room terminal unit systems and miscellaneous mechanical, electrical and plumbing systems. Also include floor plan graphics with room sensor locations with current values, locations of panels and examples of trending and custom reports.

F. Sequence of Operations: See drawings.

G. All drawings and diagrams shall be generated using the Visio Professional or AutoCAD release 2014 or higher and shall be a minimum size of 11 x 17. The Architect will furnish architectural floor plans backgrounds on floppy discs, Zip discs or CD-ROM or post on an FTP site.

H. The Contractor shall clearly identify variations from the Contract Documents, if any, and document the reason for such variation.

I. No material or equipment shall be installed before its product data has been submitted, reviewed and returned to the Contractor with the note “NO EXCEPTIONS TAKEN”, or the note, “MAKE CORRECTIONS NOTED” marked thereon. In the event of the latter note, the correction noted shall be made and noted in the as-built set. Materials installed or work performed without the review of drawings and/or review of software flow diagrams is subject to rejection.

J. Digital copies (unless more required by Division 1) of product data for materials and equipment covered by each Section of this Division shall be submitted for review.

1. Materials and equipment covered by an individual section shall be bound together and submitted as one package along with a summary spread sheet listing the various components submitted and their intended use and application.

2. The Contractor shall submit the required data in a timely manner and shall allow reasonable time for review and processing. The Contractor shall assume full responsibility for delays incurred due to rejected items.

3. Non-rejection of an item shall in no way obviate compliance with the Contract Documents.

4. The Contractor must certify and sign each section of the submittal stating that he has reviewed all of the materials included in the submittal and the submittal is in compliance with the contract documents.

1.05 OPERATION MANUALS

A. Provide complete operation and maintenance manuals, as required in Section 01700, for all systems. Manuals shall be contained in suitable loose-leaf binders with project identification on the cover and sections separated by individual tabs.

B. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS and all associated field devices. This documentation shall include specific part numbers, software versions, data and configuration files. A complete recommended spare parts inventory list shall be included with procurement lead time and expected frequency of use of each part clearly identified.

C. Workstation User's Manual shall contain the following information as a minimum:

1. System overview and networking concepts

2. Login and navigation through various menus

3. Establish and modify set points and schedules

4. Upload and download software, set points, schedules, operating parameters and status to and from the operator workstation and field hardware.

5. Collect trend data and generate trend plots

6. Enable and disable alarms and messages

7. Generate Report.

8. Backing up software and data files

9. Using the operator workstation with 'third party' software

D. Project Engineering Manual shall contain as a minimum:

1. System architecture overview

2. Hardware cut-sheets and descriptions of installed products and accessories, including Installation, mounting and connection details.

3. Wiring diagrams for all controllers and field hardware

4. Complete parts list and maintenance instructions for all installed products.

5. Commissioning, setup and backup procedures for all software and field controllers, workstation and devices.

6. Listing and description of basic terminology, alarms, messages and frequently used commands or shortcuts.

E. Software Documentation shall contain as a minimum:

1. Graphical representation of all control algorithms for every piece of mechanical equipment controlled on the project, together with a glossary or icon symbol library detailing the function of each graphical icon. 'Line by line' computer program documentation is unacceptable.

2. Detailed description of control sequences used to achieve the specified sequences.

3. Graphical representation of the mechanical equipment hierarchy for the project including all equipment controlled by the BAS. I.e. a VAV terminal box may be the source for increased cooling demand and requires the primary VAV AHU to operate which requires the chillers to operate.

4. Detailed listing of all specified alarm and event messages programmed for designated mechanical/electrical equipment and required operator action.

5. Documented listing of all system software, including the operating system and the system application programs. Listing shall include sufficient information to allow a person familiar with the programming language, but unfamiliar with the program, to understand it.

6. Graphic flow diagrams "Flow charts" of all software programs used on this project.

F. Manuals shall also contain the following information:

1. All information required by and specified in the "Submittals" section of these Specification in its final as-built form incorporating all revisions made as a result of the submittal process, during the installation, start-up or acceptance portion of the project.

2. CAD generated sketches of system graphics showing all monitored systems, data (measured and calculated), point addresses, and operator instructions.

3. As-built wiring diagrams of the complete system, all its components and devices.

G. In addition to the drawings included in the Operation Manuals, provide one digital set

H. For systems requiring a dedicated control panel (AHU's, CHW and HW systems, etc. the BAS contractor shall leave a printed copy of that particular systems flow diagram, SOO, wiring diagram and bill of material inside the controls enclosure.

1.06 INSTALLATION

A. The installation shall include: Hardware installation, programming and supervision, checkout, adjusting and validating, necessary for a complete fully operational system.

B. The BAS Subcontractor shall furnish and install all necessary conduits, control wiring, low voltage power wiring and conduit to control panels and field devices and all interlock wire

and conduit as shown on the drawings, stated in the sequence of operation and listed on point list and necessary for the proper operation of all specified systems.

C. Power supply, conduit and wiring from distribution panels to BAS field panels and devices, such as, but not limited to, valve actuators, terminal box controllers, damper actuators, , are a part of the work of this Section. Power supply shall be from emergency power source for all equipment connected to emergency power and/or used for Fire Life Safety operation.

D. Control wiring and conduit to automation field panels and devices, such as, but not limited to, valve actuators, terminal box controllers, damper actuators, , are a part of the work of this Section.

E. All wiring to outdoor panels and devices shall be arranged so that the conduits enter the panels and devices from the bottom in order to minimize the risk of water leaks. All conduit entries into outdoor panels and devices must be made with special weatherproof fittings.

F. Disconnects as required by the UMC 2013 section 308.0 “Means of Disconnect”, are a part of the work of this Section.

G. Wiring

1. All wiring performed by the BAS Subcontractor shall be installed in accordance with the requirements of Division 26 as well as all current and applicable local and national codes including but not limited to:

    a. NEC (NFPA 70) – National Electrical Code

    b. CMC – California Mechanical Code

    c. CFC – California Fire Code

    d. CBC – California Building Code

2. Except for Smoke Control systems, and unless required by Division 26 specifications, plenum-rated low voltage wiring may be installed without conduits in accessible, concealed spaces above ceiling plenums, if installed in a neat workmanlike manner, suspended from the structure on hangers and not touching any hot surfaces (coils). Laying bare wires and cables on the ceiling grid is prohibited.

3. For Smoke Control systems, and if required by Division 26 specifications, in addition to meeting the requirements of the electrical codes, all wiring, regardless of voltage, shall be fully enclosed within continuous raceways (conduit).

4. Concealed wiring within partition wall to temperature sensors needs to be in conduit to 8ft AFF.

5. All wiring must be color-coded and all terminations shall be numbered in accordance with applicable wiring standards and Division 26 requirements.

H. Dampers

1. All modulating and two position automatic control dampers, combination fire/smoke dampers and smoke dampers, whether shown on drawings or not, are included under work of Division 23. Any additional dampers not shown on the Drawings, but required to complete the work of Sections 25 55 00 through 25 55 60, shall be selected under the work of Section 25 55 30, but furnished and installed under Section 23 33 00.

2. Damper actuators for all modulating and two position dampers, furnished under Section 23 33 00, shall be furnished and installed under this Section. Provide all additional relays, control wiring and end switches for monitoring the status and controlling these dampers as required by the sequence of operation. Actuators for Smoke and Combination Fire/Smoke dampers shall be furnished with end switches integral with the dampers as a complete UL listed assembly under the work of Section 23 33 00.

3. Provide and install disconnects as required by the UMC 2001 section 309.0 “Means of Disconnect”.

I. BAS contractor shall label all wiring and identify power supply circuit numbers and source panels as required.

J. Provide minimum 15 minutes UPS power modules for all control devices requiring uninterruptible power to meet the smoke control system requirements if Smoke Control is part of the scope of work or if equipment controlled by the BAS will operate on Standby or Emergency Power.

1.07 STARTUP AND COMMISSIONING SERVICES

A. The BAS contractor shall participate in the Start-up procedures of all equipment and systems, such as the chilled water, hot water and steam systems, air handling systems, electrical, plumbing and Fire Life safety systems in the presence of the equipment manufacturer’s representatives, Commissioning Authority or the Owner’s representative as applicable.

B. Upon completion of the installation and after a complete point-to-point check of the system, the BAS contractor shall load the system software and perform a safe system start-up following the procedures outlined in the various Division 23 sections. The BAS Contractor shall perform all necessary calibration, testing and debugging and perform all required operational checks to insure that the system is functioning in full accordance with these Specifications

C. Each point in the system shall be tested for both hardware and software functionality. Provide a point to point test plan and test report to the commissioning agent.

D. Each system under control of the BAS shall be tested against the approved sequence of operations per functional test procedures developed by the commissioning agent. The commissioning’s agents report shall be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.

E. The Contractor in the presence of the Owner’s representative shall perform an acceptance test for all the system and train all the Owner’s designated employees in accordance with the provisions herein and the Commissioning specifications issued by the Commissioning Authority.

1.08 DEMONSTRATION AND ACCEPTANCE TESTING (FUNCTIONAL PERFORMANCE TESTING)

A. Refer to Commissioning specifications provided by Commissioning Authority

1.09 OPERATOR INSTRUCTIONS

A. If installing JCI Metasys – the BMS contractor is to provide 24 hours of owner training.

B. Alternate manufacture requirements:The system supplier shall conduct operator training on the system at acceptance time. Training shall be performed for three operator levels, and shall include the following, with a minimum of 16 hours for level 1, 24 hours for level 2 and 40 hours for level 3 of dedicated instructor time.

1. Level 1: Two persons on basic data display and interpretation of graphics, addresses, and alarm and to interpret all alarm displays and printouts, to request all data displays.

2. Level 2: Two persons (included in Level 1 class) on intermediate command and program change operations. This level of operators shall be trained to execute all manual commands (Start/Stop, Secure/Access), request all logs and change time based On/Off program times and load assignments.

3. Level 3: One-person (included in Level 1 and Level 2 classes) on total system programming. This level of operators shall be trained to install all other programs and program changes specified herein to be keyboard programmable. This training shall include complete understanding of all application packages, the custom written data file and user programs, and the ability to write and change new and existing specified programs. Trainer shall review and use documentation specified.

C. During system commissioning and prior to the guarantee period, the BAS Contractor shall provide hands-on maintenance and operation training to the Owner’s personnel. Training shall be performed for all the electrical and mechanical components of the BAS using a submitted and approved O & M manual prepared specifically for this project.

D. The system supplier shall offer retraining of the Owner’s personnel at the Owner’s expense. Supplier shall furnish a syllabus of all training courses offered, and shall maintain a published schedule of training classes and a schedule of fees for classes.

E. The training sessions shall be videotaped by the contractor and copy of the videotape handed to the Owner.

1.010 SYSTEM ACCEPTANCE

A. Satisfactory completion is when the BAS contractor has performed successfully all the required testing by the Authorities Having Jurisdiction, the Commissioning Authority and by the specifications and demonstrated performance and compliance with all Contract Documents. System acceptance shall be contingent upon completion and review of the corrected deficiencies issued by all parties.

B. Request a final review prior to system acceptance after completion of the following:

1. Installation of all systems required by the Contract Documents.

2. Satisfactory operation of all systems for a period of two weeks.

3. Tagging and Identification of all equipment as required.

4. Cleaning and painting if required.

5. Submission and acceptance of submitted maintenance and service manuals.

6. Submission of as built record drawings.

7. Satisfactory completion of training programs.

8. Delivery of maintenance tools and spare parts.

1.011 WARRANTY

A. Refer to Division 01 Warranties

B. The BAS contractor shall warrant the system (equipment, materials, programming and workmanship) for 12 months labor and 3 year parts after system commissioning acceptance and beneficial use by the owner. During the entire warranty period and at no additional cost to the owner, the BAS contractor shall maintain and update all software and firmware versions with the most current revisions issued by the system and/or product manufacturer. Also during the warranty period and at no extra cost to the owner, the BAS contractor shall provide all necessary adjustments and modifications required for a workable system consistent with the letter and intent of the Sequence of Operation of this specification

C. Within this period, upon notice by the Owner, any defects due to faulty materials, methods of installation or workmanship shall be promptly (no later than 48 hours after receipt of notice) repaired or replaced under the work of this section at no expense to the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. Manufacturer: The Building Automation Control System shall be provided by the following:

1. Johnson Controls, Inc. Metasys to match campus standard

B. Installer: Johnson Controls, Inc. direct factory branch located in Folsom, CA.

2.02 MATERIALS & PRODUCTS

A. Comply with individual Sections of this Division.

B. As a minimum, the Building Automation System shall consist of the following:

1. Network Control Units, Operator Workstations and File Servers

2. Standalone General Purpose/Multiple Application DDC Controllers.

3. Standalone General Purpose/Single Application DDC Controllers.

4. Application specific controllers.

5. Interfaces and gateways to third party controllers.

6. Floor network controllers and expansion modules.

7. Air and Hydronic Terminal equipment controllers

8. Sensors, devices, valves and actuator, etc.

C. The Building Automation Control System shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, and historical data collection and archiving.

2.03 USER INTERFACE

A. Comply with the individual sections of this Division

PART 3 - EXECUTION

3.01 CONFERENCE

A. Upon award of the Contract, before submittals are prepared and any work is started, arrange a meeting with the Commissioning agent, Engineer and Owner or their representatives to discuss the work in this Division.

3.02 BAS SYSTEM PROJECT MANAGER

A. Have present at the project site, a project manager who shall, as a part of his duties, be responsible for the following activities:

1. Coordination and interface between this Subcontractor and all other trades, Owner, local authorities, and design team.

2. Attendance at meetings as requested by the owner and the commissioning agent

3. Supervision of field technicians and coordination of all activities between his subcontractors.

4. Scheduling of work progress, manpower loading, material delivery, equipment installation and checkout.

5. Coordination of all drawings and submittals between consultants, engineers other sub-trades and his subcontractors.

6. Programming and commissioning of control system

7. Engineering submittals

3.03 DRAWINGS

A. The contract drawings are diagrammatic. Size and location of equipment is drawn to scale wherever possible. The contractor shall make use of all data included in all of the Contract Documents bust must verify this information on site.

3.04 COORDINATION WITH OTHER TRADES

A. The BAS Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall have a trained technician available on request during the balancing of the systems. The BAS Contractor shall coordinate all requirements to provide a complete air and water balance with the Balancing Contractor and shall include all labor and materials in his scope of work.

B. Review the Contract Documents for the work performed by others in order to establish grade lines and eliminate interference.

1. Work, which interferes with the work of other trades, shall be removed and rerouted at the discretion of the Architect.

2. No additional funds will be allowed for changes made necessary by interference with the work of other trades.

C. When not shown on drawing, controls contractor shall generate floor drawing showing required locations for 120V power to transformers provided and installed by the controls contractor. Div 26 to provide 120V power as required

D. Owner IT Network coordination: During system commissioning controls contractor to request IP address for new network level controllers. Patch cable to network engine is provided by others.

3.05 COMMISSIONING

A. In coordination with Division 22, 23 and 26 contractors and the Owner’s representatives, provide services and manpower necessary for commissioning of the system as required by the Commissioning Specifications.

3.06 ACCESSIBILITY

A. The installation of valves, dampers, thermometers, gauges, traps, clean-outs, control devices or other specialties requiring reading, adjustment, inspection, repairs, removal or replacement shall be conveniently and accessibly located with reference to the finished building. Refer to Division 15 sections.

3.07 PROTECTION

A. Provide adequate protection for all finished work against physical damage from whatever cause during the progress of the work and until completion. During construction, properly cap all ducts, pipes and equipment to prevent the entrance of sand and dirt. Protect equipment against moisture, plaster, cement, paint or other hazards by covering with polyethylene sheets.

B. All device locations shall be safe from water damage. No control devices shall be mounted under piping, valves or wall penetrations where water leakage may occur.

3.08 CLEANING

A. After installation is complete, clean all systems as indicated below.

1. During work in progress: Carefully clean the premises and keep all portions of the building free of debris.

2. Chrome or nickel-plated work: Thoroughly polish.

3. Factory finished items: Remove grease and oil and leave surfaces clean and polished.

3.09 WIRE LABELS/ DEVICE TAGGING

A. Comply with the requirements of Division 23, Division 26 sections and the following:

1. Controller Identification:

a. A nameplate securely fastened to the outside of the controller enclosure shall identify all controllers. Minimum size of letters shall be 1”.

2. Panel Identification:

a. A nameplate securely fastened to the outside of the controller enclosure shall identify all local control panels. Minimum size of letters shall be 1”.

3. Field Devices:

a. All field devices shall be identified by a typed (not handwritten) securely attached tag label. Each tag will consist of a stainless steel wire and stainless steel tag. The device name will match the object name on the control drawings. One tag will be provided for every valve, sensor, etc. Minimum size of letters shall be 1/2”.

4. Panel Devices:

a. A typed label shall identify all panel devices. Each tag shall consist of a black plastic tag with white lettering. Device names will match object on control drawings. One tag will be provided for every panel mounted device (transformers, controllers, etc.) Tags will be securely fixed to panel device with sticky back tape.

5. Wire Identification:

a. All low and line voltage control wiring shall be identified as referenced to the associated control diagram, at each end of the conductor or cable. Identification shall be permanently secured to the conductor or cable and shall be typed.

END OF SECTION 255500

SECTION 255520
DIRECT DIGITAL CONTROL SYSTEM AND USER INTERFACE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, applicable portions of Division 1, Division 22, 23 and 26 – Basic Materials and Methods, apply to this Section.

1.02 DESCRIPTION

A. General: Provide Direct Digital Control (DDC) system, complete, as shown, specified or required per Contract Documents.

B. Work Included in this Section: Principal items of work include, but are not limited to, the following:

1. General Purpose/Multiple Application DCC controllers.

2. Single/Application Specific DDC Controllers.

3. Single/Application Specific Controllers – Terminal Unit Controllers.

4. System Software

5. User Interface

C. Related Work Not Included in This Section: Other Division 25 sections.

1.03 DESIGN INTENT

A. The primary goals of the Building Automation System (BAS) are to maintain an environment automating and facilitating the technical operation of the facility, maximize the effectiveness of operations and maintenance personnel, and manage energy consumption, maintain IAQ and occupants comfort. As a result the BAS shall communicate with the JCI Metasys system on campus.

1.04 GENERAL REQUIREMENTS

A. Requirements of Section 25 55 00 govern the work of this Section.

B. Each system shall be provided with its own dedicated direct digital controller or application specific controller. Mechanical systems such as Air handling units, Air Terminal Units & Fan coil units or packaged systems shall not be controlled by more than one specific application controller. The intent of this section is to ensure stand-alone control for all major HVAC equipment that will require Proportional (P) Proportional & Integral (PI) or Proportional, Integral & Derivative (PID) control processes.

C. Fans, dampers, sensors and devices included as part of a “system” (example: a relief fan associated with an air handler) shall be controlled and wired to the same controller and directly controlled by the same CPU.

D. Provide 10% spare slots in all DCC panels for future expansion and addition of point modules.

E. Furnish temperature control panels (TCP) of NEMA code gauge steel with locking doors for mounting all devices. They shall meet all applicable requirements of Title 24, California Code of Regulations. All controllers, relays, switches, etc. for equipment located in mechanical equipment rooms shall be mounted in a TCP. Temperature settings, adjustments and calibration shall be done at the TCP. Any required UCMC Campus Data networks connection for this panel shall be installed inside the panel. All electric devices within a control panel shall be factory pre-piped and wired. Provide engraved laminated plastic nameplates identifying all devices mounted on the face of the control panels. A complete set of related "as-built" control drawings shall be furnished in each control panel.

1.05 GENERAL SYSTEM REQUIREMENTS

A. The Direct Digital Control (DDC) system shall be an integral part of Building Automation System (BAS). The system shall be modular in nature permitting expansion of both capacity and functionality through the addition of sensors, actuators, network controllers and operator devices.

B. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices

C. Standalone DDC panels shall be able to access any data from, or send control commands and alarm reports directly to any other DDC panel or combination of panels on the network without dependence upon a central processing device. Standalone DDC panels shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device. Systems, which do not meet this requirement, are not acceptable.

D. Provide all of the required FDD system status' and faults of each HVAC package unit economizer within the BACnet Temperature Control System graphics. FDD controller must be manufactured by the DDC supplier and approved and listed on CEC website under Fault Detection Diagnostic System Declaration List (no exceptions). Third party FDD controllers are not acceptable.

E. Where indicated by the University, provide Automatic Demand Shed Controls as required by the Building Energy Efficiency Standards - Title 24. Provide each HVAC system with Automated Demand Response (ADR) control and programming to change setpoints, reset setpoints, adjustable rate of change for setpoint change, ability to disable and allow manual control.

1. System functionality shall be demonstrated and confirmed during system start-up regardless of presence of ADR signal generator. If ADR signal is not required per project documents signal shall be simulated in software to prove complete operation.

2. Provide project names and a customer references of two projects that controls contractor has successfully implemented Automated Demand Response.

1.06 SYSTEM INTEGRATION

A. Neutral Protocol: The neutral Protocol used between systems will be BACnet over Ethernet and shall comply with the ASHRAE BACnet standard. The BACnet system integrator shall allow bi-directional communications between the host system and BACnet system over an Ethernet network.

B. BACnet integration into the Metasys network must respect existing BACnet devices and operational configurations. Failure to do so will cause outages ranging from individual devices to the entire downtown campus. BAS manufacturer must be able to utilize all of the range BACnet addresses so that any new building does not use any duplicate addresses. All costs impacts to state entity, including building tenant evacuation resulting from system outage, will be passed along to installing contractor.

C. Direct Protocol

1. The BAS shall include appropriate hardware equipment and software to allow bi-directional data communications between the BAS and third party manufactures' control panels. The BAS shall receive, react to and return information from multiple building systems including but not limited to chillers, boilers, variable frequency drives, power monitoring and metering systems, lighting systems and fire life safety systems. Integration shall be via RS-232 or RS-485 technologies.

2. All data required by the application shall be mapped into the Network controller database and shall be transparent to the operator. Point inputs and outputs from the third party controllers shall have real time interoperability with the BAS software features

D. Third party controllers shall communicate via BACnet MS/TP or IP. The manufacture of the equipment is responsible for providing and commissioning this gateway for use by the BAS system. The BMS contractor will only be responsible for integration gateways for 3rd party controllers with MODBUS.

1.07 SYSTEM ARCHITECTURE

A. First Tier or Level 1 Network – BACnet IP

1. The first tier or Level 1 network is the main backbone of the system and shall be based on an industry standard Ethernet TCP/IP.

2. Network Control Units, Operator Workstations and File Servers shall reside on the first tier network without the need of gateway devices. PC Workstation shall connect to the campus network. Network engine controllers shall live on the tier 1 network. Air Handler controllers and central plant controllers shall reside on the first tier or Level 1 Ethernet network or the Level 2 MS/TP network..

3. The first tier shall be connected to the facility wide network by way of standard network practices.

4. The system architecture shall support 100% expansion capacity of all types of DDC panels, and all point types included in the initial installation.

B. Second Tier or Level 2 Network; shall be BACnet MS/TP at 78,600 baud

C. Dynamic Data Access: All operator devices, either network resident, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment.

1.08 NETWORK DESIGN GENERAL REQUIREMENTS

A. Network design shall include the following provisions:

1. Detection and accommodation of single or multiple failures of workstations, DDC panels or the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.

2. Message and alarm buffering to prevent information from being lost.

3. Error detection, correction and re-transmission to guarantee data integrity.

4. Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event that an operator device does not respond.

5. Synchronization of the real-time clocks in all DDC panels.

1.09 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Where indicated for supporting operator PCs, servers, and other equipment as indicated, provide a UPS as required

PART 2 - PRODUCTS

2.01 STANDALONE GENERAL PURPOSE/MULTIPLE APPLICATION DDC CONTROLLERS

A. General: Standalone DDC panels shall be microprocessor based, multi-tasking, multi-user, and real-time digital control processors.

B. Each standalone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the attached point list.

C. Each General Purpose/Multiple Application Controller must be capable of standalone direct digital operation utilizing its own 10 bit processor, non-volatile flash memory, input/output, 12 bit A to D conversion, hardware clock/calendar and voltage transient and lightning protection devices. All non-volatile flash memory shall have a battery backup of at least five years. Firmware revisions to the module should be able to be made from the local workstation, portable operator terminals or from remote locations over LANs.

D. The General Purpose/Multiple Application Controllers shall be expandable to the specified I/O point requirements. Each controller shall accommodate multiple I/O Expander Modules via a designated expansion I/O bus port. These expander modules shall expand the total point capacity of each controller. The controller, in conjunction with the expansion modules, shall act as one standalone controller.

E. All communication and input/output signals shall be hardwired (wireless technology is not acceptable).

F. Memory: Each DDC panel shall have sufficient memory to support its own operating system and databases including.

1. Operator I/O.

2. Control processes.

3. Custom processes.

4. Support applications.

5. Alarm management.

6. Dial-Up communications.

7. Manual override monitoring.

8. Energy management applications.

9. Historical/trend data for all points maintenance.

G. Each General Purpose/Multiple Application Controller shall execute application programs, calculations, and commands via a 10-bit microcomputer resident in the controller. All operating parameters for application programs residing in each controller shall be stored in read/writable nonvolatile flash memory within the controller and will be able to upload/download to/from the operator workstation.

H. All point data; algorithms and application software within a controller shall be custom programmable from the operator workstation.

I. Each General Purpose/Multiple Application Controller shall contain both software and firmware to perform full DDC PID control loops.

J. Local Override Switches: Provide local override switches where shown on drawings. If required, the override switches will manually override automatic or centrally executed commands at the DDC panel via local manual switches. Provide operator override switches for binary output control points and gradual positioning switches for analog output control points as indicated in the point schedule. Local override switches are not required when the override function can be achieved at the output device (starter, valve, damper, etc.) and the device is located in sight of the DDC panel.

K. Hardware Override Monitoring: Monitor the override status and position of each override as a discrete condition in addition to point status and alarm condition. Include this information in logs and summaries to inform the operator that automatic control has been inhibited. DDC panels shall also collect override activity information for daily and monthly reports.

L. Integrated On-Line Diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel.

M. Surge and Transient Protection: Provide isolation consistent with IEEE Standard 587-1980 at all networks terminations, and all field point terminations to suppress induced voltage transients.

N. Power Fail Restart: In the event of loss of normal power, there shall be an orderly shutdown of all standalone DDC panels to prevent the loss of database or operating system software.

O. Economizer Fault Detection and Diagnostics (FDD) as required by the CEC Building Energy Efficiency Standards - Title 24. Controller shall be approved and listed on the CEC website under Fault Detection Diagnostic System Declaration List.

2.02 STANDALONE GENERAL PURPOSE / SINGLE APPLICATION DDC CONTROLLERS

A. The standalone DDC controller capacity shall be capable of being extended through the use of remote Single/Specific Application Controllers (SAC).

B. Provide a minimum of one controller per air handler

C. All communication and input/output signals shall be hardwired (wireless technology is not acceptable).

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

E. Each SAC shall have sufficient memory to support its own operating system and databases including:

1. Control processes.

2. Energy management applications.

3. Operator I/O (portable service terminal).

F. Each General Purpose/Single Application Controller shall execute application programs, calculations, and commands via a 10-bit microcomputer resident in the controller. All operating parameters for application programs residing in each controller shall be stored in read/writable nonvolatile flash memory within the controller and will be able to upload/download to/from the operator workstation.

G. Each General Purpose/Single Application Controller must be capable of standalone direct digital operation utilizing its own 10-bit processor, non-volatile flash memory, input/output, 10 bit A to D conversion, hardware clock/calendar and voltage transient and lightning protection devices. All non-volatile flash memory shall have a battery backup of at least five years. Firmware revisions to the module should be able to be made from the local workstation, portable operator terminals or from remote locations over modems or LANs.

H. All point data, algorithms and application software within a controller shall be custom programmable from the operator workstation.

I. Each General Purpose / Single Application Controller shall contain both software and firmware to perform full DDC PID control loops.

J. The operator shall be able to access any SAC point data or program through the network resident PC workstation or any PC or portable operator's terminal connected to any DDC panel in the network.

K. Integrated on-line diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel.

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

M. Air Handling Unit (AHU) Controllers: AHU controllers shall support, but not be limited to, the following configurations of systems to address current requirements as described in the Sequence of Operation portion of this specification, and for future expansion.

1. Large Air Handling Units: Mixed Air - Single Path; Mixed Air - Dual Path; 100% Single Path; 100% Dual Path.

2. AHU Controllers shall support all the necessary point inputs and outputs to perform the specified control sequences in a completely standalone fashion including but not limited to all associated dampers, sensors and actuators.

3. AHU controllers shall have a library of control routines and program logic to perform the sequence of operation as specified in the Sequence of Operation portion of this specification.

4. Continuous Zone Temperature Histories: Each AHU controller shall automatically and continuously, maintain a history of the associated zone temperature to allow users to quickly analyze space comfort and equipment performance for the past 24 hours. A minimum of one sample every 15 minutes shall be stored.

5. Alarm Management: Each AHU controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

2.03 APPLICATION SPECIFIC CONTROLLERS - TERMINAL UNIT CONTROLLERS

A. Each terminal unit controller shall provide both standalone and networked direct digital control of pressure independent constant and variable volume terminal boxes. Each controller shall contain both software and hardware to perform full DDC P, PI and PID loop control and able to operate as a standalone controller and maintain the assigned space temperature in the event of a loss of communication with the network. Each controller shall execute application programs, calculations and commands via a 10-bit microprocessor resident within the controller. All communication and input/output signals shall be hardwired (wireless technology is not acceptable).

B. The controller shall determine airflow by dynamic pressure measurement using a dead-ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters. Each controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.

C. When continuous operation at occupied flow is required, provide an “Autozero” module in order to provide periodic recalibration of the air velocity transducer without changing the air volume being delivered.

D. The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops and shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. This feature will reduce commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes. The controller shall be able to support various types of zone temperature sensors with all options listed in the specifications.

E. The controller shall provide the ability to download and upload configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.

F. All operating parameters for application programs residing in each controller shall be stored in the controller’s non-volatile memory. Setpoint changes initiated over the network shall be written to the controller’s non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.

G. Firmware or application programs, stored in the controller memory shall conform to the sequence of operation specified in Section 25 55 50. Controllers with manufacturer-preprogrammed sequences (configurable controllers) are unacceptable. Controllers shall be fully programmable and able to be reprogrammed in accordance with the specified sequences in section 25 50 50. Firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.

H. The portable operator interface shall provide the user with the following functionality as a minimum:

1. Display system status (heating, cooling, etc.)

2. Display and change all point and set points

3. Set and change heating/cooling dead bands

4. Set and change PI loop gains

5. Set and change system mode (occupied/unoccupied)

6. Set and change system schedule

7. Override all set points

8. Override all digital and analog outputs

9. Command all digital and analog outputs

10. Select application mode

11. Assign controller address

I. The controllers shall have LED indication for visual status of communication, power and all outputs

J. Inputs

1. Analog inputs shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:

   a. 0-10 VDC Sensors

   b. 10,000Ω Type II Thermistors

   c. 4-20 ma sensors

   d. 0-5 VDC sensors

2. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input “bouncing.”

3. For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.

K. Outputs

1. Analog outputs shall provide the following: 0-10 VDC (4-20 mA) outputs

2. Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.

3. For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.

4. Each controller shall provide modulating control 0-10 VDC (4-20 mA) to reheat valves. Floating Point Control is not acceptable.

L. The controller’s performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop’s sample interval, which may be used to continuously monitor and document system performance. The air-terminal controller, VAV, CAV and other types shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the air-terminals.

1. Absolute temperature loop error

2. Signed temperature loop error

3. Absolute airflow loop error

4. Signed airflow loop error

5. Average damper actuator duty cycle.

M. The controller shall detect system error conditions to assist in managing the zones. The error conditions shall consist of:

1. Unreliable space temperature sensor

2. Unreliable differential pressure sensor

3. Starved box

4. Insufficient cooling

5. Insufficient heating

N. Provide an electronic damper actuator with modulating control. Obtain damper torque ratings from the terminal box manufacturer and size the actuator accordingly. Actuator shall have a minimum of 35 in-lb. of torque and be protected against overload. Mount actuator on damper shaft without the need for additional linkage. A visual pointer shall indicate the position of the actuator. The damper actuator shall be capable of stroking 90 degrees in 95 seconds for damper positioning to speed commissioning and troubleshooting tasks.

O. Terminal Unit Controllers shall carry the following listings: UL 916 and UL 864, UUKL classification (if part of a Smoke Control system) and FCC compliance.

2.04 SYSTEM SOFTWARE

A. General

1. The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher-level computer for execution.

2. Software shall be modular in design to provide maximum flexibility, expansion and future revision of the system. All functionality described herein shall be regarded as a minimum.

3. The system software shall include the following as a minimum:

a. Complete database entry.

b. Configuration of all controller and operator workstation application programs to provide the sequence of operation indicated.

c. Graphics of each system as shown in the I/O Summary Tables.

d. Report generation, configuration of reports and point summaries.

e. Event / alarms comprised of priority alarms, alarms, and messages.

4. The system software shall be comprised of the following elements:

a. Graphical User Interface.

b. System Configuration Utilities.

c. Graphical Programming.

d. Direct digital control software.

e. Application software.

B. Control Software Description

1. Pre-Tested Control Algorithms: The DDC panels shall have the ability to perform the following pre-tested control algorithms.

a. Two-position control.

b. Proportional control.

c. Proportional plus integral control.

d. Proportional, integral, plus derivative control.

e. Automatic control loop tuning.

2. Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

3. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during normal start-up and also restart after power restoration periods by automatically introducing time delays between successive start commands to heavy electrical loads.

4. Energy Management Applications: DDC panels shall have the ability to perform any or all of the following energy management routines:

a. Time of day scheduling.

b. Calendar based scheduling.

c. Holiday scheduling.

d. Temporary schedule overrides.

e. Optimal start.

f. Optimal stop.

g. Night setback control.

h. Enthalpy switchover (Economizer).

i. Peak demand limiting.

j. Temperature compensated load rolling.

k. Fan speed/CFM control.

l. Heating/cooling interlock.

m. Cold deck reset.

n. Hot deck reset.

o. Hot water reset.

p. Chilled water reset.

q. Condenser water reset.

r. Chiller, boiler and heat exchanger sequencing.

5. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user to customize. Programs shall be applied to building equipment as described in the Sequence of Operations.

6. Custom Process Programming Capability: DDC panels shall be able to execute custom, project specific processes defined by the user, to automatically perform calculations and special control routines.

7. Process Inputs and Variables: It shall be possible to use any of the following in a custom process.

a. Any system measured point data or status.

b. Any calculated data.

c. Any results from other processes.

d. User defined constants.

e. Arithmetic functions (+,-,*,/, square root, exp, etc.).

f. Boolean logic operators (and, or, exclusive or, etc.).

g. On-delay/off-delay/one-shot timers.

8. Process Triggers: Custom processes may be triggered based on any combination of the following:

a. Time interval.

b. Time of day.

c. Date.

d. Other processes.

e. Time programming.

f. Events (e.g., point alarms).

C. Dynamic Data Access

1. A single process shall be able to incorporate measured or calculated data from any and all other DDC panels on the local area network. All hardware and

communications cabling necessary to enable any point in any process to be global shall be furnished, such that any existing or any spare point can be designated as a global point in software.

2. In addition, a single process shall be able to issue commands to points in any and all other DDC panels on the local area network.

3. Advisory/Message Generation: Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote device such as a printer or pager.

4. Custom Process Documentation: The custom control programming feature shall be self documenting. All interrelationships defined by this feature shall be documented via graphical flow charts and English language descriptors.

D. Historical Data and Trend Analysis: A variety of historical data collection utilities shall be provided to automatically sample, store, and display system data in all of the following ways.

1. Continuous Point Histories: Standalone DDC panels shall store Point History files for all analog and binary inputs and outputs.

a. The point history routine shall continuously and automatically sample the value of all analog inputs at half-hour intervals. Samples for all points shall be stored for the past 24 hours to allow the user to immediately analyze equipment performance and all problem related events for the past day.

b. Point history files for binary input or output points and analog output points shall include a continuous record of the last ten status changes or commands for each point.

2. Control Loop Performance Trends: Standalone DDC panels shall also provide high resolution sampling capability with an operator adjustable resolution of 10-300 seconds in one second increments for verification of control loop performance.

3. Extended Sample Period Trends

a. Measured and calculated analog and binary data shall also be assigned to user definable trends for the purpose of collecting operator specified performance data over extended periods of time. Sample intervals of 1 minute to 2 hours, in one-minute intervals, shall be provided.

b. Each standalone DDC panel shall have a dedicated buffer for trend data, and shall be provided with sufficient memory to store a minimum of 5000 data samples.

E. Data Storage and Archiving

1. Trend data shall be stored at the standalone DDC panels. Provide sufficient memory at the standalone DDC panels to store the trend data to be uploaded to hard disk storage when archival is desired.

2. Uploads shall occur based upon user defined interval, manual command, or when the trend buffers become full. All trend data shall be available in disk file form for use in 3rd Party personal computer applications.

F. Runtime Totalization: Standalone DDC panels shall automatically accumulate and store runtime hours for binary input and output points as specified in the Point List portion of this Specification.

1. The totalization routine shall have a sampling resolution of one minute or less.

2. The user shall have the ability to define a warning limit for runtime totalization. Unique, user specified messages shall be generated when the limit is reached.

3. Analog/Pulse Totalization

a. Standalone DDC panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user selected analog and binary pulse input type points.

b. Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g., kWh, gallons, kBtu, tons, etc.).

c. The totalization routine shall have a sampling resolution of one minute or less.

d. The user shall have the ability to define a warning limit. Unique, user specified messages shall be generated when the limit is reached.

G. Event Totalization: Standalone DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.

1. The event totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

2. The user shall have the ability to define a warning limit. Unique, user specified messages shall be generated when the limit is reached.

2.05 USER INTERFACE

A. Mobile, Web Based, User Interface (MUI)

1. General

a. The Mobile, Web Based, User Interface shall be HTML5-compliant and provide device-agnostic access to the system from smartphones, tablets, portable and desktop computers. User Interfaces that require software installation on the client device (ex. Java, MicrosoftSilverlight®, Adobe® Flash®), or software downloads from an online app store shall not be acceptable for these purposes.

b. The MUI shall provide system operators with a simple location-based navigation approach to finding information, including the ability to search for any location by name and to bookmark a location in a standard browser.

c. The same user interface elements shall be accessible from any type of personal computer or mobile device running any type of operating system supported (ex. iOS, Android, Windows). It shall automatically adapt and optimize the display for the screen size and touch screen navigation.

d. The user interface shall provide support for up to 50 concurrent users from individuals with defined access to the system.

2. Navigation Trees

a. A dedicated location based navigation tree shall be provided as part of the UI in order to navigate to specific places within the facility on a hierarchical basis (typ. Facility, Building, Wing, Floor, Room)

b. The location-based tree shall use place names familiar to the operator without training or familiarization regarding special codes and conventions utilized in the generation of the BMS.

c. Clicking or tapping on a location name in the tree shall display the home page associated with the space and simultaneously expand the tree to display the next level of spaces below the one selected.

3. Dashboard Displays

a. The user interface shall provide the ability to view equipment visualizations, floor plans, and/or other graphics on mobile or desktop client devices in a browser environment, without the need for additional plugins or software. Graphics shall be accessible via a space (for floorplans, campus maps, etc.) or equipment dashboard.

b. Standard dashboards shall be configured for each defined space including one of the following predefined or custom elements:

c. Equipment Serving Space

d. Potential Problem Areas

e. Equipment Summary

f. Graphic Display (if specified)

g. Schedule

h. Standard dashboards shall be configured for each system or device (typ. mechanical or electrical equipment) including the following predefined or custom elements:

i. Trend

j. Equipment Activity Summary

k. Equipment Relationships Summary

l. Equipment Data

m. Graphic Display (if specified)

n. Schedule

o. Users with appropriate permissions shall have access to a Dashboards Manager that can change the display order of Summaries and Data elements, add or remove elements and apply custom dashboards layouts to equipment and space by type.

p. Dashboard Manager shall apply dashboards to spaces or equipment based on the viewing platform (Desktop/Tablet or Phone) in order to tailor the user experience to the needs of the specific user base.

q. Default dashboard displays by space and equipment type shall be created per the guidelines in this specification or by mutual agreement with the owner's representative.

4. Alarm Management

a. The user interface shall provide a single display of all potential issues in a facility including items currently in alarm, warning, override, out-of-service and offline.

b. The user interface shall provide notification of new alarms, visually and audibly.

c. The user interface shall provide the ability to view a summary of alarms, including a chart of the number of alarms in each of the defined alarm priority ranges. The priority ranges should be filterable.

d. The user interface shall provide the capability to view multiple occurrences of the same alarm, ultimately providing the ability to acknowledge or discard all occurrences of the alarm in a single action.

e. The user interface shall provide the capability to view, and filter on, all alarms present in a well-defined mechanical system using the equipment serving equipment relationships.

f. The user interface shall provide the capability to acknowledge and discard all occurrences of at least 1000 alarms in one operation

g. The user interface shall provide the user with the understanding of what physical space is being affected when an alarm occurs. The user interface shall provide the ability to filter alarms by physical space affected when the alarm occurred.

h. The user interface shall provide the capability to monitor alarms 24/7 without requiring an active login to the system, accessible via segregated web page. The user interface shall provide the capability to enabled or disable the 24/7 alarm monitor mode if desired.

5. Equipment Activity Summary

a. The user interface shall provide a filterable, single display, of all activity related to a specific piece of equipment including user changes,

discarded user changes, pending alarms, discarded alarms, and acknowledged alarms for at least one year of historical data.

b. Filters shall allow only specific activities for specific data points occurring within a specific time and date window to be displayed.

c. It shall be possible to export a .csv copy of the currently displayed summary by clicking or tapping on the export icon.

d. Clicking on the information icon in front of any displayed activity listed in the summary shall expand the display to include the name of the user, server time, value prior to the activity, the ability to annotate the activity and a user selectable icon for displaying a trend graph of the point.

6. Equipment Relationships Summary

a. The user interface shall provide a summary of all equipment and spaces related to the operation of the system or device currently selected for viewing.

b. Include the capability to navigate to the home page of any related piece of equipment or space with a single click or tap on the desired element.

7. Equipment Data Summary

a. The user interface shall provide a summary of all data pertaining to a particular piece of mechanical or electrical equipment in a tabular format.

b. Clicking or tapping on any value in the summary shall display a related command panel allowing the user to command, override, or change service condition of the point selected and to annotate such actions for future reference

c. It shall be possible to export a .pdf copy of the report with a single click on the associated export icon.

8. Equipment Serving Space Summary

a. The user interface shall provide a summary of all mechanical and electrical equipment as defined in the points list that serves a selected space from the navigation tree.

b. The summary shall be capable of including a subset of the viewable points for each system representing the key elements of interest to operators without subjecting them to long lists of points irrelevant to basic operation.

9. Potential Problem Areas

a. The user interface shall provide a summary of all points in the system related to the space that are not operating correctly (e.g. alarm, off normal or not communicating correctly) in order to provide the operator with a quick update on current conditions.

b. The information shall include

1) Point status (via color

2) Point name

3) Value of the point when the summary was taken

4) Equipment that contains the offending point

5) Space that is served by that equipment

10. Equipment Summary

a. The UI shall provide a summary that allows the user to compare all similar equipment that serves the space as well as downstream (child) spaces in order to evaluate conditions quickly and determine patterns for troubleshooting purposes.

b. Each unique equipment type shall be selectable and display a representative set of values along with the space(s) being served by the device. Equipment types can be selected from a dropdown menu in the summary.

11. User Defined Summaries

a. Provide the capability to view, command, and modify large quantities of similar data in summaries without the use of a secondary application (e.g. a spreadsheet). These summaries shall be generated automatically or user defined. User defined summaries shall allow up to seven user defined columns describing attributes to be displayed including custom column labels with up to 100 rows per summary.

12. Trend

a. The user interface shall provide the capability to view historical trend data from multiple pieces of equipment in both bar and line formats.

b. The user shall have the ability to navigate to a selection list of frequently viewed trends.

13. Graphics

a. The user interface shall display an equipment visualization or graphic within the context of its associated space (building, floor, room, etc.) or equipment dashboard.

b. Graphics shall include the ability to define individual information layers for operator selection in order to clarify systems status and simplify operation on mobile devices. Where desired a master layer may be defined to include important information about the facility on all graphic screens.

c. Graphics shall support the use of photo-realistic symbols as well as color change and animation to match the status of the related system control point.

d. It shall be possible to export a time stamped .pdf file of the graphic being viewed in order to communicate the current conditions in the space or the equipment being viewed and to provide a historic record.

e. An integral graphic manager shall be provided including the following features and capabilities:

1) Creation and modification of graphics from any HTML5 capable browser without the need for additional plug-ins or software packages

2) Access to a full suite of pre-defined templates for air and water sourced HVAC applications as well as the ability to add custom templates as created for other use. Pre-aliased graphic templates may be defined and saved for repetitive representations of common mechanical and electrical equipment.

3) A full suite of pre-defined three dimensional symbols for mechanical and electrical systems as well as all line, text and shape tools required for integration into a graphic with zoom and pan capabilities on multiple platforms and in multiple browsers.

4) The ability to search and replace items in multiple graphics with a single command

5) The ability to import and insert photos and images into the graphic

f. The ability of the graphics manager to create and edit graphics including the ability to bind graphic elements to the values and conditions of system points in both an on-line and off-line mode.

g. As required, the BMS Contractor shall provide software licenses in the name of the owner for programming, configuration and graphics building tools to allow designated representatives to make changes, modifications or additions to the system. While future updates or revisions may require and update fee, the owner shall incur no additional cost if they choose not to update. Systems that require any annual or time-limited licensing fees shall not be permitted.

14. Scheduling

a. The user interface shall provide the capability to display, in a singular view, all of the effective schedules in the context of the space (building/floor/room, etc.) or equipment that the schedule effects. The software should have the ability to display an effective schedule, for the present, or a future date.

b. The user interface shall provide a report of all schedules affecting a space or equipment. The report shall provide the user details of events that comprise the weekly schedule and exception schedule(s). The report shall provide a means of viewing individual breakout scheduling elements for Weekly Schedule, Exceptions and Default Commands

c. The user interface shall provide the capability to efficiently change or modify schedules in mass quantities. This includes the capability to add, in bulk, exceptions to schedules, in addition to assigning, in bulk, weekly schedules.

15. Command and Control

a. It shall be possible to command system analog and binary points via a dropdown menu accessed by clicking or tapping on the value shown in any equipment summary or graphic display and completing the task in the resultant menu including an optional annotation.

b. Commanding multiple points shall be possible on displays where multiple like system elements can be chosen.

16. Search

a. Typing a text string in the Search box shall display a list of all occurrences of that string in the MUI. When a string is represented in the description of a space or network element, selecting it shall display its default dashboard.

17. Offline Operation

a. The Mobile UI shall have the ability to operate in an offline mode in order to create or edit graphics and dashboard elements.

B. Site Management Portal and Associated Application Components

1. General – The Site Management Portal and its user interface shall serve as the primary tool for engineering personnel for the maintenance of the BMS

2. All features and functions of the Site Manager and associated user Interface defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.

3. The software shall run be accessible and operational on a Microsoft Internet Explorer (11.0 or higher) browser and support the following functions:

a. Configuration

b. Commissioning

c. Data Archiving

d. Monitoring

e. Commanding

f. System Diagnostics

4. Operator Interface

a. An integrated browser based client application shall be provided as the user interface program for operators familiar with the detailed operation of the Building Management System and charged with the maintenance and optimization of the mechanical/electrical systems in the facility.

b. All Inputs, Outputs, Setpoints, and all other parameters as defined shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.

c. The user interface software shall provide help menus and instructions for each operation and/or application.

d. The system shall support customization of the UI configuration and a home page display for each operator.

e. All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.

5. Navigation Trees

a. The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum, provide a tree that identifies all systems on the networks.

b. Provide the ability for the operator to add custom trees.

6. Alarms

a. Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:

7. Reports and Summaries

a. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:

1) All points in the BMS

2) All points in each BMS application

3) All points in a specific controller

4) All points in a user-defined group of points

5) All points currently in alarm

6) All points locked out

7) All user defined and adjustable variables, schedules, interlocks and the like.

b. Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.

8. Schedules

a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:

1) Weekly schedules

2) Exception Schedules

3) Monthly calendars

b. It shall be possible to define one or more exception schedules for each schedule including references to calendars

c. Changes to schedules made from the User Interface shall directly modify the schedule database stored in an engine or server.

9. Security/Passwords

a. Multiple-level passwords access protection shall be provided via roles and permissions. The feature will allow the system to base access on a user's job title or role and allow the user/manager access interface control, display, and database manipulation capabilities based on an assigned password.

b. Each user shall have the following: a user account name a complex password or passphrase

c. The system shall allow each user to change his or her password at will.

d. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.

e. Each login attempt is recorded in the system Audit Log with the option to record the IP address of the PC that made the login.

10. Historical trending and data collection

a. Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:

1) Any point, physical or calculated, may be designated for trending. Two methods of collection shall be allowed:

2) Defined time interval

3) Upon a change of value

4) Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.

b. Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time-scheduled basis.

11. Trend data viewing and analysis

a. Provide a trend viewing utility that shall have access to all database points.

C. Mobile Access Portal Gateway

1. General: The Mobile Access Portal (MAP) Gateway shall provide a complementary extension to the DDC system user interface requirements previously described in these specifications. The MAP Gateway shall provide an HTML5 browser interface between mobile devices and DDC controllers without the requirement for operational engines or servers. A task specific mobile application shall not be required to use the MAP Gateway.

a. The MAP Gateway shall be a hardware/software device which consists of a combination WiFi Access Point hotspot and user interface web server, with BACnet MS/TP RS-485 connectivity, and optional Ethernet IP connectivity.

b. When not connected via the Ethernet IP port, the MAP Gateway shall provide a secure, isolated connection to controllers on the BACnet MS/TP field bus with no opportunities to "jump off", or bridge over, to the site's IT infrastructure.

c. The MAP Gateway shall not require the user to purchase or install any software or applications on the user's smart phone, tablet, PC, or smart device.

d. The MAP Gateway shall include the following pre-configured user interface web pages linked to real-time data in the field controllers:

1) Device List Page

2) Device Home Page

3) Device Alarm Page

4) Point View/ Edit Page

e. Airflow Balancing: The gateway shall provide a tool for VAV box commissioning and air balancing for controllers provided under this specification. Connectivity to the individual boxes will not require connection to each controller but rather a connection to a single device on the MS/TP network within WiFi range.

f. The MAP Gateway shall include an RS-485 Port configured as BACnet MS/TP Master.

PART 3 - EXECUTION

3.01 INSPECTION OF CONDITIONS

A. Examine all related work and surfaces before starting work of this Section. Report to the Architect, in writing, conditions, which will prevent proper provision of this work. Beginning of work of this Section without reporting unsuitable conditions to the Architect constitutes acceptance of conditions. Perform any required removal, repair or replacement of this work caused by unsuitable conditions at no additional cost to the Owner.

3.02 INSTALLATION OF CONTROL PANELS

A. All DDC panels shall be installed in a neat workmanlike manner, in a convenient accessible location. Do not install any panel to be in a location where it may be subject to accidental damage or malfunction due to elements or vibrations from equipment, piping or ductwork.

B. All panels shall be located indoors. No outdoors DDC panels on this project.

C. Installation of Digital Terminal Unit Controllers

1. Terminal Controller, airflow transducer, damper actuator shall be shipped to the Terminal Box manufacturer for factory mounting. Factory mounting shall be the responsibility of the box manufacturer. Terminal box manufacturer to provide control transformer and all necessary fuses and disconnects required.

2. Terminal Box manufacturer shall factory install and wire the Terminal Controller, airflow transducer, damper actuator in a NEMA 1 UL listed enclosure. The terminal boxes shall arrive on site, pre-wired using screw connections and terminal blocks, so that connection of room temperature sensor, communications trunk, reheat valve and power shall complete the installation.

3. When terminal box is being fed from multiple power sources:

a. Separate each power source in accordance with NEC (Emergency power and Normal power)

b. Separate each power type in accordance with NEC (Low and High voltage)

c. Use a separate, local disconnect for each power source (Provided by terminal box manufacturer).

d. Clearly identify the different power sources and post a warning indicating that the terminal box is fed from multiple power sources.

4. All cost associated with shipping the Terminal Unit Controllers, actuators and transducers, furnished under this section, to the terminal unit manufacturer shall be borne by the BAS contractor.

5. Installation of Terminal Unit Controllers, actuators and transducers by terminal unit manufacturer will be at terminal unit manufacturer's cost.

3.03 INTEGRATION OF SYSTEM

A. The Building Automation System Contractor must provide a list of all the mechanical equipment and other Building Automation Systems that their system is capable of seamlessly interfacing with as part of their proposal along with a list of projects as reference to validate their claim.

B. At a minimum, the Building Automation System must be able to communicate through data lines, with the chillers, boilers, VFDs, lighting, fire alarm system and water treatment system for monitoring and control. Refer to other specification sections and/or Notice to Bidders for specific manufacturers on this project.

C. Complete all inter-wiring between panels, operator terminals, field devices such as sensors, operators, etc. as required, in a workmanlike manner.

END OF SECTION 255500

SECTION 255530
ELECTRONIC SENSORS, DEVICES AND FIELD HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Controllers, electronic sensors, devices, instrumentation and field hardware, complete, as shown on the plans, specified in the point list, and required by the sequence of operations for a complete and functional control system.

a. Temperature sensors & transmitters

b. Relative humidity sensors and transmitters:

c. Air quality measurement

d. Water flow measurements

e. Hydraulic pressure and differential pressure transmitters

f. Water flow and level sensors and switches

g. Air pressure sensors and switches

h. Airflow measuring stations

i. Electrical power switches and sensors

j. Control devices

k. Automatic control valves

l. Damper actuators

m. Enclosures

n. Pressure monitoring systems (TSI)

B. Related Work:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions, applicable portions of Division 1, Section 23 05 00 – General Provisions and applicable Division 22, 23 and Division 26 sections.

C. Conditions:

1. Requirements of Section 25 55 00 govern the work of this Section.

1.02 SUBMITTALS

A. Comply with the requirements of Division 1 and Section 25 55 00.

1.03 QUALITY ASURANCE

A. General: Materials, equipment and installation shall comply with all applicable building laws and published standards as described in Section 17000. In addition, comply with the following standards:

1. UL

2. NEC

3. ANSI

4. OSHA

5. ASHRAE

6. SMACNA

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide field devices for input and output of digital (binary) and analog signals into DDC hardware. Provide signal conditioning for all field devices as recommended by field device manufacturers, and as required for proper operation in the system.

B. It is the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.

C. Unless otherwise mentioned in this section, field devices specified herein are generally ‘two-wire’ type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, or is not designed to work with ‘two-wire’ type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide ‘four-wire’ type equal transmitter and necessary regulated DC power supply as required.

D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.

E. Accuracy: As used in this Section, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis. Sensor accuracies specified below shall be minimum accuracy requirements.

F. Mount all sensors and transmitters in a convenient location, visible and accessible for maintenance. For duct mount sensors, a neoprene grommet (sealtite fitting and mounting plate) shall be used on the sensor to prevent air leaks.

2.02 TEMPERATURE SENSORS & TRANSMITTERS

A. Duct Temperature Sensors:

1. Provide 10,000Ω Type II Thermistors sensing element. The system error (sensor and transmitter) shall not exceed ±0.5°F over the specified range.

B. Flexible Averaging Sensors:

1. Provide up to 25' continuous resistance element averaging sensor when sensing temperature in mixed air applications or where stratified conditions occur or when large quantities of air are being measured.

2. Also provide flexible averaging sensors when measuring temperatures downstream of a heating or cooling coil.

3. Position the sensor as close to the coil as possible to avoid any "hunting" of the valve and not too close in order to avoid any radiation. Install sensor in a crisscross pattern across the duct and provide temperature averaging over the entire length of the probe.

C. Rigid Averaging Sensors:

1. Provide sensors of the rigid averaging type downstream of air handlers and when duct size exceeds 12" in width. Probe length shall be equal or close to the duct width.

D. Single Point Sensors:

1. Single point sensors shall be allowed in branch duct. Single point sensors can also be used to measure return air temperatures.

E. General Space Temperature Sensors

1. Definition

a. General space temperature sensors/transmitters are defined as sensors connected to and used by air-terminal box controller to control a room temperature.

2. Requirements

a. Provide a 10K or 100KΩ thermistor type-sensing element with accuracy equal to or better than +/- 0.36°F at 77°F. Sensor to be factory calibrated and matched with specified controller.

b. Space (room) temperature sensors shall be occupant warm cool adjustable, with override button and no display unless otherwise indicated. Space temperature, humidity and CO2 sensor shall be readable and setpoints adjustable by the BAS system operator through devices connected to the DDC system panels and operator workstations

c. Provide the following additional features where indicated:

1) For LCD zone temperature sensors provide at a minimum four (4) color indicators (blue, red, amber and green) that will cast a glow onto the wall below the sensor to be used as visual indicator to the occupants of the condition of the system. The color and on/off state of the Status Light indicator shall be fully programmable.

a) Red LED shall be used to locally identify Economizer Fault Detection and Diagnostics (FDD) fault as required by Building Energy Efficiency Standards - Title 24.

2) Digital room temperature and set point display where required.

F. Specific Application Space Temperature Sensors

1. For special applications, procedure rooms and sensitive spaces and/or where humidity control is required, provide a space temperature sensor consisting of a 100Ω Platinum RTD with a TCR of 0.000385 Ω/Ω/°C. The temperature sensor and transmitter shall be matched and factory calibrated to eliminate sensor tolerance from system accuracy. The system error (sensor and transmitter) shall not exceed ±0.5°F over the specified range.

G. Fluid Temperature Sensors - Immersion Probes

1. Provide,10,000 OHM Type II Thermistor sensing element with temperature coefficient of 0.000385 Ω/Ω/°C. The system error (sensor and transmitter) shall not exceed ±1°F over the specified range.

2. Provide sensing element in temperature conductive compound in sealed moisture/waterproof stainless steel tube with a threaded fitting. Install in an appropriate matching stainless steel thermowell pressure rated and constructed in accordance with the system working pressure.

3. Fill the thermowell with a thermal-conducting compound. The sensor and the well shall be supplied as a complete assembly including wellhead Greenfield fitting. Mount the thermowell in an elbow of the pipe facing the direction of flow.

4. Sensors used in BTU or process calculations shall be matched and accurate to ±0.1°F over the process temperature range. Submit a manufacturer's calibration report indicating the calibration certification traceable to the National Bureau of Standards (NBS).

2.03 RELATIVE HUMIDITY SENSORS AND TRANSMITTERS:

A. Fast response relative humidity transmitters with the following features

1. Range: 0-100% RH and accuracy better than ~~± 3% and ± 1.7%.~~ ±2% for 20% to 80% RH±

2. Operating range of ~~23~~32°F to ~~131~~122°F.

3. Output signal 4 to 20 mA or 0-10V with screw terminals for wire connections.

4. Two point field calibration of transmitter.

5. Filter for sensor protection.

B. General

1. When sensing mediums below the ambient dew point, provide a suitable case insulator to prevent internal condensation and moisture on the sensor and transmitter.

2. Provide an NIST traceable calibration certificate with each sensor/transmitter where required.

C. Acceptable Manufacturers

1. Vaisala Veris Dwyer ACI JCI

2.04 OUTSIDE AIR SENSORS (IF REQUIRED)

A. General:

1. Sensors shall be mounted on the roof in an appropriate housing designed to withstand the environmental conditions to which they will be exposed.

2. The sensors shall be located so they shall not be affected by exhaust air, solar effect (except for solar compensator) or cooling tower air circulation. The sensors shall be located where they can be serviced without the need of a ladder or lift equipment.

3. For Outside Air Temperature, provide a Dwyer TE-RND-B outside air temperature sensor with sun shield.

4. For Outside Air Temperature and Humidity, provide a Dwyer RHP-3R3B combo outside air temperature sensor and humidity sensor with sun shield.

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~~2.05 AIR QUALITY MEASUREMENTS~~

~~A. Duct Mounted CO_2 Sensors and Transmitters:~~

~~1. Provide a self-compensating, return air duct mounted CO_2 transmitter with an industry standard, 4-20 ma output signal. Measurement range shall be 0 to 2000 ppm with an Accuracy (including repeatability, non-linearity and calibration uncertainty) ± (2 % of range + 2% of reading). Long-term stability <±5 % of range /5 years and a Response time (63%) of 1 minute.~~

~~2. Locate the sensors to be as shown on the drawings.~~

~~3. Transmitter shall be by Vaisala , Veris, Dwyer, Setra or ACI, JCI~~

~~B. Wall mounted CO_2 Sensors and Transmitters~~

~~1. CO2 sensor shall have an accuracy of +/- 30 ppm over the range of 0-2000 ppm or better.~~

~~2. CO2 sensor shall utilize Automatic Baseline Correction to maintain sensor calibration without the need for manual calibration.~~

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C. CO Sensors and Transmitters

1. Sensor shall utilize state of the art enhanced MOS sensor technology microprocessor controlled and compensated for temperature and humidity. Unit shall not require field calibration. The sensor shall output a 4 – 20mA and can be mounted up to 5,000 ft from the BAS panel. Additional RS 485 interface shall be provided for optional direct connection to a BAS.

2. The monitor unit shall have discrete LEDs to indicate Warning, Alarm and Sensor status. Auxiliary relays shall also be provided for remote indication

3. Transmitter shall be by MSA model TGM or equal

D. Refrigerant Monitoring:

1. The Refrigerant Monitor shall The Chillgard RT Monitor utilizes stable and selective photoacoustic infrared (IR) technology to sense refrigerant gases at levels as low as 1 part-per million and can be configured to monitor from up to eight remote areas. The Refrigerant Monitor shall be capable of being configured to detect a specific refrigerant or a group of refrigerants.

2. The analyzer shall be capable of monitoring over a range of 0-1000 ppm with a sensitivity of 1 ppm in the 0-100 ppm range and +10% of reading in the 100-1000 ppm range.

3. Three separate alarm set point levels shall be provided. The set points shall be independently adjustable for any value for a given range. The set points shall provide drive signals to user interface relays. The alarm set points shall have the capability of providing the user a selection of latching or non-latching.

4. The system shall be capable of supplying a 4-20 mA isolated sourcing signal and 0-10 VDC, signal representing the gas concentration being sampled.

5. Refrigerant Monitor shall be Chillguard RT by MSA or equal.

2.06 WATER FLOW MEASUREMENTS

A. General

1. Install flow sensor as shown on the P&ID and locate in pipe runs in accordance with manufacturer instructions and specifications for length of straight pipe runs required before and after the device to ensure accuracy.

2. Provide an integral Stainless Steel Three-Valve manifold for isolation of transmitter without depressurizing the lines.

3. Sensor and transmitter (specified hereunder) shall be sent to a certified laboratory for an NIST traceable calibration in order to achieve better than +/- 0.5% measurement accuracy. Provide and submit all flow calibration reports.

B. Magnetic Flow Meter – Chilled, Domestic and Hot water

1. Provide a magnetic flow meter with and accuracy up to ±0.15% of volumetric flow rate accuracy over 13:1 flow turndowns, ±0.25% over 40:1 flow turndown.

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2. The magnetic Flow Meter shall be Rosemont , Onicon or equal.

3. If meter is installed higher than 4' AFF, a remote display must be provided.

C. Differential Pressure Flow Meter:

1. Where straight pipe required for Magnetic Flow Meter cannot be provided, provide a differential pressure type flow meter. Construction material shall be 316 Stainless steel with flanged end fittings.

2.07 STEAM MEASUREMENTS

A. Vortex Shedding Meter

1. Provide Rosemont or equal Vortex Shedding flow meter with integral temperature sensor and reducer (if needed). Sensor accuracy shall be 1.35% of rate

2. Wetted material shall be 316 SS. Transmitter shall be remote mounted or integral mounted (depending on accessibility) on flow tube with integral configuration/display module. Transmitter shall be capable of 4-20mA and HART Protocol.

3. Mount the meter horizontally. Avoid mounting transducers downstream of modulating valves or butterfly valves. Upstream Straight Run should be 20 Diameters upstream, and 10 diameters downstream. Straight runs can be reduced with filed adjustments.

4. Model number: 8800D-R-060-S-A3-N-1-D-1-MTA-M5-RXX-Q4. Consult factory to confirm sizing for specific flow conditions.

2.08 HYDRAULIC PRESSURE AND DIFFERENTIAL PRESSURE TRANSMITTERS:

A. Provide standard 4-20mA output. Incorporate a temperature measurement to compensate for thermal effects and provide transient protection. Accuracy shall be +/- 0.075% of span or better.

B. Provide transmitter with a LCD display and failure mode alarm capabilities.

C. Wetted parts of the sensor and electronic housing shall be 316L stainless steel.

D. Differential Pressure Transmitter shall be Rosemount model 3051CD with LCD display and integral mount 3-valve manifold. Pressure Transmitters shall be Rosemount , Veris, Setra, ACI or equal.

2.09 WATER FLOW AND LEVEL SENSORS AND SWITCHES

A. Water Flow Switches:

1. Provide differential pressure type flow switch with adjustable sensitivity and setpoint. When a differential pressure is exerted upon the sensing elements a single pole, double throw (form "C" contact) will be operated. Switch shall be PENN model P74 for 150 psig system and "Mercoid" DP series for 300 psig systems or equal.

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~~B. Liquid Level Switches:~~

~~1. Provide 2-position level switches where required or shown. Floating mercury switch type, completely sealed against moisture and corrosion. Mount where accessible for maintenance and inspection. Switch contact "make" and "break" set point shall be adjustable. Switch shall be Weil 8230 Series or equal.~~

~~C. Liquid Level Sensors and Transmitters~~

~~1. Kele or equal. Type depends on application.~~

~~2010~~2.05 AIR PRESSURE SENSORS AND SWITCHES

A. Differential Pressure Switches

1. Pressure switches shall have a repetitive accuracy of ±1% of their operating range and shall withstand up to 150% of rated pressure. Sensors shall be diaphragm or Bourbon tube. Actuation shall be adjustable over the operating pressure range.

2. The switch output shall be a SPDT snap switch rated for the application. Provide the switch complete with mounting brackets sensing tips and electrical screw type connections.

3. High and low differential pressure cut off switches shall be of the manual reset type for equipment or personnel protection. Switch to be UL Listed.

B. Differential Pressure Transmitter

1. Sensor shall have no moving parts and shall include NIST standards certification. Provide a standard 4-20mA analog output signal with an accuracy of +/- 0.25% of full span. Connections shall be barbed fittings for tubing and screw type for electrical connections.

2. Differential pressure transmitters for duct static pressure shall have a range of 0"-2.5" w.g. For differential pressure across pre-filters the transmitter shall have a range of 0"-1" for final filters, a range of 0"-2.5" w.g. maximum or as scheduled on the drawings.

3. Manufacturer and Model Number: Setra with LCD Display or equal.

C. Shielded Room, Plenum and Space Static Pressure Probes (SAP)

1. Provide for each room or space, a shielded static pressure probe suitable for surface mount (SAP/1), recessed flush (SAP/3) or suspended (SAP/2) mounting, complete with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, and 1/8" FPT (3/4" FPT (for S.A.P./2)) takeoff fitting, all contained in an aluminum (316 stainless steel) casing, with brushed finish on exposed surfaces.

2. The probes shall be capable of sensing the static pressure in the proximity of the sensor to within 1% of the actual pressure value while being subjected to a maximum airflow of 1000 FPM from a radial source.

3. The shielded room or space static pressure sensors shall be the SAP/1/2/3 shielded static air probes as manufactured by Air Monitor Corporation or equal.

4. The shielded plenum static pressure sensors shall be the SAP/3 shielded static air probes as manufactured by Air Monitor Corporation or equal.

5. For room sensing the range shall be bidirectional ± .1 or .25" w.g. (Setra 2641-0R1WB or Dwyer 607-0B) or equal.

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~~D. Static Outside Air Probe (SOAP)~~

~~1. Provide for the room or space static pressure indicating or controlling systems an outdoor static pressure sensor constructed of 10 gage Type 316 stainless steel with a 2" diameter FPT connection.~~

~~2. The outdoor air probe shall be capable of sensing the outside atmospheric air pressure to within 2% of the actual value when subjected to radial wind velocities up to 40 miles per hour with approach angles up to 30º to the horizontal.~~

~~3. The static outside air probe shall be the SOAP as manufactured by Air Monitor Corporation or equal.~~

E.D. General Requirements for Pressure Switches and Transmitters

1. Select sensor with appropriate range for the application so that normal operation will occur at mid range of the sensor span.

2. Duct sensing pressure applications where the velocity exceeds 1500 fpm shall utilize a static pressure traverse probe.

3. Mount Pressure Switches and Transmitters outside of the Air Handler Enclosure. High and Low static pressure switches shall be installed in a lockable and labeled enclosure.

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~~2.011 AIRFLOW MEASURING STATIONS~~

~~A. General~~

~~1. Application: For pressurization control using the fan tracking method, for air flow measurements and minimum outside air measurement and control.~~

~~2. The Air Flow Measuring Station shall consist of an airflow measuring sensor(s) and matched transmitter.~~

~~3. Fan Air Flow Measuring Stations shall be out of the air stream type (piezo ring) provided and installed by the Air Handler manufacturer. The Transmitters shall be calibrated and programmed by the Air Handler manufacturer.~~

~~4. The manufacturer shall produce and submit a report containing all formulas, values and calibration data for verification and record.~~

~~5. For duct mounted and for OA measurements when air velocities less than 400 fpm are anticipated, a thermal dispersion type flow meter shall be provided.~~

B. Air Flow Traverse Probe Stations

1. Airflow traverse probes shall be of the insertion type, capable of continuously measuring air volume in the duct served.

2. Each airflow traverse probe mounted within the station shall contain multiple total and static pressure sensors located along its exterior surface, and internally connected to their respective averaging manifolds.

3. The flow sensors shall not protrude beyond the surface of the probe(s), and shall be the offset (Fechheimer) type for static pressure and the chamfered impact type for total pressure measurement. The airflow station's measured accuracy shall not be affected by directional flow having yaw and/or pitch angles up to 30º.

4. Stations shall be AMCA certified and be capable of measuring the airflow rates within an accuracy of ±2% without the use of correction factors over a velocity range of 400 to 4000 FPM. (For velocities less than 400 fpm use the Thermal Dispersion type)

5. Airflow measuring station shall be Air Monitor "VOLU-probe/VS" or FAN-E for locations with limited straight duct runs.

6. Installation: For duct mounting follow the manufacturer installation instructions for location and quantity of required sensors. For outdoor installations provide the transmitter in a NEMA 4 enclosure

7. The transmitter shall be: Air Monitor Corporation or Ebtron or JCI. The transmitter shall have and accuracy of 0.25% of natural span including non-linearity, hysteresis and repeatability. The transmitter shall be provided with an automatic zeroing circuit.

C. Thermal Dispersion Type

1. Sensors: Sensors shall use thermal dispersion technology with two "bead in glass," hermetically sealed thermistor probes at each measurement point. The system shall be factory calibrated to NIST traceable standards and not require calibration or adjustment over the life of the equipment. Each sensor probe shall be provided with a UL plenum rated cable with terminal connectors and gold plated contacts.

2. Transmitter: The transmitter shall be microprocessor based and capable of processing up to 16 independent sensing points per location. The transmitter shall have 16-character alphanumeric display for airflow and diagnostics. The output shall be 0-10VDC or 4-20 mA selectable. The transmitter shall be capable of indicating individual sensor airflow and ignore any malfunctioning sensors.

3. Installation: For duct mounting follow the manufacturer installation instructions for location and quantity of required sensors. For outdoor installations provide the transmitter in a NEMA 4 enclosure.

4. Airflow measuring station and transmitter shall be Ebtron Gold series model GTA116-PC or JCI equal.

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2.0122.06 ELECTRICAL POWER SWITCHES AND SENSORS

A. Current Switches

1. For 1/5 to 30 HP motors, provide self powered precision solid-state switches; UL listed with direct input to the BAS for general status and proof-of-performance monitoring. Provide switch with adjustable set point, “Trip” and “Power” LED indicators. Provide screw type terminations. Switch to by Veris Industries model H-608 (Split Core).

2. For 35 HP and above, provide self powered precision solid-state switches; UL listed with direct input to the BAS for general status and proof-of-performance monitoring. Provide switch with adjustable set point, “Trip” and “Power” LED indicators. Provide screw type terminations. Switch to by Veris Industries model H-908 (Split Core).

3. For use with Variable Frequency Drives, use Neilsen-Kuljian, Inc., SENTRY 250 series or equal. The switch shall be split core, with adjustable set point, and a frequency operating range of 6 to 100Hz and LED indication.

4. For fractional horsepower 120 V motors, use” Veris” Industries model Hawkeye 500 series. Provide Switch with adjustable set point (if amp draw is 0.5 and above), HOA switch, relay power LED and sensor calibration LED (if amp draw is 0.5 and above).

B. Current Transducers:

1. Provide a UL listed current transducer with a 4-20mA linear output proportional to the current being measured with an accuracy of ± 0.5% or better. Transducer will have reverse polarity protection. Transducer shall be Kele model 4CMA or equal. For currents above 20 Amps, use model SA series – Split core.

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2.0132.07 CONTROL DEVICES

A. Control Relays

1. Relays used for interposing or isolation duty shall be of the plug-in environmentally sealed three poles, double throw (3PDT) type with indicator light. Provide one relay type for interchangeability site wide.

2. The relay coil operating voltage shall be that required for the intended duty up to and including 240 V AC and 110V DC at 2 VA. Contact shall be UL rated for 10 amps. Relay shall be Potter & Brumfield Model KUP-14*3 or equal.

3. Suitable plug-in socket shall be of the 11-tab insertion type suitable for 10-amp service. Socket assembly shall have barriered screw terminals and mounting holes.

4. Socket shall have edge tabs for use with a track mounting system. Relays shall be mounted using a track mounting system. Socket shall be Potter & Brumfield Model 27E121 or equal.

B. Timing Relays

1. Time delay relays shall be UL listed, plug-in environmentally sealed with base. The relay coil and timer circuit voltage shall be that required for the intended duty.

2. Time delays both on energizing and/or de-energizing shall be adjustable and required. Furnish each timing relay with LCD status indicator.

3. For delay break types, indicator shall be off after time out, flashing while timing, and on when output is energized. Timing relays shall be function programmable by pin jumper selections assuming voltages are compatible. Furnish compatible plug-in socket as specified for control relays above.

4. Timing relays shall be OMROM Tateisi Electronics Company solid state timer Model H3CA or equal.

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~~C. Pilot Lights:~~

~~1. Provide where required by Sequence of Operation for indication light emitting diodes (LED's). Red, green, blue and yellow LED's shall be used where pilot indicators are required.~~

~~2. Assemblies shall be complete to mount in 5/16" diameter holds with locking speed nut. Extended leads as required and external limiting resistor for 120V AC operation. External resistor shall be factory furnished, integrally fastened and secured to wire lead.~~

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~~D.~~C. Potentiometers

1. Provide panel mounted carbon core or plastic film type potentiometers with 4-20mA transmitters where shown or required for manual override control. Wire wound types shall be unacceptable.

2. Product: Allen Bradley 800T or equal.

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~~E.~~D. Power Supply:

1. Provide where shown or required DC power supplied with isolated outputs, fold back current limiting and precision regulations. Power supply shall be sized for 200% of the connected load.

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~~F. Air Solenoid (E.P. Valves):~~

~~1. Solenoid air valves shall be 2-position electric to pneumatic devices capable of feeding a pneumatic signal through a common port from either a normally closed or normally open port. Select coil voltage as appropriate.~~

~~2. Provide Landis & Gyr Model EP265 or an approved equal where capacities are less than 0.3 CFM at 1-psi pressure drop. Provide ASCO Model 8320 for higher flow rates.~~

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~~2.01~~2.08 AUTOMATIC CONTROL VALVES

A. General

1. Control valves shall be selected and sized by the BAS manufacturer based on the requirements of this section and the Authority method as described in ASHRAE Handbook (Fundamentals, HVAC Applications and HVAC Systems and Equipment).

2. The valves shall comply with specification section 255500 and 255520 and design drawings for rating and construction.

3. Close-off (Differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following close off pressure requirements:

    a. Two-Way Water Valves: 150% of total system (pump) head at the valve location.

    b. Three-Way Water Valves: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.

    c. Steam Valves: 150% of operating (inlet) pressure.

4. Valve body rating shall be equal to the system rating as specified in Division 15.

5. Select control valves for branch design flow and location on hydronic distribution network. Valves shall be selected, when at design flow, to provide pressure drop of at least 25% of the branch circuit from supply line to the return line. Select valves to be within their range of controllability for each circuit. Valves nearer to pumps on direct return systems will be smaller than line size and provide more system dynamic pressure drop than valves far from the pumps. Obtain campus distribution flow model from the University to confirm system differential pressure available at the building. Submit selected valves in a schedule showing actuator and C_V rating, as well as flow rate, pressure drop, duty, accessories and part numbers for approval.

6. Control valves and actuators shall be covered by a 5-year manufacturer warranty.

B. Quality Assurance

1. Belimo shall manufacture valves and actuators unless a required valve is not available from Belimo. Danfoss valves and actuators are accepted as or equal to Belimo

2. Reheat zone valves shall be “Belimo” Stainless Steel Ball Valves.

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a. Model VG1241 Series

3. Air handler coil valves shall be “Belimo” Stainless Steel Ball Valves.

4. Bypass valves shall be “Belimo” electronic globe valves with linear characteristics.

5. Isolation valves shall be “Belimo” electronic butterfly or ball valves 2” to 14” with Belimo or MAR actuators

C. Cooling and heating coil control shall be fully proportioning throttling type with modulating plugs or characterization discs for equal percentage flow characteristics.

D. Cooling coil control valves shall be spring return open “NO” and heating coil control valves shall be spring return closed “NC”. Other applications shall be as scheduled.

E. Isolation Valves: ON/OFF, two position control valves shall be line size “Butterfly” or ball type.

F. Modulating valves (other than heating or cooling coil flow control control) shall be “Globe” or ball type with linear characteristics.

G. Globe Valves

1. Valves ½" through 1" shall be constructed with a brass body and screwed ends. Trim (seat, stem and plug) shall consist of a removable cage providing valve plug guiding throughout entire travel range. A stainless steel trim shall be provided. Operator, stem and plug assembly shall be removable for servicing.

2. Valves 1-1/2" through 2" shall be constructed with a brass body and screwed ends. For special duty, valves may be selected to have bronze or cast iron bodies with screwed or flanged ends. A stainless steel trim (seat, stem and plug) shall be provided.

3. Valves 2-1/2" and above shall be constructed with a cast iron body and have flanged connections. A stainless steel trim (seat, stem and plug) shall be provided.

H. Electronic characterized control valves

1. Electronic characterized control valves shall have a TEFZEL flow characterization disk installed at the inlet of the valve. The valve trim, shall utilize a stainless steel ball and stem. Valve body shall be chrome plated forged brass with female NPT threads. Bodies to 1-1/4” shall be rated at 600 PSI and from 1-1/2’ to 3” at 400 PSI.

2. The valves shall have a self –aligning blowout proof stem with dual EPDM O-rings packing design. Fiberglass reinforced Teflon seats shall be used. The valve shall have a four bolt mounting flange to provide a four position, field changeable electronic actuator mounting arrangement.

3. A non metallic coupling, constructed of high temperature, continual use material shall provide a direct, mechanical connection between the valve body and the actuator. The coupling shall be designed to provide thermal isolation and eliminate lateral and rotational stem forces. Vent hole shall be provided to reduce condensation build-up.

I. Butterfly valves shall have a cast iron lug body, 304 stainless steel disk, 416 stainless steel shaft, EPDM O-ring, and RPTFE bushings.

J. Automatic Control Valve Actuators - Belimo

1. The actuator manufacturer shall have ISO 90001 certification and the actuator shall be UL listed under standard 873.

2. The actuator shall have NEMA type 2 housing and shall be applied in accordance with the manufacturer instructions.

3. Electric actuators shall consist of a high torque, reversible electric motor coupled through a permanently lubricated reduction gearbox directly to a valve stem coupling. The valve actuator shall provide the maximum torque required for valve close off for the required application

4. Provide adjustable end of travel switches; one for "OPEN" and one for "CLOSED" which will stop the motor at set valve stem positions.

5. The actuator shall be modulating with spring return, or two position with spring return as called out in this section, sequence of operation and/or point list.

6. Cooling coil control valves shall be provided with spring return open “NO” actuators and heating coil control valves shall be provided with spring return closed “NC” actuators. Other applications shall be as scheduled.

7. Upon loss of power or signal the actuator shall close or open under the power of the spring.

8. Provide a manual de-clutching override to allow manual valve operation without electric power.

9. Provide integral end (auxiliary) switches to indicate the required position of the valve where required. End (auxiliary) switches shall be “Form C” contacts, enclosed in a watertight housing. If integral ends switches are not available, provide switches as an “add-on” accessory.

10. All modulating valves shall have a positive feedback signal corresponding to the actual valve position, which can be wired back to the control system.

11. Each actuator shall have current limiting circuitry or microprocessor overload protection incorporated in its design to prevent damage to the actuator.

12. Provide a visual position indicator and an attached 3’ cable for easy installation to a junction box.

K. Pressure Gauge Fittings:

1. Provide test gauge ports suitable for the attachment of Schrader fittings. The ports shall be mounted in line together on the back plane of control panel and labeled as to source.

2. Gauges required by BAS contractor shall be installed only at a test gauge port location by removing the Schrader fitting and installing the gauge. Provide one high accuracy test gauge with 5’ of flexible connection tube and connector per control pane to be left in the panels for operator use.

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~~2.0152~~.09 DAMPER ACTUATORS

A. Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association C22.2 No. 24 certified as meeting correct safety requirements and recognized industry standards and shall be approved for installations in air plenums.

B. Electronic damper actuators for dampers that are part of a smoke evacuation/pressurization scheme must comply with the requirements of UBC 905.14 “Response Time.”

C. Where smoke control dampers do double duty, i.e. are used for controlling floor static pressures with modulating actuators, provide UL listed actuator with spring return complying with the requirements of UBC 905.14 “Response Time.”

D. Additional Requirements

1. The actuator shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp shall be of a "V" bolt design with associated "V" shaped, toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a "V" clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or setscrew type fasteners are not acceptable.

2. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.

3. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe are not acceptable.

4. All spring return actuators shall be capable of both clockwise and counterclockwise spring return operation by simple changing the mounting orientation.

5. Proportional actuators shall accept a 0-10 VDC or 0-20 mA control signal and provide a 2-10 VDC or 4-20 mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable.

6. All 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 watts for DC applications. Actuators operating on 120 VAC power shall not require more than 10 VA. Actuators operating on 230 VAC power shall not require more than 11 VA.

7. All proportional actuators shall have an external, built-in switch to allow the reversing of direction of rotation.

8. Actuators shall be provided with a conduit fitting and a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of operating the actuator housing to make electrical connections.

9. Actuators shall be design for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 5-year manufacturer's warranty, starting from the date on installation. The manufacturer shall be ISO9001 certified.

10. Electronic damper actuators shall be as manufactured by Belimo or JCI.

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2.0162.010 ENCLOSURES

A. Enclosures shall be rated and comply with the standards of The National Electrical Manufacturers Association (NEMA) as specified herein:

1. NEMA 1 – General Indoor Location

2. NEMA 3 - Outdoor

3. NEMA 4 – Wet locations (Central Plant, pump rooms…)

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4. NEMA 12 – Plenums

~~2.017 TSI PRESSURE MONITOR & SENSOR~~

~~A. The room pressure monitor system shall be completely independent for each individual patient room. The room pressure monitor system shall not depend on measurements from other patient room monitor systems.~~

~~B. The room pressure monitor system shall measure the pressure differential between the patient room and reference space. The room pressure sensor shall have a resolution of 5% of the measured value and shall detect any change in the room pressure within 0.1 second, with a minimum reading of 0.00001 inches H2O.~~

~~C. The room pressure monitor system shall accept one to three pressure sensor input. The primary sensor shall measure the pressure differential between the patient room and corridor.~~

~~D. Each monitor shall have a full color touch screen interface with a minimum touchscreen size of 4.3 inches. Screen shall be capable of displaying multiple colors at one time. The monitor shall be capable of displaying room mode, alarm status, user-configurable room label and all measurements connected on a single screen without scrolling. Displays that change the backlighting color or external LEDs to indicate alarm status are not acceptable. Monitors that use keypads are not acceptable.~~

~~E. Local audible and visual alarms and relay contacts shall be enabled whenever either measured room pressure differential falls below its user configurable low alarm set point or rises above its user configurable high alarm set point, after a configurable delay. The pressure sensor shall have individual alarm set points for high and low alarms. A mute function shall temporarily silence the audible alarm for a user configured delay. Manual or automatic reset of the alarms shall be configurable.~~

~~F. The room pressure monitor will use the flow station to calculate the Air Changes per Hour ventilation rate for the patient room. Local audible and visual alarms shall be enabled whenever the measured air volume falls below its configurable low alarm set point, after a configurable delay. Supply and exhaust flows shall have individual alarm set points. The audible alarm shall have a mute function to temporarily silence the alarm for a user-configured delay. Manual or automatic reset of the alarms shall be configurable.~~

~~G. The room pressure monitor system shall have Positive Mode, Negative Mode and No Isolation Mode. Users can change room mode either with an input from a keyswitch or through the touchscreen without accessing the full menu system. The keyswitch or touchscreen shall change the room mode from Positive Mode or Negative Mode to No~~

1 ~~Isolation Mode (and back), allowing the room to be used for standard patient care. In No Isolation Mode, the room pressure monitor will disable all alarms.~~

~~H. Calibration of room pressure differential and air flow shall be done electronically through the use of the integral keypad. Calibration shall consist of adjusting the sensor zero point and sensor span to match a reference measurement. Password protection of the calibration items shall limit unauthorized access. Neither remote calibration nor calibrating through the use of potentiometers is acceptable.~~

~~I. The room pressure monitor shall have the ability to communicate with a building automation system (BMS) via Modbus, BACnet® MS/TP communication protocols.~~

~~J. The room pressure sensor shall be bi-directional with an accuracy of 10% of reading. The sensor shall be capable of being mounted in the corridor (reference space) or the patient room (controlled space). The room pressure sensor shall use two in-line ceramic coated RTDs to measure the pressure differential. The room pressure sensor shall be temperature compensated over a range of 55°F to 95°F. Sensors employing a thermistor-based sensor or that cannot differentiate between positive and negative pressures are not allowed. Field-calibration of the sensor shall be performed through the touchscreen on the room pressure controller.~~

~~K. Acceptable manufactures: TSI, JCI~~

1 ~~2.0182.011~~ INCIDENTAL WORK

A. The BAS installer shall inspect the installation of the following equipment and devices provided under other sections.

1. Work included as part of Sections Sections 230523 and 232113:

a. Installation of automatic valves, separable wells specified to be supplied by the BAS manufacturer.

b. All necessary pressure taps, drain and overflow connections, piping, tubing and valves related to BAS instrumentation and devices.

2. Work included as part of Sections 233300 and 233400:

a. Furnish and install all automatic dampers and provide necessary blank off plates or transitions required for dampers that are smaller than duct size.

b. Assemble multiple section dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.

c. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation and fix seal permanently in place only after stratification problems have been eliminated.

d. Provide access doors or other approved means of access through ducts for service to equipment.

B. Air Handler Devices: Installation of control devices associated with air handlers including but not limited to damper actuators, temperature and pressure sensors shall be provided for mounting at the air handler unit factory where applicable. All cost associated with shipping the devices furnished under this section, to the air handler unit manufacturer shall be borne by the BAS contractor.

C. Interface with Chiller Controls

1. Refrigeration chillers are furnished with integral translator panels for direct interface with BAS.

2. Chiller Start/Stop, Status, Temperature reset and demand-limiting functions shall be accomplished using hardwired points directly from the BAS to the chiller interface control panel. All other functions shall be via the data link (BACnet). Coordinate with chiller manufacturer all the hardware and software requirements for a complete interface as specified.

1 ~~2.019~~2.012 INSPECTION OF CONDITIONS

A. Examine all related work and surfaces before starting work of this Section. Report to the Architect, in writing, conditions which will prevent proper installation of this work. Beginning of work of this section without reporting unsuitable conditions to the Architect constitutes acceptance of conditions. Perform any required removal, repair or replacement of this work caused by unsuitable conditions at no cost to the Owner.

END OF SECTION 255530

SECTION 26 05 00

ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. 019113 – Commissioning

B. 011813 – Sustainable Design Requirements

1.2 WORK INCLUDED

A. Furnish and install all necessary labor, materials, tools and equipment to perform and completely finish the work according to the intent of this specification, and the accompanying drawings.

B. Provide conduit, wires and other miscellaneous materials, equipment and devices, not specifically mentioned in other sections of Division 26, but necessary and/or required for equipment or system operation of function.

C. Review all specification sections and drawings for equipment requiring electrical service. Provide service to and make connections to all such equipment requiring electrical service. Refer to Section 260519 of these specifications for connection requirements.

D. Drawings indicate design loads and voltages and corresponding control equipment, feeders, and overcurrent devices. If equipment actually furnished, other than for equipment provided by the University, have loads or voltages other than those indicated on the drawings or specified herein, control equipment, feeders, and overcurrent devices shall be adjusted in size accordingly at no additional cost to the University. Such adjustment shall be subject to the review of the University's Representative.

E. Provide connections of all equipment specified under this section and any other section and Division 22 and 23 including installation and connection of all relays, remote starters, etc. and the connection of all motors and controllers. Control wiring for Division 22 and 23 systems shall be provided by Division 23. Review Division 23 specifications and shop drawings for control systems to assure compatibility between equipment furnished under Division 26 and wiring furnished under Division 22 and 23. Motor controllers (starters) shall be furnished and installed under Division 26, unless specified to be furnished as an integral component of the equipment or unless controller is variable frequency drive type. Provide the number and type of auxiliary contacts necessary to interlock the equipment and provide the control sequence in Division 22 and 23.

1.3 LOCAL CONDITIONS

A. Examine site; verify dimensions and locations against drawings and become informed of all conditions under which work is to be done before submitting proposal. No allowance will be made for extra expenses because of omission on Contractor's part to include cost of work under prevailing conditions.

B. Information shown relative to services is based upon available records and data shall be regarded as approximate only. Minor deviations found necessary to conform with actual locations and conditions shall be made without extra cost.

C. Extreme care shall be exercised in excavating near existing utilities to avoid any damage thereto; be responsible for any damage caused by such operations.

D. Request any utility shutdown, dig permit or road closure through the University's Representative, 14 days in advance. Include detailed procedure and proposed schedule. In each case approval must be obtained from the University's Representative for the requested shutdown time and work involved. Shutdown work shall be performed on overtime hours if so directed by the University.

E. Protect premise and work of other trades from damage arising out of installation of work of this division. If damage has occurred, repair or replace materials and parts of premises as directed by University's Representative at no cost to the University.

1.4 CODES AND STANDARDS

A. Applicable codes are those specified in Section 01 41 00 – Regulatory Requirements. Nothing in the Drawings or Specifications shall be construed to permit work not conforming to these codes, latest edition as adopted by authority having jurisdiction.

B. Material Standards: All material shall be new and shall conform to the standards where such have been established for the particular material in question. Publications and Standards of the organization listed are applicable to materials specified herein. Also refer to Division of these specifications: Insulated Cable Engineers Association (ICEA), Institute of Electrical and Electronic Engineers (IEEE), Edison Electric Institute (EEI), American Wood Preservers Association (AWPA), National Board of Fire Underwriters (NBFU), Illuminating Engineering Society (IES), Electrical Testing Laboratory (ETL).

C. Code compliance is mandatory - no information or details on the drawings or specifications permits work not conforming to code. Where work is shown to exceed minimum code requirements perform work per drawings and specifications.

1.5 DRAWINGS

A. The drawings indicate the arrangements of electrical equipment. Review architectural drawings and details for door swings, cabinets, counters and built-in equipment; conditions indicated on architectural plans shall govern. Coordinate installation of electrical equipment with structural system and mechanical equipment and access thereto. Coordinate installation of recessed electrical equipment with concealed ductwork and piping, and wall thickness.

B. Do not scale drawings. Obtain dimensions for layout of equipment from Architectural plans and details unless indicated on Electrical plans. Field measurements take precedence over dimensioned drawings.

C. Bring all discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the University's Representative.

D. Equipment layout is based on one manufacturer's product or from composite dimensions from multiple manufacturers. Where equipment selected for use on the job differs from layout, coordinate space requirements and connection arrangements with Engineer. Equipment which exceeds specified maximum dimensions or which reduces required clearances shall not be accepted.

1.6 RECORD DRAWINGS

A. Upon completion of all Work, but before final acceptance, the Contractor shall furnish the University's Representative with complete sets of reproducible drawings updated and corrected to "as-built" conditions as specified. The contract documents drawings issued for bid shall be revised for "as-built" conditions. Include electronic panelboard files in Excel format updated to "as-built" conditions, copies of all submittal data, shop drawings, control Panel layout, point to point wiring diagram, conduit routing, underground duct banks, site lighting and any other detailed drawings.

B. All symbols, designations, and layers used in preparing Record Drawing shall match those used in Contract Drawings and electronic files.

C. Show all buried and concealed conduit, stub-outs, etc. Locate all buried conduit and stub-outs by dimensions from permanent, easily located and identifiable portions of structure; also, dimension ends of stub-outs, etc. Note depth of buried items below grade.

1.7 SUBMITTALS

A. Shop Drawings and Product Data:
1. Submit for review by the University's Representative data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, catalogs, cuts, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements; model numbers alone will not be acceptable. Provide complete electrical characteristics for all equipment. Submittals for lighting fixtures shall include Photometric data.
2. Refer to the individual sections for identified equipment and materials for which submittals are required.
3. Refer to Division 1 for required procedures.

B. Operation and Maintenance Data and Instruction:
1. Refer to Division 1 for detail requirements.
2. Printed Material: Provide required printed material for binding in operation and maintenance manuals.
3. Instructions of University Personnel:
   a. Before final inspection, as designated by the University's Representative provide a competent representative to instruct University's designated personnel in systems under this division of the specifications. For equipment requiring seasonal operation, perform instructions for other season within six months unless requested otherwise.
   b. Use operation and maintenance manuals as basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
   c. Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials mentioned herein or on drawings require that each item listed be provided and of quality noted, or an approved equal. All material shall be new, full weight and standard in all respects and in first-class conditions. Materials and equipment shall be uniform throughout the installation. Where possible, all materials used shall be of the same brand or manufacturer throughout for each class of material or equipment.

B. Grade or quality of materials desired is indicated by trade names or catalog numbers stated herein. Substitutions will be also be evaluated on maintenance track record and parts availability for previous installations that have been installed a minimum of five years. Refer to Specification Section 01 33 23. Dimensions, sizes and capacities shown are a minimum and shall not be changed without permission of Engineer.

C. All electrical equipment and materials shall satisfy minimum requirements of NEMA, IEEE and ANSI standards. All materials must be UL approved, or if not covered by UL testing standards, shall be test and approved by ~~an independent~~ a Nationally Recognized Testing Laboratory (NRTL).

D. Work such as painting, patching, welding or carpentry related to the work of this Division shall be performed by the appropriate trade experienced in that work, but shall be provided for under this Division.

E. The following systems will be purchased and installed separately by the University. Provide all the conduit and outlet boxes required for complete installation under this contract. Provide input to and coordination with the University's Representative during the preparation of the shop drawings. Review shop drawings provided by University's Representative for installation information and provide comments as required. Installation of conduit and outlet boxes shall be governed by shop drawing requirements. All special system conductors will be provided and installed by the ~~University~~ contractor; all conductors required for 120-volt power shall be provided under this contract. Notify the University's Representative of required dates for shop drawing completion and material delivery to coordinate with overall construction schedule. Specification sections contained herein are based on a complete system - individual components to be provided by the University are not identified other than by the requirements of this paragraph.
   1. Security Cameras and camera mounts.

PART 3 - EXECUTION

3.1 ELECTRICAL SYSTEMS OPERATIONAL TESTS, MANUFACTURERS SYSTEMS CERTIFICATION AND DESIGN AUTHORITY ASSISTANCE

A. Commissioning The project will have selected building systems commissioned. The equipment and systems to be commissioned are specified in Section 01 91 13. The commissioning process is described in Section 01 91 13.

3.2 GENERAL

A. All electricians to be state certified and apprentices in an approved training program.

B. When changes in location of any work are required, obtain approval of University's Representative before making changes.
   1. Make changes at no extra cost.

C. Do not change indicated sizes without written approval of University's Representative.

D. Provide all necessary offsets and crossovers in conduits, raceways, cabletrays and ducts.

E. Provide flexible connections of short length to installations or equipment subject to vibration or movement and to all motors. Provide a separate bonding conductor across all flexible connections.

F. Install exposed conduits parallel to walls and ceilings and vertically plumb, unless otherwise indicated.

G. Existing equipment or electrical wiring which is to remain, but has been removed to facilitate the installation of the new equipment, shall be restored to its original operating condition.

H. Where electrical items penetrate fire or smoke rated walls, ceilings and floors, comply with Section Division 7.

I. Before any cutting, burning, heating or other work that will emit smoke, dust or other products of combustion that may set off the fire alarm system, request a fire alarm system shutdown from the University's inspector. This request shall be made at least 14 days prior to the date the shutdown is required. If this requirement is ignored and triggers the fire alarm system the offending party shall be responsible for all false alarm charges from the fire department. Instruct all personnel of this requirement before they are permitted on the job site. If the job site has a portable fire alarm system installed for the construction period, turn the system on and off each working day.

J. Provide concrete foundations or pads as follows for floor mounted electrical equipment where indicated on the drawings:
1. Install minimum 4” high concrete pads or as indicated. Other pad dimensions shall be as required to accommodate the equipment installed.
2. Use 3,000 PSI (14 Kg/s/mm) concrete.
3. Reinforce with 6” x 6” W2.9 x W2.9, 10GA (3.4mm) mesh, with short dowels into floor at 12” OC around perimeter.
4. Chamfer top edges ¾” (18mm).
5. Make all faces smooth.
6. Set anchor bolts for equipment. Consult with user.
7. Coordinate the size of all pads, the location of all anchor bolts, and the location of all vibration isolators.

3.3 QUALITY ASSURANCE AND PROJECT SAFETY

A. Provide quality assurance and project safety programs. Satisfy the minimum acceptable requirements provided in the specifications.

3.4 PREPARATION

A. Examine Drawings and Site; be familiar with types of construction where electrical installation is involved.
1. Work shall be neatly installed in a professional manner in accordance with NECA Standard of Installation. Work shall be coordinated with other trades to avoid conflicts. Clarifications will be made by University's Representative and minor adjustments shall be made without additional cost to University. Obtain clarification from University's Representative concerning any obvious discrepancies or omissions in work before bidding. All work involved in correcting obvious errors or omissions after award of Contract shall be performed as directed by University's Representative without additional cost to University.

B. Layouts of equipment, accessories and wiring systems are diagrammatic (not pictorial), but shall be followed as closely as possible. Drawings and Specifications are for assistance and guidance, and exact locations, distances, levels, etc., will be governed by Site.

C. Schedule of Values:
1. Refer to Division 1 for submittal requirements.
2. Provide a schedule of values for the electrical work specified under Division 26. Include separate labor and material itemization for each line item requested. The itemized schedule of values will be used to determine project completion and progress for payment requests, including overhead

and profit for each itemization. Schedule of values must be submitted and approved prior to first pay request. Provide the following line items as a minimum level of itemization:

a. Electrical service and distribution (include all power equipment, i.e., panelboards, transformers, feeders, motor controllers, etc.).
b. Lighting systems (include all fixtures, lamps, branch circuiting, and lighting controls).
c. Devices (include all power outlets and branch circuit wiring not associated with lighting, motors, or equipment connections).
d. Equipment connections (include all wiring and connection to HVAC, elevators, etc., including controlling devices and feeders).
e. Basic work and materials (include work common to all systems, i.e., backboards, cutting and patching, demolition, temporary services, record drawings, permits, etc.).
f. Special systems (itemize separately, including emergency power supply system, grounding system, UPS equipment, etc.).
g. Communications/signaling systems (include all low voltage systems, itemized separately, i.e., fire alarm, sound paging, security, etc.).

3.5 WORKING SPACE

A. Provide adequate working space around electrical equipment in compliance with Article 4 of Electrical Safety Orders. In general, provide 36” minimum clear workspace in front of panelboards and controls.
   1. 36" @ 250V and less.
   2. 42" @ 250V to 600V.

3.6 PRODUCT DELIVERY, STORAGE, HANDLING, AND PROTECTION

A. Inspect materials upon arrival at Project and verify conformance to Contract Documents. Prevent unloading of unsatisfactory material including University furnished material. Handle materials in accordance with manufacturer's applicable standards and suppliers recommendations, and in a manner to prevent damage to materials. Store packed materials in original undamaged condition with manufacturer's labels and seals intact. Containers which are broken, opened, damaged, or watermarked are unacceptable and shall be removed from the premises and replaced at no additional cost to the University.

B. All material, except items specifically designed to be installed outdoors, shall be stored in an enclosed, dry building or trailer. Areas for general storage shall be provided. Provide temperature and humidity control where applicable. No material for interior installation, including conductors, shall be stored other than in an enclosed weathertight structure. Equipment stored other than as specified above shall be removed from the premises and replaced at no additional cost to the University.

C. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Conditions shall be those for which the equipment or materials are designed to be installed. Equipment and materials shall be protected from water, direct sunlight, cold or heat. Equipment or materials damaged or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced at no additional cost to the University.

3.7 CARE AND CLEANING

A. Remove oil, dirt, grease and foreign materials from all raceways, fittings, boxes, panelboard trims and cabinets to provide a clean surface for painting. Touch-up scratched or marred surfaces of lighting

fixtures, panelboard and cabinet trim, motor control center, switchboard or equipment enclosures with paint furnished by the equipment manufacturers specifically for that purpose.

B. Accessible elements of disconnecting and protective devices of equipment, coils of dry type transformers and the like shall be cleaned with compressed air (less than 15 PSI) and the enclosures vacuum cleaned prior to being energized.

C. Clean light fixtures and lamps thoroughly, just prior to final inspection. Fixture enclosures, shielding, etc., shall be cleaned by an approved method.

D. Do not paint trim covers for flush mounted panelboards, telephone cabinets, pull boxes, junction boxes and control cabinets unless required by the University's Representative. Remove trim covers before painting. Under no conditions shall locks or exposed trim clamps be painted.

E. Unless indicated on the drawings or specified herein to the contrary, all painting shall be done under the PAINTING Section of these Specifications.

F. Where plywood backboards are used to mount electrical equipment provided under Division 26, paint backboards with two coats of light gray semi-gloss fire retardant paint under Division 26.

G. Plywood, Mounting Backboard for Communications Equipment - Plywood mounting backboard shall extend ceiling-to-floor (10’), unless otherwise specified. Mount plywood to cover the entire area on which connecting hardware and cable management hardware may be mounted. Mounting board shall be AC-grade or better, void-free plywood, with a minimum thickness of 19 mm (¾”).

1. Two-coats of FR-S fire-retardant rated paint shall be applied to all exposed surfaces. The plywood-rating stamp shall be left exposed for inspection purposes.

2. Securely fasten plywood to wall-framing members. Use flush hardware and supports to mount plywood.

3. Ensure that the strength and placement of the hardware are sufficient to handle the total anticipated load (static and dynamic) and mounting of cabling components.

4 Color of paint shall be **WHITE**.

H. All broken, damaged or otherwise defective parts shall be repaired or replaced without additional cost to the University. Work shall be left in a condition satisfactory to University's Representative. At completion, carefully clean and adjust all equipment, fixtures and trim installed as part of this work. Systems and equipment shall be left in a satisfactory operating condition.

I. All surplus materials and debris resulting from this work shall be periodically cleaned out and removed from site; this includes surplus excavated material.

3.8 EXCAVATING AND BACKFILLING

A. Excavate and backfill as required for installation of electrical work. Restore all surfaces, roadways, sod, walks, curbs, walls, existing underground installation, etc., cut by installations to original condition in an acceptable manner. Maintain all warning signs, barricades, flares and lanterns as required by the Safety Orders and local ordinances.

B. Excavation: Dig trenches straight and true to line and grade, with bottom clear of any rock points. Support conduit for entire length on undisturbed original earth. Minimum conduit depth of crown shall be 2’ below finished grade.

C. Backfill: All backfill material shall be local material free of rubble, rubbish or vegetation. Trenches shall be backfilled and compacted to 90% of maximum dry density at optimum moisture content in layers not to exceed 6" when compacted.

3.9 CUTTING AND PATCHING

A. Provide necessary cutting and patching required to accomplish the work of Division 26.

B. Do not endanger the stability of the structure by cutting, drilling or otherwise modifying the structural members of the building. Direct all requests for structural modifications to the University's Representative for approval. Proceed with these modifications only as directed by the University's Representative.

C. Cutting and patching requirements will be modified only if General Construction Specifications and drawings specifically state that certain portions or all cutting and patching required for each of the various trades is to be performed.

D. Refer to General Construction Specifications for execution and requirements for patching and painting and comply with applicable provisions as to materials and quality of installation.

3.10 PROTECTION

A. In performance of work, protect work from damage. Protect electrical equipment, stored and installed, from dust, water or other damage.

3.11 EQUIPMENT IDENTIFICATION

A. Panelboards, remote control switches, terminal boxes, etc., shall be properly identified according to section 260553 of these specifications.

3.12 RUST INHIBITER

A. Channels, joiners, hangers, caps, nuts and bolts and associated parts shall be plated electrolytically with zinc followed immediately thereafter by treating freshly deposited zinc surfaces with chromic acid to obtain a surface which will not form a white deposit on surface for an average of one hundred twenty (120) hours when subjected to a standard salt spray cabinet test, or shall be hot dipped galvanized.

3.13 ELECTRICAL SYSTEMS OPERATIONAL TESTS, MANUFACTURERS SYSTEMS CERTIFICATION AND DESIGN AUTHORITY ASSISTANCE

A. Testing:
1. Provide tests specified in other sections. Test all wiring and connections for continuity and grounds; where such test indicate faulty insulation or other defects, locate, repair and retest. Balance loads at panelboards. Furnish all testing equipment.
2. Refer to the individual specification sections and Section 26 90 90 of the specifications for test requirements.
3. Prior to the final inspection, the systems or equipment shall be tested and reported as therein specified. Five (5) typewritten copies of the tests shall be submitted to the University's Representative for approval. Testing does not replace the requirement for final inspection of the project work.

4. All electrical systems shall be tested for compliance with the specifications.

B. Manufacturers Certifications:
   1. The electrical systems specified herein shall be reviewed for compliance with theses specifications, installation in accordance with the manufacturers' recommendations and system operation by a representative of the manufacturer. The manufacturer shall submit certification that the system has been reviewed by the manufacturer, is installed in accordance with the manufacturer's recommendations and is operating in accordance with the specifications.
   2. Provide manufacturers certification for the following systems:
      a. Fire Alarm System
      b. Clock System
      c. Security Systems
      d. Intercom System
      e. Public Address System
      f. Lighting Control Systems
      g. Automatic transfer switches
   3. Design Authority Assistance:
      a. Remove equipment covers (i.e. panelboard trims, motor controls, device plates, and junction box covers) as directed for inspection of internal wiring. Accessible ceilings shall be removed as directed for inspection of equipment installed above ceilings.
      b. Energize and de-energize circuits and equipment as directed. Demonstrate operation of equipment and systems as directed by the University's Representative.
      c. Provide authorized representatives of the manufacturers to demonstrate to the University's Representative compliance with the specifications of their respective system during or prior to the final inspection at a time designated by the University's Representative. Refer to the specific specification section for additional testing requirements. Representatives of the following systems are required for demonstrations:
         1) Fire Alarm System
         2) Intercom System
         3) Surveillance System
         4) Public Address System
         5) Lighting Control System
         6) Automatic Transfer Switches

3.14 CLOSING OF AN UNINSPECTED WORK

A. Do not allow or cause any of work installed hereunder to be covered up or enclosed before it has been inspected and approved.

B. Should any work be enclosed or covered up before it has been approved, uncover such work and after it has been inspected and approved, make all repairs necessary to restore work of others to conditions in which it was found at time of cutting, all without additional cost to the University.

3.15 TEMPORARY FACILITIES

A. Provide temporary shop office and storage space on site only at locations approved by the University's Representative. Remove these facilities upon completion of work.

3.16 NOISE AND VIBRATION

A. Cooperate in reducing objectionable noise or vibration. If noise or vibration occurs as a result of the use of improper material or installation, correct these conditions at no cost to the University.

END OF SECTION 26 05 00

SECTION 26 05 19
LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

GENERAL

1.1 DESCRIPTION

A. The work required under this section of the specifications consists of furnishing, installing and connecting the building wiring system, 600 volts and below. Exterior branch circuit wiring and feeder conductors extended beyond the building are included. Wiring systems for communication and alarm systems are not included in this section unless specified to be included, by reference, in the respective specification sections for alarm and communication systems.

1.2 RELATED WORK

A. Section 260533 – Raceways

B. Section 260520 – Electrical Connections for Equipment

1.3 QUALITY ASSURANCE

A. Industry Reference Standards. The following specifications and standards are incorporated into and become a part of this Specification by Reference.
1. Underwriters' Laboratories, Inc. (UL) Publications:
   a. No. 83 Thermoplastic - Insulated Wires
   b. No. 486 Wire Connectors and Soldering Lugs
   c. No. 493 Thermoplastic - Insulated Underground Feeder and Branch Circuit Cables
   d. No. 854 Service Entrance Cables
2. Insulated Cable Engineers Association Standards (ICEA):
   a. S-61-402 Thermoplastic Insulated Wire and Cable
3. National Electrical Manufacturer's Standards (NEMA):
   a. WC-5 Thermoplastic Insulated Wire and Cable
   b. WC-26 Wire and Cable Packaging
4. UBC Standard 4-1 for non-combustible materials for wires and cables above non-sprinklered ceilings.

B. Acceptable Manufacturers: Products produced by the following manufacturers which conform to this specification are acceptable.
1. Hydraulically applied conductor terminations:
   a. Scotch (3M)
   b. Thomas and Betts (T&B)
   c. or equal
2. Mechanically applied (crimp) conductor terminations:
   a. Scotch (3M)
   b. Thomas and Betts (T&B)
   c. or equal
3. Vinyl electrical insulating tape:
   a. Scotch (3M)
   b. Tomic
   c. or equal
4. Twist-On Wire Connectors:
   a. Buchanan
   b. Ideal

c. or equal

5. Encapsulated insulating kits:
   a. Essex Group, Inc.
   b. Raychem
   c. Scotch (3M)
   d. or equal
6. Portable cable fittings:
   a. Crouse Hinds
   b. T & B
   c. or equal
7. Insulated cable:
   a. Pirelli Cable Corp.
   b. Southwire Co.
   c. or equal

C. Performance: Conductors shall be electrically continuous and free from short circuits or grounds. All open, shorted or grounded conductors and any other damaged insulation shall be removed and replaced with new material free from defects.

D. Delivery, Storage and Handling: Deliver wire and cable in accordance with NEMA WC-26. Wires and cables shall not be stored in an exterior or unprotected location. Material subject to direct exposure to the elements shall be replaced and removed from the project. Bring wire to job in original unbroken packages. Obtain approval of University's Representative before installation of wires.

1.4 SUBMITTALS

A. Submit shop drawings in accordance with the Conditions of the Contract and Division One Specifications Sections for the conductors, terminations, connectors, insulating tape, and insulating kits.

B. Submit field test reports indicating and interpreting test results required by the "Electrical Equipment Acceptance Testing" section of these specifications.

PRODUCTS

1.5 GENERAL MATERIALS REQUIREMENTS

A. Provide all materials under this section of the specifications.

B. All wire and cable shall be UL listed and shall bear a UL label along the conductor length at intervals not exceeding 24 inches.

C. All conductors shall have size, grade of insulation, voltage and manufacturer's name permanently marked on the outer cover at intervals not exceeding 24 inches.

D. Conductor size shall be a minimum of No. 12 AWG. Conductor size shall not be less than indicated on the drawings. The minimum size of emergency systems conductors shall be No. 10 AWG.

E. Insulation voltage level rating shall be 600 volts.

F. All conduit and conductor sizes indicated on the drawings are based upon copper conductors. 60C ampacities shall be used for sizing of all wire and cable for branch circuits and feeders rated below 125

amps. 75C ampacities shall be used for sizing of all wire and cables for feeders rated 125 amps and above.

G. Use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet.

1.6 PRODUCT/MATERIALS DESCRIPTION - CONDUCTORS

A. Conductors shall be stranded copper, 90°C, type THHN/THWN or XHHW unless otherwise indicated on the drawings, required by the California Electrical Code, or specified herein.

B. Fixture wire shall be No. 16 AWG silicone rubber insulated, stranded fixture wire, type SFF-2 (150°C), or No. 16 AWG thermoplastic, nylon jacketed stranded fixture wire, type TFFN (90°C). Color code as specified herein shall not be required for fixture wire; however, neutral conductor shall be identified distinctly from phase conductors. Conductors connected to vaportight fixtures shall be type AF.

C. Control conductors for use on 120 volt control wiring systems shall be No. 12 AWG stranded type THHN/THWN, where properly protected, unless indicated otherwise on the drawings. Switch legs are not considered control wiring.

D. Portable power cables and outlets shall be provided where indicated on the drawings. Cables shall be sized as indicated on the drawings with equal size green equipment ground. Cables shall be jacketed 600 volt SO type. Cable connectors shall be steel case liquid tight sized for cable diameter and shall use strain relief gland fitting to prevent tension on conductor terminals. Where cable drops are indicated on the drawings, use wire mesh strain relief cable grips at both ends of cable. Use cast type outlet device box for device cable drops.

E. Wire shall be 1991 Code type copper wire of not less than 98% conductivity. All wires shall be stranded. Wires shall bear the Underwriters' label, be color coded and be marked with gauge, type and manufacturer's name on 24" centers.

1.7 SPLICES, TAPS, AND CONNECTORS

A. Splices, taps and connectors (No. 10 AWG and smaller) - Splices and joints shall be twisted together electrically and mechanically strong and insulated with approved type insulated electrical spring connectors.

B. Splices, taps and connectors (No. 8 and larger) - Joints and connections shall be made with Burndy, T & B, or equal, solderless tool applied pressure lugs and connectors. Uninsulated lugs and wire ends shall be insulated with layers of plastic tape equal to insulation of wire and with all irregular surfaces properly padded with "Scotchfil", 2nd product or equal putty prior to application of tape. Tape shall be equal to Scotch #33, General Electric #AW-1, or equal. Feeder splicing, where permitted, shall be made with high compression sleeve type connector followed by manufactured splicing kit utilizing as insulators, resins poured into a ready-to-use plastic mold to provide a uniform, moisture-proof tough, impact-resistant insulation. Hydraulically applied crimping sleeve or tap connector sized for the conductor. Insulate the hydraulically applied connector with 90°C, 600 volt insulating cover provided by the connector manufacturer. Insulator materials and installation shall be approved for the specific application, location, voltage and temperature and shall not have an insulation value less than the conductor being joined.

C. Electrical insulating tape shall be 600 volt, flame retardant, cold and weather resistant, minimally .85 mil thick plastic vinyl material; Scotch No. 88, Tomic No. 85, Permacel No. 295, or equal.

EXECUTION

1.8 EXECUTION

A. Install all wiring in raceway system, except where conductors are indicated or specified not to be installed in raceway. Any conductors found to be damaged or defective, including insulation damaged during installation, shall be removed and replaced at no expense to the University.
   1. Pull conductors into raceway simultaneously where more than one is being installed in the same raceway.
   2. Use UL listed pulling compound or lubricant where necessary to reduce cable pulling tension below the manufacturer's recommended levels. Compound used shall not deteriorate conductor or insulation.
   3. Use pulling means, including fish tape, cable rope, or basket-weave wire/cable grips that will not damage cable or raceway.

B. Connect all conductors. Torque each terminal connection to the manufacturers recommended torque value. A calibrated torquing tool shall be used to insure proper torque application.

C. Do not install more conductors in a raceway than indicated on the drawings. A maximum of three branch circuits are to be installed in any one conduit, on 3 phase 4 wire system, unless specifically indicated otherwise on the drawings. No two branch circuits of the same phase are to be installed in the same conduit, unless specifically indicated on the drawings.

D. Conductors shall be tested to be continuous and free of short circuits and grounds.

E. Maintain phase rotation established at service equipment throughout entire project.

F. Group and lace with waxed linen lacing cord (T & B "Ty-Rap", Holub "Quik-Wrap" or equal) all conductors within all enclosures, i.e., panels, motor controllers, equipment cabinets, switchboards, etc.

G. Splices in homerun conductors to panelboards, switchboards, switchgear, motor control centers, motor control enclosures, and other panels shall be kept to the minimum practicable and shall only be made as necessary to support pulling of the conductors. Make splices in conductors only within junction boxes, wiring troughs and other enclosures as permitted by the California Electrical Code. Do not splice conductors in pull boxes, panelboards, safety switches, switchboard, switchgear, motor control center, or motor control enclosures.

H. Splices in conductors installed below grades are not permitted, unless approved in writing by the University's Representative. For taps indicated on the drawings and approved splices below grades, connections shall be made in flush mounted watertight junction box with crimp connectors and watertight resin encapsulating insulating kit. Service entrance conductors shall not be spliced.

I. Support conductors installed in vertical raceways at intervals not exceeding those distances indicated in the California Electrical Code. Support conductors in pull boxes with bakelite wedge type supports or "Kellem" grips or equal, provided for the size and number of conductors in the raceway. Do not splice conductors in pull boxes used for vertical cable supports unless written permission for splicing is obtained. Where splicing is permitted, make splice with hydraulically applied splicing sleeve.

J. Terminate conductors No. 10 AWG and smaller specified in Division 26 to be stranded, with crimp type lug or stud. Direct termination of stranded conductors without crimp terminator to terminal screws, lugs, or other points is not permitted even if terminal is rated for stranded conductors. Crimp terminal shall be the configuration type suitable for terminal point.

K. Make connections between fixture junction box and fixture with fixture wire.

L. Control, communications or signal conductors shall be installed in separate raceway systems from branch circuit or feeder raceway, unless indicated otherwise on the drawings.

M. Conductor lengths for parallel circuits shall be equal. Do not configure isolated phasing in separate conduits for parallel conductors.

N. Install a minimum of twelve inches (300 mm) of slack conductor at each outlet.

O. Thoroughly clean conductors prior to installing lugs and connectors.

P. Secure portable cables in accordance with the CEC. Install strain relief devices to prevent tension on terminations if cable is pulled. Install cable grips on drops and connect to outlet box or structure. Leave slack cable loop at drop point.

Q. All cables and wires passing through manholes and handholes shall be full looped inside the manhole and handhole and supported on galvanized steel racks.

1.9 IDENTIFICATION

A. Color Code Conductors:
1. Color code all secondary service, feeder and branch circuit conductors. Control and signal system conductors need not be color coded.
2. Coding shall be as follows:
   a. 208Y/120 volt three phase four wire wye system - Phase A: Black, Phase B: Red, Phase C: Blue, Neutral: White, Travellers: Orange.
   b. 480Y/277 volt three phase four wire system - Phase A: Brown, Phase B: Violet, Phase C: Yellow, Neutral: Gray, Travellers: Pink.
   c. Grounding conductors shall be green. Grounding conductors for isolated ground circuits shall be green with a yellow trace.
3. Phase conductors No. 10 and smaller shall have solid color compound insulation or color coating. Phase conductors No. 8 and larger shall have solid color compound, color coating or colored phase tape. Colored tape shall be installed on conductors in every box, at each terminal point, cabinet, through manhole or other enclosure.

B. Conductors within pull boxes shall be grouped and identified with nylon tie straps with circuit identification tag.

C. Identify each control conductor at its terminal points with wrap around tape wire markers. I.D. to indicate terminal block and point designation, or other appropriate identifying indication.

D. Refer to ELECTRICAL IDENTIFICATION section of these specifications for additional identification requirements.

1.10 TESTING

A. Refer to Electrical Equipment Acceptance Testing section of this specification for testing requirements.

END OF SECTION
26 05 19

SECTION 26 05 20
ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Electrical Connections to equipment specified under other sections or as shown on drawings.

1.02 SUBMITTALS

A. None Required.

1.03 REFERENCE STANDARDS.

A. Underwriters Laboratories.

B. NEMA WD5 – Specific Purpose Wiring Devices.

1.04 QUALITY ASSURANCE

A. Field verify equipment rating with manufacturers nameplate data. Adjust feeders and overcurrent protectors as required to comply with code requirements.

PART II - PRODUCTS

2.01 LUGS

A. Acceptable Manufacturers.

1. Burndy Corporation.

2. ILSCO Corp.

3. Or Equal

B. Compression Type: Seamless, one piece, copper, size per conductor applied to, two NEMA Drill.

C. Set Screw Type: Pin type compression fittings for use on #2 AWG and larger conductor sizes, barrels filled with conductive paste.

2.02 CRIMP ON TERMINALS

A. Acceptable Manufacturers

1. Thomas-Betts

2. 3M

3. Or Equal

B. Crimp on, insulated terminals for use on #14 AWG thru #10 AWG conductor size, flanged fork or ring torque style.

2.03 CONNECTORS, SPLICES AND TAPS

A. Acceptable Manufacturers

1. Burndy

2. ILSCO

3. Or Equal

B. Compression or set screw type with insulating cover for use on #8 AWG and larger conductor.

C. Split bolt connectors with insulating covers for use on #6 AWG and larger conductor.

2.04 WIRE CONNECTORS

A. Acceptable Manufacturers

1. Ideal Industries

2. Buchanan

3. Or Equal

B. Conical spring type with nylon or plastic outer shell, color coded to denote wire size, for use on #14 AWG thru #10 AWG conductors.

C. Butt Compression style insulating crimp splices for use on #14 AWG and smaller conductors.

PART III - EXECUTION

3.01 INSTALLATION

A. Bus Connection: Use compression lugs, bolt to bus bars using cap screws, lock washers and nuts of material electrically compatible with bus.

B. Set Screw Connection: Install pin type compression fitting of similar construction as compression lugs.

C. Terminations to Motors: Use crimp on connectors for motor terminations from stranded conductors and where terminal lugs are not provided by equipment supplier. Use ring-tongue terminals where ever possible.

D. Use connector manufacturer approved crimping tool to install connectors. Do not remove conducting strands or oversize connector. Apply insulating tape over exposed conductor to 150% of conductor insulating material.

E. Tighten connections to ensure maximum surface contact between terminals.

F. Strip insulation per manufacturers instructions, use conductive paste where required.

G. Install electrical connections as indicated; in accordance with equipment manufacturer's written instructions and with recognized industry practices.

H. Coordinate with other work, including wires, cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

I. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

J. Fasten identification markers to each electrical power supply conductor which indicates their voltage, phase and feeder number in accordance with Electrical Identification section. Affix markers on each terminal conductor, as close as possible to the point of connection.

3.02 INSPECTION

A. Inspect area and conditions under which electrical connections for equipment are to be installed. Do not proceed with the work until conditions are acceptable for terminations.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installing of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirements. Correct malfunctioning units at site, then retest to demonstrate compliance.

B. Test all wiring and connections for continuity and grounds; where such test indicate faulty insulation or other defects, locate, repair and retest. Balance loads at panelboards. Furnish all testing equipment.

C. Provide documentation of all tests as specified by this and other sections in the following formats. Submit in an electronic form (2 copies) and in hard paper form (2 copies). Submit interim test reports to the University’s Representative and ‘final’ acceptance test reports (where only one test iteration is required consider it be the ‘final’) to the prime electrical contractor (for a single, consolidated submission of all electrical test and O&M’s to the University). Compile the electronic copies (including graphics or drawings) entirely in the current version of Acrobat Abode complete with an interactive field linked Table of Contents (linked to the chapters and subsections within the report). Submit electronic copies on a CD (or CD's).

D. All electrical systems testing (power and low voltage) as described by each central collection point for all test documentation, whether the tested systems were provided and installed under his contract or not. All Division 16 contractors and vendors are required to cooperate with the prime electrical contractor in this regard and the single submission of tested results shall be considered a contract requirement of all contractors and vendors for all electrical, communication, data, etc. work performed under Division 16.

E. Provide a copy of the test documentation with the O&M Manual submission.

END OF SECTION 26 05 20

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Power System Grounding.

2. Communications System Grounding.

3. Electrical Equipment and Raceway Grounding and bonding.

1.02 SUBMITTALS

A. Submit a complete set of marked-up record drawings to indicate installed location of system grounding electrode connections, and routing of grounding electrode conductor.

B. Submit certified test results stating ground resistance from service neutral at service entrance.

1.03 REFERENCE STANDARDS

A. National Electrical Manufacturers Association (NEMA).

B. American National Standards Institute (ANSI).

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Oz Gedney.

B. or equal

2.02 MATERIALS

A. Ground Rods: Copper encased steel 1” diameter, minimum length – 10’.

B. Ground Clamp: Water pipe connection, bronze two-piece with serrated jaws, lug sized for grounding electrode conductor.

C. Connectors, Compression Type: Bronze or Copper, pretreated with conductive paste, sized for conductor to which applied.

D. Connectors, Exothermic Weld Type: Powder actuated weld. Bond made through exothermic reaction producing molten copper from premixed copper oxide and aluminum powder. Form bond in mold or crucible.

2.03 SECONDARY GROUNDING SYSTEM

A. The main grounding system shall consist of bare copper ground wires connected to a UFER ground placed below the bottom of the structural slab. The grounding system shall include, but is not limited to ground cables, fittings, connectors and all other devices and material as required to render the system complete and meet the requirements of CEC Article 250. Connect grounding system to all building columns.

B. Except where specifically indicated otherwise, all exposed noncurrent carrying metallic parts of electrical equipment, metallic raceways systems, grounding conductor in nonmetallic raceways and neutral conductor of the wiring system shall be grounded. The ground connection shall be made at the main service equipment of each service and shall be extended to all required components of CEC Article 250.

2.04 GENERAL BRANCH CIRCUITS GROUNDING

A. All grounding conductor wire shall be insulated green copper conductors.

B. All conduit bushings shall be grounding type.

C. All grounding connections shall be made with solderless lugs and nonferrous hardware.

2.05 CONDUIT BANK GROUNDING

A. Provide a size 4 /0 bare copper grounding conductor for each of the campus utility distribution conduit banks shown on drawings. Install this grounding conductor within the ground floor slab and parallel to the respective conduit bank.

PART III - EXECUTION

3.01 INSTALLATION OF THE MAIN SERVICE ENTRANCE GROUND

A. Provide a main service entrance grounding system with cables, connections, and ground buses as shown on the drawings and specified. Provide all necessary materials and testing of the grounding system.

B. Where available the incoming water service, sprinkler system piping, building steel, UFER ground mat, footing electrode ground rod, and grounding ring encircling the building shall all be bonded together to form a grounding electrode system per CEC Section 250.

C. Install the grounding system to obtain a ground resistance of the grounding grid not to exceed 5 ohms. Provide testing of the ground grid to obtain a ground resistance rating. If the resistance exceeds 5 ohms, contact the University's Representative for review of installation and additional procedures.

3.02 UFER GROUND SYSTEM

A. UFER Ground System shall consist of a bare service ground copper ground conductor connected to a UFER ground placed within the structural slab in contact with the earth.

B. UFER Ground Mat: Form a continuous conductor mat by serpentining bare copper conductor of minimum length 60' in the bottom of the structure foundation footing. The maximum resistance of the ground mat shall not exceed 5 ohms under normally dry conditions. If this ground resistance cannot be obtained with the 60' of mat conductor, additional mat shall be installed in contact with the earth in the bottom of the structural foundation.

3.03 GENERAL BRANCH CIRCUITS AND FEEDERS

A. All conduit systems, equipment housings, material housings, junction boxes, cabinets, motors, ducts, wireways, cable trays, light fixtures, portable equipment and all other conductive surfaces shall be solidly grounded in accordance with the California Electrical Code to form a continuous, permanent and effective grounding system.

B. Install a separate green grounding conductor in all conduits, including feeder, branch circuit, and flexible; both metallic and non-metallic. The conduit systems shall not be relied upon as the system equipment grounds. Size all grounding conductors per CEC 250 unless a larger ground is indicated on the drawings. Secure grounding conductors using approved methods to each pull box, junction box, and equipment housing.

C. All panelboards, junction boxes, pullboxes, wireways and equipment enclosures shall be bonded to the conduit systems.

D. All building expansion joints shall be bonded.

E. Isolated ground receptacles shall have both an isolated ground conductor and a separate equipment grounding conductor.

3.04 MOTOR CIRCUITS

A. All motor circuits shall have a ground wire pulled with the phase conductors. The ground wire shall be extended from the panel ground bus and shall be bonded at all junction boxes, pullboxes, disconnect switches, controllers, motor connection boxes, and motor frames. Each motor with a Variable Frequency Drive controller shall have a dedicated grounding conductor. Ground these motors back through the VFD controller as recommended by the drive manufacturer to eliminate radio frequency interference. Also, the wiring between the VFD controller and the motor shall be in a dedicated conduit.

3.05 SEPARATELY DERIVED SOURCES

A. All secondary neutrals for the 120/208-volt wye services of dry type transformers and UPS equipment shall be grounded to building steel. Connection shall be made with cable sized according to Table 250.102(C)(1) of the California Electrical Code. Extend separately derived insulated ground to the transformer in rigid steel conduit.

3.06 EQUIPMENT ROOM GROUND TERMINAL BAR

A. Mount bar by anchors and bolts using 1-½” long segments of ½” rigid conduit as spacer between bar and wall. Use a minimum of two supports, 18” on center. Connect all grounding electrode system conductors, system enclosure ground bus, and other indicated electrode systems to the terminal bar. Each telecom/his room shall have a ground bar with a minimum of six lugs or screws. Interconnect telecom/his ground bars to building steel with No. 6 AWG insulated copper conductor.

3.07 FLEXIBLE RACEWAY GROUNDING

A. Install a ground conductor inside all flexible raceways (e.g. flexible steel, liquid tight). Bond the conductor to the enclosure or ground bus in the nearest box or access on either side of the flexible section. Size conductor as specified, indicated or required by code, whichever is larger.

3.08 SECTIONAL RACEWAY

A. Install a ground conductor in all sectional raceways with removable covers for access (e.g., plug-in strips, surface raceways systems, and wireways). Size conductor in accordance with the CEC for the largest phase conductor size installed in raceway, or as indicated. Bond all sections of the raceway to the ground conductor. Connect all receptacle ground terminals in the raceway to the ground conductor, and make other ground connections indicated. This also includes all sectional raceways installed in or on University provided furniture. All surface metal raceways shall be UL listed as an equipment grounding conductor.

3.09 GENERAL GROUNDING REQUIREMENTS

A. All ground connectors shall be bronze of the clamp type. All clamp accessories such as bolts, nuts, and washers shall also bronze to assure a permanent corrosion-resistant assembly. Connector shall be as manufactured by Burndy Engineering Company, Ilsco Corporation, or equal. Make connections easily accessible for inspection, underground or concealed in floors or walls.

B. All ground cable splices, joints, and connections to ground rods shall be made with an exothermic welding process which shall provide a weld with current-carrying capacity not less than that of the conductors welded. Soldered connections shall not be used.

C. All ground wire shall be insulated, unless otherwise indicated on the Drawings, extra flexible stranded copper cables. Grounding cables installed in earth shall be laid slack.

D. Lighting and power panelboards shall be grounded by connecting a grounding conductor to the grounding stud and to the incoming and outgoing feeder conduits grounding bushings. Each grounding-type bushing shall have the maximum ground wire accommodation available in standard manufacturer for the particular conduit size. Connection to the bushing shall be with wire of this maximum size.

E. The equipment for the fire protection alarm system shall have its grounding terminal connected to the ground lug on the panelboard serving the system by means of a #6 green coded insulated conductor, run in ¾" steel conduit, utilizing a ground clamp.

END OF SECTION 26 05 26

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Conduit and equipment supports.

2. Fastening hardware.

3. Vibration Isolation.

1.02 SUBMITTALS

A. Submit for each isolator, complete manufacturer's description including quantity loading and static deflection.

1.03 REFERENCE STANDARDS

A. American Plywood Association. (APA)

B. Underwriters Laboratories. (UL) "Building Materials Directory".

1.04 QUALITY ASSURANCE

A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

PART II - PRODUCTS

2.01 SUPPORT CHANNELS

A. Acceptable Manufacturers – Support Channels

1. Unistrut

2. Super Strut

3. Or Equal

B. Support Channel: 12-gauge galvanized or painted steel, "U" section, 1-½" square nominal in section.

C. Hardware: Manufacturer's standard as required to support equipment. Provide corrosion resistant finish.

2.02 CONDUIT SUPPORTS

A. Conduit clamps, straps, and supports shall be steel or malleable iron for all exposed individual conduit runs. Clip type hangers may be used in concealed areas on individual

conduit runs. Group mounted, exposed or concealed shall be supported by trapeze hangers constructed of formed steel channels and threaded rods.

2.03 VIBRATION ISOLATION

A. Provide vibration isolation in all supporting hardware for vibrating electrical equipment, (e.g., transformers). Isolators shall be as recommended by manufacturer to maximize their effect. Isolators shall be as manufactured by Mason Industries, or equal.

PART III - EXECUTION

3.01 INSTALLATION

A. Fasten hanger rods, conduit clamps, outlet and junction boxes to building structure using bolts, beam clamps, and spring steel clips.

B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

C. Do not fasten supports to piping, ductwork, mechanical equipment, other conduit, or roof deck.

D. Install all support devices according to manufacturers guidelines and recommendations.

E. Do not drill through structural framing members.

F. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

G. Install freestanding electrical equipment on concrete pads four inches high and overlapping equipment footprint by two inches on all sides.

H. Install surface-mounted cabinets and panelboards with minimum of four anchors. Provide steel channel supports to stand cabinet one inch off wall, or on ¾” plywood backboards.

I. Install plywood backboards over gypsum board or directly to stud framing as indicated. Fasten to studs with self-tapping screws according to APA recommendations.

J. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls with #10 S.M.S. at 12" o.c., 4 minimum, typical unless otherwise noted.

K. Do not support equipment or fixtures from the roof deck. Provide necessary framing and joist hangers to span between structural members to locate hangers properly.

L. Do not exceed a maximum point load of 100 lbs. to any member. Locate point loads at least 4’ from any other point load on the same member.

M. All equipment shall be installed in full compliance with all applicable seismic requirements of Title 24, Part 2, CBC.

END OF SECTION 26 05 29

SECTION 26 05 32
PULL BOXES AND JUNCTION BOXES

PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior Pull and Junction Boxes

2. Exterior Pull and Junction Boxes.

1.02 SUBMITTALS

A. None Required.

1.03 REFERENCES

A. Underwriters Laboratories (UL)

B. National Electrical Manufacturers Association (NEMA) #250 - Enclosures for Electrical Equipment (1000 volts maximum).

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. O.Z. Gedney; General Signal

B. Hoffman

C. Or Equal

2.02 PULLBOXES AND JUNCTION BOXES

A. Indoor general purpose boxes shall be a NEMA 1 enclosure, constructed of code gauge galvanized steel. The boxes shall be constructed from a single piece of steel with folded and welded corners. The boxes shall have a flat removable, galvanized sheet metal cover held in place with binder head sheet metal screws. Supply boxes with no knockouts.

B. Outdoor boxes shall be cast iron with a plain cast iron cover. Covers shall be neoprene gasketed and shall be NEMA 4 watertight construction. The cover shall be held in place by stainless steel screws. The cart wash and waste management areas shall be considered outdoor locations.

C. Size boxes by code requirements related to the number and size of conduits and wire entering the box.

D. Boxes recessed in earth or concrete, use an outside flanged recessed cover box. Outdoor boxes mounted on surface, use an unflanged box.

E. Conduit openings shall be bossed, drilled and tapped in outdoor boxes.

F. Standard size metal boxes stamped from galvanized steel shall be used for indoor general purpose where size and capacity are acceptable by code.

G. Boxes shall be of the depth required for wiring capacity. Boxes shall be cast iron with threaded hubs for vaportight and wet locations.

H. Boxes for hazardous (classified) locations shall be approved for the classification and use.

I. Provide boxes with a blank cover.

J. Underground pull-boxes shall be high-density reinforced concrete with end and side knock-outs. All pull-boxes shall be back filled with concrete. Each pull-box shall be equipped with the following reinforced concrete accessory:

1. 10" extension

2. Slab

3. Lid with hold down bolts and labeled with usage. (Steel checker plate with hold down bolts in traffic areas.)

PART III - EXECUTION

3.01 INSTALLATION

A. Pull boxes and junction boxes required are not shown on the plans; however, they shall be provided to meet Code requirements and improve ease of wire pulling. Provide pull boxes or junction boxes in conduit runs over 90' long or when more than 4 quarter bends occur in a conduit run. Boxes shall be sized to meet CEC requirements.

B. Mount all pullboxes and junction boxes securely to the building structure. Boxes shall not depend on conduit for support.

C. Install pullboxes and junction boxes such that covers are accessible. Do not install in finished areas unless approved by University's Representative.

D. Cut or sheared edges shall be filed or honed, eliminating all sharp edges.

E. Pullboxes and junction boxes shall be installed with unused or open knockouts plugged.

F. Install pullboxes direct buried in earth or concrete flush with surface, square with surrounding structures.

G. All junction boxes shall be labeled on cover indicating circuit number and panel number and all wires shall be labeled in junction boxes with circuit numbers.

END OF SECTION 26 05 32

SECTION 26 05 33
RACEWAYS

PART I - GENERAL

1.01 DESCRIPTION

A. This section covers the complete interior and exterior raceway system.

B. Definition: The term conduit, as used in this Specification, shall mean any or all of the raceway types specified.

1.02 QUALITY ASSURANCE

A. Referenced Industry Standard: The following specifications and standards are incorporated into and become a part of this Specification by reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:

a. No. 1 Flexible Metal Electrical Conduit

b. No. 1242 Rigid Galvanized Conduit

c. No. 467 Electrical Grounding and Bonding

d. No. 651 Rigid Nonmetallic Electrical Conduit

e. No. 797 Electrical Metallic Tubing

f. No. 1242 Intermediate Metal Conduit

2. American National Standards Institute (ANSI):

a. C-80.1 Rigid Galvanized Conduit

b. C-80.3 Electrical Metallic Tubing

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.

1. Metallic Conduit Fittings:

a. RACO

b. Thomas and Betts

c. or equal

2. Support Channel:

a. Powers

b. Unistrut

c. or equal

3. Non-Metallic Conduit and Fittings:

a. Carlon

b. Thomas and Betts

c. or equal

4. Fiberglass Reinforced Epoxy Conduit Systems:

a. FRE Conduit, Inc.

b. United Fiberglass

c. or equal

C. Coordination

1. Coordinate conduit installation with electrical equipment furnished.

2. Coordinate conduit installation with contract documents. Adjust installation to eliminate conflicts. Review all shop drawings submitted under this and other sections to insure coordination with all equipment requiring electrical service and to avoid conflict interferences. Coordinate installation sequence to avoid conflicts including equipment access and provide the fastest overall installation schedule.

1.03 STORAGE AND HANDLING

A. Refer to the Basic Electrical Requirements section of the specifications for storage and handling requirements.

B. Non-metallic conduits stored on-site prior to installation shall be stored on a surface off of the ground and shall be protected from the direct rays of the sun and from debris.

C. Damaged, oxidized, warped, improperly stored material or material with excessive amounts of foreign debris will be removed from the project and replaced with new materials, at no cost to the University.

PART II - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein.

B. All conduit and fittings shall be listed and bear a label by Underwriters' Laboratories (UL) for use as raceway system for electrical conductors.

C. Raceway is required for all wiring, unless specifically indicated or specified otherwise.

D. Size: The minimum size of conduit shall be ¾". The size of all conduits shall be in accordance with the CEC using 30% fill, but not less than indicated on the drawings.

E. Bushings shall be metallic insulated type. Weatherproof or dust-tight installations shall be liquid-tight with sealing ring and insulated throat. Bushing shall be OZ/Gedney type KR, or equal (Or equal, no known equal.)

F. Expansion and deflection fittings shall be OZ/Gedney, type DX, or equal

G. All under floor/ground raceways will be cleaned and mandrilled before wire is installed.

2.02 EMT CONDUIT AND FITTINGS

A. Electrical Metallic Tubing shall conform to UL 797, cold rolled steel tubing with zinc coating on outside and protective enamel coating on inside.

B. Electrical Metallic Tubing (EMT) couplings and connectors shall be steel compression "concretetight" type. Malleable iron, die cast or pressure cast fittings are not permitted. All connectors shall be nylon insulated throat type. Fittings shall meet same requirements for finish and material as EMT conduit. Box connectors shall be equipped with insulated throat.

C. Connectors at cabinets, boxes, and gutters shall be metallic nylon grounding type with insulated bushings.

2.03 RIGID AND IMC CONDUIT and FITTINGS

A. Intermediate metallic conduit and rigid steel conduit shall conform to UL 6, standard weight, mild steel pipe, zinc coated on both inside and outside by a hot dipping or sherardizing process. Inside and outside of conduit shall be finished with a protective coating.

B. Fittings for rigid steel and IMC shall be standard threaded couplings, locknuts, bushings and elbows. Fittings shall be assembled with anti-corrosion, conductive anti-seize compound at joints made absolutely tight to exclude water. All materials shall be steel or malleable iron only. Setscrew or non-thread fittings are not permitted.

C. Bushings shall be metallic insulating type consisting of insulating insert molded or locked into the metallic body of the fittings.

D. Erickson-type couplings may be used to complete a conduit run. IMC couplings may be the integral retractable (Uni-Couple) type.

E. Connectors at cabinets, boxes, and gutters shall be metallic nylon grounding type with insulated bushings.

2.04 NON-METALLIC CONDUIT AND FITTINGS

A. Non-metallic conduit shall be heavy wall, Schedule 40 PVC or Schedule 80 PVC.

B. Non-metallic conduit fittings shall be of the same material as the conduit furnished and be the product of the same manufacturer. PVC 90º bends shall not be used. Wrapped rigid will be used in its place. Double lap of Calpico 10 mil or approved equal.

C. Maximum length of non-metallic conduit shall be twenty feet. Mark each length clearly and durably with nominal trade size, type of material, and UL label.

D. Material shall have tensile strength of 7,000 psi at 73.4ºF, flexural strength of 11,000 psi and compression strength of 8,600 psi.

E. Non-metallic conduit shall be suitable for direct burial without concrete encasement.

F. All joints shall be solvent welded, 1" minimum size unless indicated on drawing.

G. All underground or underfloor conduit shall be cleaned and mandrelled before wire is installed.

2.05 FIBERGLASS REINFORCED EPOXY CONDUITS

A. Rigid non-metallic fiberglass reinforced epoxy conduits (FRE) shall be composed of glass filaments encapsulated in an epoxy matrix. All FRE conduits and fittings shall be pigmented with carbon black dispersed homogeneously throughout the epoxy glass matrix for UV protection. Conduit shall be suitable for continuous operation from -40ºC to +110ºC.

2.06 CONDUIT SUPPORTS

A. All parts and hardware shall be zinc-coated or have equivalent corrosion protection.

B. Conduit straps shall be single hole cast metal type or two hole galvanized metal type. Conduit clamps shall be spring steel type for use with exposed structural steel.

C. Conduit support channels shall be 1.5" x 1.5" x 14 gauge galvanized (or with equivalent treatment) channel. Channel suspension shall be minimum ¼" threaded steel rods. Spring steel clips are not acceptable. Conduit straps shall be spring steel conduit straps compatible with channel. Wire or chain is not acceptable for conduit hangers. All installations shall meet applicable seismic requirements.

D. Individual conduit hangers shall be galvanized spring steel specifically designed for the purpose, sized appropriately for the conduit type and diameter, and have pre-assembled closure bolt and nut and provisions for receiving threaded hanger rod. Support with ¼" threaded steel rod for individual conduits 1.5" and smaller and ⅜" rod for individual conduits 2.0" and larger. All installations shall meet applicable seismic requirements.

E. Individual conduit straps on metal studs shall be spring steel and should wrap around entire face of stud securely biting into both edges and have provisions for screwing into stud. Size for conduit to be support. Tie wraps are not acceptable.

F. Support multiple conduits from metal studs using pre-assembled bar hanger assembly consisting of hanger bar, retaining clips and conduit straps.

G. Refer to Section 16190 of these specifications for additional material requirements. Refer to Seismic Control for additional seismic requirements.

2.07 FLEXIBLE CONDUIT AND FITTINGS

A. Flexible conduit shall be steel metallic type, zinc coated on both inside and outside by hot dipping or sherardizing process.

B. Where specified herein, indicated on the drawings, or when used in damp or wet locations, as classified by the California Electrical Code, flexible conduit shall be liquid tight. Liquid-tight conduit shall be galvanized with extruded polyvinyl covering and with water-tight connectors.

C. All flexible conduit shall be classified as suitable for system grounding.

D. Connectors for flexible conduit shall be steel insulated throat type rated as suitable for system ground continuity. Connectors for liquid tight flexible conduit shall be screw-in ground cone type.

E. Flexible conduit shall not be less than ¾" trade size and in no case shall flexible conduit size be less than permitted by the California Electrical Code for the number and size of conductors to be installed herein.

F. No aluminum flexible conduit shall be used.

2.08 MISCELLANEOUS CONDUIT FITTINGS AND ACCESSORIES

A. Vinyl all weather electrical tape for corrosion protection shall be Scotch #88, Tomic #85, Permacel #295 or equal.

B. Expansion and deflection couplings shall be in accordance with UL 467 and UL 514. They shall accommodate ¾" deflection, expansion, or contraction in any direction and shall allow 30º angular deflections. Couplings shall contain an internal flexible metal braid to maintain raceway system ground continuity.

C. Fire and smoke stop materials shall be UL rated to maintain the fire floor or firewall partition rating.

PART III - EXECUTION

3.01 INSTALLATION

A. General

1. Conceal all conduits, except in unfinished spaces such as equipment rooms or where indicated by symbol on the drawings or as approved by the University's Representative. Run concealed in areas having finished ceilings and furred walls. Run all cross conduits and vertical risers or drops concealed in wall and/or partitions. Run vertical risers or drops up or down between wall studs. Should it be necessary to notch any framing members, notch only at locations in a location and manner approved by University's Representative.

2. Exposed conduit below 8'-0" shall be rigid type.

3. Provide flexible connections of short length to equipment subject to vibration or movement and to all motors. Provide a separate bonding conductor in all flexible connections.

4. Support conduits per seismic guidelines outlined in section 16012.

5. Maintain a minimum of 6" clearance from conduit to steam or hot water pipes.

6. Leave all empty conduits with a galvanized pull wire or nylon pull rope.

7. Install as complete raceway runs prior to installation of cables or wires.

8. Flattened, dented, or deformed conduits are not permitted and shall be removed and replaced.

9. Secure rigid conduit i.e., rigid galvanized conduit and intermediate metal conduit, to sheet metal enclosures with two (2) locknuts and insulated bushing. Secure EMT to sheet metal enclosures with insulated throat connectors.

10. Fasten conduit support device to structure with wood screws on wood, toggle bolts on hollow masonry, anchors as specified on solid masonry or concrete, and machine bolts, clamps, or spring steel clips, on steel. Nails are not acceptable.

11. Protect conduits against dirt, plaster, and foreign debris with conduit plugs. Plugs shall remain in place until all masonry is complete. Protect conduit stud-ups during construction from damage; any damaged conduits shall not be used.

12. Seal all conduits originating from outside building from below grade, all conduits entering refrigerated spaces, i.e., freezers and coolers, and all conduits entering exterior mounted electrical equipment with insulating electrical putty to prevent entrance of moisture. Waterproofing material shall not contain creosote or polysulfides which are not compatible with the waterproofing system.

13. Install conduit with wiring, including homeruns as indicated on the drawings. Any change resulting in a savings in labor or materials is to be made only in accordance with a contract change. Deviations shall be made only where necessary to avoid interferences and when approved by University's Representative by written authorization.

14. Where conduit passes through finished walls or ceilings, provide steel escutcheon chrome plates or paint as directed.

15. Provide sleeves for conduit passing through floor slabs and/or concrete masonry walls.

16. Conduits which penetrate roof membranes shall be installed in accordance with manufacturer's recommendations and architectural specifications.

17. Separate raceway systems are to be installed for power systems and for control, signal and communications systems. Do not install control, signal or communications cables in the same raceways as branch circuit or feeder cables, unless indicated otherwise on the drawings.

18. Provide expansion fitting in all conduits where length of run exceeds 200’ or where conduits pass building expansion joints.

19. Telephone, and data, and all service entrance conduits shall be installed with wide sweep 90º bends; minimum radius shall be 60”.

B. Uses Permitted

1. Galvanized rigid conduit or IMC shall be used as follows:

   a. For primary and secondary service (except when installed below the ground floor slab and above the building mat slab) and for secondary unit

substations, switchboard, motor control center, dry-type transformer and panelboard feeders.

b. Buried in or in contact with earth to be half-lapped with omic pipe wrapping tape with sealant applied to all joints.

c. In poured concrete walls or block walls, in concrete vaults, floor and roof construction, provided a minimum of 2" of cover is maintained.

d. In all walls up to the first outlet box where fed from rigid conduit in damp locations or locations exposed to the weather.

e. In exposed locations below 8’ above the floor, including all mechanical rooms.

f. All elbows for underground plastic conduit.

g. All conduits for interior wiring systems whose voltage is above 600 volts.

h. All conduits entering refrigerated spaces.

i. Elsewhere where indicated on the drawings.

j. For emergency branch feeders and circuits installed outside of building.

2. Electrical metallic tubing (EMT) shall be used as follows:

a. Concealed in stud partitions and hollow masonry walls.

b. For connections from junction box to lighting fixtures except in accessible ceilings.

c. Above In

d. suspended or accessible ceilings above 8’.

e. Exposed in dry locations above 8 feet where not subjected to mechanical damage.

f. In furred ceiling spaces.

g. For fire alarms system conduit. Paint red 6" wide every eight feet.

3. Rigid non-metallic conduit shall be used as follows:

a. For the branch circuit wiring for exterior lighting pole bases and bollards (horizontal runs only).

b. All elbows, both vertical and horizontal, shall be GRC.

c. Any non-metallic PVC conduit used for emergency power systems shall be schedule 80 PVC.

d. The communications conduit shall be schedule 40 PVC.

4. All other conduit, unless excluded herein, not permitted in accordance with the California Electrical Code, or otherwise indicated on the drawings, shall be electrical metallic tubing (EMT).

5. Conduit types shall not be mixed indiscriminately with other types in the same run, unless specified herein or required by the CEC.

6. Use flexible conduit for connections to motors, dry type transformers, electrical duct heaters, unit heaters, expansion joints, and flush mounted lighting fixtures. Conduit must be secured.

   a. Flexible conduit used for connection of motor, dry type transformers, electric duct heaters, and unit heaters, shall not exceed 18" in length.

   b. Flexible conduit from outlet box to flush mounted lighting fixture shall not exceed ~~6~~ 3 feet in length.

   c. Maintain ground continuity through flexible conduit with green equipment grounding conductor; do not use flexible conduit for ground continuity.

   d. Liquid tight conduit shall be used to connect equipment in mechanical equipment rooms and exterior installations, and for final connections to all equipment containing water or other liquid service.

7. Service entrance conduits shall be installed "outside" of the building as defined by the CEC. Provide concrete encasement where required.

8. No conduit requiring cutting of cross-webs of concrete masonry units is permitted. Conduit shall be threaded through cells or concrete masonry units lowered around conduit. Neither horizontal joint reinforcement nor bond beam reinforcement shall be cut for conduit installation.

9. Where hazardous locations, as classified by the California Electrical Code, exist, all conduits and fittings and the installation of these materials shall comply with Article 500 of the California Electrical Code.

10. LB condulets for conduits larger than 1-½" I.D. shall not be used unless of the mogul design and secured to the building structure within 6" below and along the side of the condulet.

C. Below Grade Raceway Installations

1. Direct Burial Conduit

   a. Unless otherwise indicated install top of conduits 24" minimum below finished grade. Maximum depth shall be 36". Utility primary conduit shall be 48" below finished grade. All conduits not under building slabs or parking lots shall be encased in a minimum of 3" concrete. All concrete for primary conduit shall contain a red pigment dye to make it readily noticeable. Provide 10% red oxide per cubic yard of material.

   b. Install top of conduits ~~6~~ 18" minimum below bottom of building slabs.

   c. Install top of conduits 30" minimum below grade, below roads and any other paved surfaces.

d. Place a 4" wide, bright yellow, non-biodegradable plastic tape 12" above all underground conduit outside of building foundation.

e. Where transition is made from below grade PVC installation to a metallic conduit system above grade or slab, and at transition at manholes and service switchgear, make transition with rigid galvanized elbow and extend through slab or above grade with galvanized rigid steel conduit. For corrosion protection, where the elbow penetrates surface, wrap with vinyl all-weather electrical tape or coat with bituminous asphaltic compound, for 6" above and below concrete surface.

f. For excavation and backfilling, refer to Section 16010 and Division 2 of these specifications.

g. Conduit shall be run following the most direct route between points and the route shall be coordinated with other disciplines.

h. All open conduit ends shall be plugged during construction to prevent water, mud, concrete and debris from entering. Prior to the installation of cables, each conduit shall be cleaned by pulling a standard, flexible mandrel not less than 12" long, with diameter approximately ¼" less than inside diameter of conduit, through the conduit. In addition, a brush with soft bristles and diameter approximately equal to inside diameter of conduit shall be pulled through conduit.

i. For all underground runs of two or more conduits, separators or spacing blocks made of plastic or other suitable nonmetallic, nondecaying material shall be placed on not greater than four foot centers. They shall be of the interlocking type both horizontally and vertically. ducts shall be anchored to prevent movement during placement of concrete.

j. Before installing the last 8" of lift of backfill for all primary feeders and for secondary service feeders, install plastic identification tape warning of buried electrical lines the full length of duct bank trench.

D. Raceway Installations Within Concrete

1. Conduit can only be installed within concrete where shown on the drawings or with the agreement of the Structural Engineer of Record

2. Conduit shall be run following the most direct route between points.

3. Conduit shall not be installed in concrete which is less than 3" thick or where the outside diameter is larger than ⅓ of the slab thickness.

4. Conduits installed in concrete slabs shall be buried in the concrete slab. Wire low conduits to upper side of the bottom reinforcing steel, and upper conduits to the lower side of the top reinforcing steel. Separate parallel runs of conduits within slab by at least ~~1".~~ 3".

5. Conduits shall not be installed within shear walls unless specifically indicated on the drawings. Conduits shall not be run directly below and parallel with load bearing walls.

6. Protect each metallic conduit installed in concrete slab or conduits 1.5" and smaller passing through a concrete slab against corrosion where conduit enters and leaves concrete by wrapping conduit with vinyl all-weather electrical tape.

7. Conduit stub-up penetrations through slabs shall be installed with the top of a threaded conduit coupling flush with the finished slab.

8. Protect all conduits entering and leaving concrete floor slabs from physical damage during construction.

9. Install all conduits penetrating rated fire floors to maintain the fire and thermal rating of the floor penetrated.

E. Concealed (Above Ceilings and in Walls) and Exposed Raceway Installation

1. Conduit shall be run parallel or at right angles to walls, ceilings, and structural members.

2. Support branch circuit conduits at intervals not exceeding 10’ and within 3’ of each outlet, junction box, cabinet or fitting. Attach individual branch circuit conduits to structural steel members with spring steel type or beam conduit clamps and to non-metallic structural members with one hole conduit straps. For exposed conduits and where conduits must be suspended below structure, single conduit runs shall be supported from structure by hangar rod and conduit clamp assembly. Multiple conduits shall be supported by trapeze type support suspended from structure. Do not attach conduits to ceiling suspension system channels or suspension wires.

3. Attach feeder conduits larger than 1" trade diameter to or from structure on intervals not exceeding 10’ with conduit beam clamps, one hole conduit straps or trapeze type support in accordance with support systems described for branch circuit conduits.

4. Single-flange clamps are unacceptable

5. Exposed conduits shall be painted, see Section 09900 of the specifications.

6. For fire alarms system conduit. Paint red 6" wide every eight feet.

7. Install conduit sleeves in slabs where conduits 2.0" and larger pass through. Sleeves shall extent 1" minimum above finished slab. Seal all spare sleeves and between conduits and sleeves to maintain fire rating and to make watertight and smoketight.

8. Install all conduits or sleeves penetrating rated firewalls or fire floors to maintain fire rating of wall or floor.

9. Conduits rigidly secured to building construction on opposite sides of a building expansion joint shall be provided with an expansion and deflection coupling. In lieu of an expansion coupling, conduits 2-½" and smaller may be provided with junction boxes on both sides of the expansion joint connected by 15" of slack flexible conduit with bonding jumper.

3.02 ADJUSTMENT, CLEANING AND PROTECTION

A. Clean: Upon completion, clean all installed materials of paint, dirt, and construction debris. All conduit systems shall be cleaned of water and debris prior to the installation of any conductors.

END OF SECTION 26 05 33

SECTION 260535
ELECTRICAL BOXES AND FITTINGS

PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pressed Steel Boxes and Fittings.

2. FS and FD Boxes.

1.02 SUBMITTALS

A. None required.

1.03 REFERENCE STANDARDS

A. Underwriters Laboratories (UL).

B. National Electrical Manufacturers Association (NEMA) #250 - Enclosures for Electrical Equipment.

C. NEMA 051 - Sheet steel outlet boxes, device boxes, covers and box supports.

D. NEMA 052 - Non-metallic outlet boxes, covers and box supports.

PART II - PRODUCTS

2.01 STEEL BOXES AND FITTINGS

A. Acceptable Manufacturers:

1. Midwest Electric

2. RACO

3. or equal

B. Boxes to be non-gangable, having knockouts as required and compatible covers or extension rings suitable for installed devices.

C. Boxes to be galvanized stamped steel, with grounding lug tapped hole.

D. Provide ⅜" fixture studs in ceiling outlet boxes where required.

2.02 FS AND FD BOXES

A. Acceptable Manufacturers:

1. Appleton

2. Crouse - Hinds

3. or equal

B. Provide cast iron alloy boxes with epoxy paint or galvanized finish. Aluminum or pot metal boxes are not acceptable. Boxes shall have threaded hubs sized for conduit without adapters and threaded holes for securing cover. Device boxes shall be provided with proper weatherproof, gasketed cover assemblies, junction and pull boxes shall be provided with flat gasketed covers. Fixture boxes shall be 4" round or as required for the fixture. Junction and pull boxes requiring more than one gang shall be multi-gang FS or FD or dimensioned cast boxes with cast covers.

PART III - EXECUTION

3.01 GENERAL

A. Install all boxes so they are completely covered by the wall plate or fixture.

B. Provide galvanized one-piece or welded pressed steel boxes and fittings unless indicated otherwise. Provide galvanized steel outlet box covers for surface mounted galvanized steel boxes in unfinished areas. Boxes in unfinished areas, installed exposed, shall be cast type "conduit" for switches and convenience outlets. Exposed boxes mounted below 8' from finished floor shall be cast type. Provide blank cover for all boxes without fixture or device.

C. Provide FS and FD boxes and required covers surface mounted in damp or wet locations and as indicated on plans. Boxes shall be securely mounted using mounting lugs or other method made in a way so as not to degrade the weatherproof nature of the system.

D. Install all outlet boxes rigidly, plumb, and level. Secure outlet boxes to ceiling system support members and wires using only clips designed and approved for the purpose. Do not cut insulation in outside walls to install outlet boxes. Do not use through-the-wall boxes unless specifically noted. Do not install boxes back-to-back in adjoining rooms. Offset outlet boxes installed back-to-back in fire-rated walls and partitions a minimum of 24 inches horizontally. Protect boxes during construction to prevent entrance of foreign materials such as concrete, mortar, plaster, paint, etc.

E. Flush mounted boxes shall be installed with opening edge flush with finish surface.

F. Pull boxes shall be provided in all runs of 90' or more in length or such that not more than four 90^{o} bends occur between boxes. Junction and pull boxes shall be located in accessible locations and shall be concealed in finished work and shall be permanently identified with system label. Where concealed accessible space is not available in finished areas, boxes shall be flush mounted with rings and blank plates at standard boxes, flanges and plaster stops at large boxes. Flush boxes shall be carefully aligned to be plumb. Locations to be coordinated with University's Representative prior to installation.

G. 4" octagonal boxes or square boxes with plaster rings shall be used for ceiling or wall light fixture outlets. Boxes for fixtures shall be equipped with fixture studs. Boxes shall be supported as required to carry loads as required by code. Other ceiling outlets shall be 4" square or larger with plaster rings unless indicated otherwise on drawings. Boxes shall be flush mounted or concealed in finished construction.

H. Provide minimum of ¾" plaster rings designed for the purpose for outlet boxes in plaster or gypsum board walls.

I. Provide masonry boxes and extension rings for boxes in concrete block, brick, and glazed tile walls. Secure with auxiliary plates, bars or clips and grout in place.

J. Install outlet device mounting rings such that they extend no more than $^{1}/_{16}$", or are recessed no more than $^{3}/_{16}$" from wall surface.

K. Support all outlet boxes independently from the raceway systems. Securely support by adequate wood backing or by manufactured adjustable channel type heavy-duty box hangers. Boxes with metal box hangers shall be attached to metal studs. Box hangers shall be securely tied or welded (where permitted) to metal studs. Paint weld with rest inhibitor.

L. Install outlet boxes for electric water coolers concealed inside cooler cabinets. Locate outlet boxes as recommended by equipment supplier.

M. For dimensional locations of the actual installed location shall not vary from the dimensioned location by more than plus or minus one-half inch, unless otherwise noted.

N. Boxes for local switches shall be at least 1-½" deep 4" square for 1 or 2 gang switches, with switch plaster rings and gang box with gang cover.

O. Boxes for telephone and data shall be minimum 2-⅛" deep.

P. Use screws and not nails to support outlet boxes.

Q. Nails shall not be used to support outlet boxes. Boxes must be accurately placed for finish, independently and securely supported by adequate wood backing or by manufactured adjustable channel type heavy-duty box hangers. Boxes with metal box hangers shall be attached to metal studs. Box hangers shall be securely tied or welded (where permitted) to metal studs. Paint weld with rust inhibitor. Boxes installed in masonry, tile, or concrete block construction shall be secured with auxiliary plates, bars or clips and be grouted in place.

END OF SECTION 260535

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART I - GENERAL

1.01 DESCRIPTION

A. Extent of electrical identification work is as outlined by this specification.

B. Types of electrical identification work specified in this section include the following:

1. Buried cable warnings.

2. Electrical power, control and communication conductors.

3. Operational instructions and warnings.

4. Danger signs.

5. Equipment/system identification signs.

1.02 QUALITY ASSURANCE

A. CEC Compliance: Comply with CEC as applicable to installation of identifying labels and markers for wiring and equipment.

B. UL Compliance: Comply with applicable requirements of UL Std 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

C. ANSI Compliance: Comply with applicable requirements of ANSI Std A13.1, "Scheme for the Identification of Piping Systems".

D. NEMA Compliance: Comply with applicable requirements of NEMA Std No's WC-1 and WC-2 pertaining to identification of power and control conductors.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's data on electrical identification materials and products.

B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide electrical identification products of one of the following (for each type marker):

1. Brady, W.H. Company

2. Panduit Corporation

3. or equal

2.02 ELECTRICAL IDENTIFICATION MATERIALS

A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, provide single selection for each application.

B. Color-Coded Plastic Tape:

1. Provide manufacturer's standard self-adhesive vinyl tape not less than 3 mils thick by 1-½" wide.

a. Colors: Unless otherwise indicated or required by governing regulations, provide orange tape.

C. Underground-Type Plastic Line Marker:

1. Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried cable.

D. Cable/Conductor Identification Bands:

1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.

E. Plasticized Tags:

1. Manufacturer's standard pre-printed or partially pre-printed accident-prevention and operational tags, of plasticized card stock with matte finish suitable for writing, approximately 3-¼" x 5-⅝", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording, e.g., DANGER, CAUTION, DO NOT OPERATE.

F. Self-Adhesive Plastic Signs:

1. Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., 208V, EXHAUST FAN, RECTIFIER.

2. Colors: Unless otherwise indicated, or required by governing regulations, provide white signs with black lettering.

3. Baked Enamel Danger Signs:

4. General: Provide manufacturer's standard DANGER signs of baked enamel finish on 20-gauge steel; of standard red, black and white graphics; 14" x 10" size except where 10" x 7" is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with

recognized standard explanation wording, e.g., HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH.

G. Engraved Plastic-Laminate Signs:

1. Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

2. Thickness: ⅛", except as otherwise indicated.

3. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

2.03 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

PART III - EXECUTION

3.01 APPLICATION AND INSTALLATION

A. General Installation Requirements:

1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of CEC and OSHA.

2. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.

3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

B. Conduit Identification:

1. Where electrical conduit is exposed in spaces with exposed mechanical piping which is identified by color-coded method, apply color-coded identification on electrical conduit in manner similar to piping identification. Except as otherwise indicated, use white as coded color for conduit.

C. Box Identification:

1. After completion, using an indelible wide tip marker, indicate on the cover of each junction and pull box the designation of the circuits contained therein, i.e., A-1, 3, 5. Use a black marker for normal power circuits a red marker for critical circuits, an orange marker for life safety circuits, and a green marker for equipment circuits.

2. All junction and pull boxes for wiring systems above 600V shall be identified with high voltage warning labels installed every 20 linear feet in accordance with OSHA standards. All boxes shall also be painted red, see Section ~~09900~~ 09 91 23 of the specifications.

3. All junction and pull boxes for the fire alarm system shall be painted red. All raceway for the fire alarm system shall be labeled "Fire Alarm" in red letters on intervals not to exceed ten feet.

D. Underground Cable Identification:

1. During back-filling/top-soiling of each exterior underground electrical, signal or communication conduits, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.

2. Install line marker for every buried conduit.

E. Cable/Conductor Identification:

1. Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panel boards, shop drawings, contract documents, and similar previously established identification for project's electrical work. Refer to Section ~~16120~~ 26 05 19 of these specifications for color-coding requirements.

F. Operational Identification and Warnings:

1. Wherever required by OSHA or directed by the University, to ensure safe and efficient operation and maintenance of electrical systems, including prevention of misuse of electrical facilities equipment by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposed. Request a meeting with the University prior to substantial completion to coordinate warning requirements.

G. Danger Signs:

1. In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations identified by the University as constituting similar dangers for persons in or about project. Request a meeting with the University prior to substantial completion to coordinate danger sign requirements.

a. High Voltage: Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 110-120 volts.

b. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, or damage to or loss of property.

H. Equipment/System Identification:

1. Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication/control/signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, ½" high lettering, on 1-½" high sign (2" high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:

   a. Electrical cabinets and enclosures.

   b. Access panel/doors to electrical facilities.

   c. Transformers.

   d. Fire alarm control panel, battery cabinets, voice alarm system cabinets, and transponders.

   e. Automatic transfer switches.

2. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate. Identification of flush mounted cabinets and panel boards shall be on the inside of the device.

3. Panel boards, individually mounted circuit breakers, and each breaker in the switchboards, secondary unit substations, and distribution panels shall be identified with an engraved plastic laminate sign. Plastic nameplates shall be multicolored laminated plastic with faceplate and core as scheduled. Lettering shall be engraved minimum ¼" high letters.

   a. 480/277-volt normal power equipment shall be identified with white faceplate with green core.

   b. 480/277-volt critical branch power equipment shall be identified with white faceplate with yellow core.

   c. 480/277-volt life safety branch power equipment shall be identified with white faceplate with red core.

   d. 480/277-volt equipment branch power equipment shall be identified with white faceplate with blue core.

   e. 208/120-volt normal power equipment shall be identified with green faceplate with white core.

f. 208/120-volt critical branch power equipment shall be identified with yellow faceplate with white core.

g. 208/120-volt life safety branch power equipment shall be identified with red faceplate with white core.

h. 208/120-volt equipment branch power equipment shall be identified with blue faceplate with white core.

i. Equipment identification is to indicate the following:

1) Equipment ID abbreviation.

2) Voltage, phase, wires and frequency.

3) Emergency or other system.

4) Power source origination.

Example: Panel SLGHA1
480/277V, 3 Ø, 4 W
Life Safety System
Fed by EM1

j. Submit complete schedule with the shop drawings listing all nameplates and information contained thereon.

END OF SECTION 26 05 53

SECTION 26 07 00
REMODELING ELECTRICAL INSTALLATIONS

PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. General requirements for remodeling and modifying existing electrical installations.

2. Disposition of existing materials and equipment.

1.02 SUBMITTALS

A. Requests for service interruption to power, communications, telephone, etc.

1.03 UTILITY FEES

A. Include all SMUD charges for service location, connection charges, permits, or work performed by utility.

B. Utility: SMUD
P.O. Box 15830
Sacramento, CA 95852-1830
916-732-5776

PART II - WORK REQUIREMENTS

2.01 GENERAL REQUIREMENTS

A. Obtain written approval from the University prior to interrupting services for power, communication, telephone, etc. All interruptions shall be planned shutdowns and must comply with the University's published standards. Unless otherwise indicated on the drawings, all equipment shall be de-energized prior to any work being accomplished. All electrical equipment shall be considered energized until proven otherwise and an energized electrical work permit shall be submitted for approval.

B. The University will be occupying the existing building during construction. Provide any temporary connections necessary to maintain services to the existing electrical installation.

C. Work which involved a service outage to areas occupied by the University shall be performed on an overtime basis. Work shall continue until service is restored.

D. Coordinate all removal work to maintain services to all equipment and areas until such time as these items are removed or demolished.

2.02 ELECTRICAL INSTALLATION REMOVAL AND MODIFICATIONS

A. Abandoned Circuits and Equipment: Remove all wire back to its source wherever existing circuits are abandoned. Remove abandoned raceways and boxes unless

concealed in concrete or masonry construction. Remove all abandoned electrical equipment.

B. Remaining Circuits and Equipment: Reinstall existing electrical installations disturbed. Certain existing electrical installations may be located in walls, ceilings or floors that are to be removed and are essential for the operation of other remaining installations. Where this condition occurs provide a new extension of original circuits, raceways, equipment and outlets to retain service continuity. Installations shall be concealed in finished areas.

C. Lighting Installations: Remove lighting fixtures located in areas where ceilings or walls are to be replaced and reinstall fixtures unless new fixtures are indicated. Where conduit and wiring serving these fixtures must be removed to permit demolition work, provide new conduit and wire to obtain the same circuit arrangement as originally existed.

D. Equipment Reuse:

1. Assume that all existing equipment and fixtures indicated to be reused are in good working condition and can be installed without repairs. Items found to be in need of repair or in unusable condition, shall require notification of the University's Representative for direction or decision. Any damage to equipment caused in removal or handling shall be corrected under this contract.

2. Fixtures and other equipment removed and to be re-used shall be cleaned before reinstallation. Provide new lamps for reused light fixtures.

E. Added Circuits: All loads and circuits to existing panelboards shall be balanced between phases. On existing panelboards where circuits are changed, revise panel directories with new typed directories.

PART III - EXECUTION

3.01 DISPOSITION OF EXISTING MATERIAL AND EQUIPMENT

A. All material and equipment which is noted, or required by the University to be salvaged and which is not scheduled to be reused or relocated shall be carefully removed and shall be delivered to the University and stored where directed on the site.

B. Carefully remove and store on the site all material and equipment noted or specified to be reused or relocated. Thoroughly clean this equipment prior to installation.

C. Remove all other materials or debris resulting from demolition operations from the site.

3.02 DISPOSITION OF EXISTING BALLASTS CONTAINING (PCBs)

A. Environmental Protection Agency (EPA) Regulations required controlled disposal of fluorescent light ballasts containing polychlorinated biphenyls (PCB's) when removed from service. The ballasts involved were generally manufactured between 1950 and 1979.

B. Provide suitable ballast collection containers at the project site. Check the ballasts in all fluorescent fixtures removed from service under this contract. Some ballasts may be labeled to indicate whether they do or do not contain PCBs. Remove from the fixtures all ballasts known or assumed to contain PCBs and place them in the designated ballast collection container and arrange for the disposal of the ballasts off the site in manner approved by the EPA.

END OF SECTION 16070

SECTION 26 27 26
WIRING DEVICES

PART I - GENERAL

1.01 SUMMARY

A. Section includes:

1. Wall Switches
2. Receptacles
3. Device Plates
4. GFI Receptacles
5. Incandescent Dimmers

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Division 1.

B. Provide manufacturers product specification sheets for all specified devices.

1. Include specific color, material and finish.
2. Include manufacturers catalog device number.
3. Include manufacturers spec data to specifically indicate conformance with these specifications.

C. Samples: Provide device and plate samples if indicated or requested by the University's Representative.

1.03 REFERENCE STANDARDS

A. National Electrical Manufacturers Association.

1. NEMA WD-1 - General Purpose Wiring Devices.
2. NEMA WD-5 - Specific Purpose Wiring Devices.

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Leviton

B. Pass and Seymour/Sierra

C. or equal

2.02 WALL SWITCHES

A. Type: Quiet toggle AC heavy-duty rated 20 ampere at 120/277 volt. Provide the configuration listed in the table below or as indicated.

B. Grade: Heavy-duty industrial grade. Refer to reference manufacturer below.

C. Construction: Back and side wired, with silver alloy contacts and screw down wire termination clamps. Switch shall be self-grounding and include a grounding screw terminal.

D. Color: Toggles shall be ivory color finish. Switches on critical or equipment branch power shall be red. Verify color with University's Representative prior to order.

E. Key Switch: Provide locking type switch with key where indicated. Provide key with each switch.

F. Pilot switches: Lighted handle type with red pilot illuminated when switch is in "On" position.

G. Reference Manufacturer: Leviton catalog numbers are used in the following table to identify specific switches and grade:

Poles	Amps	Volts-AC	Cat. No.	Remarks
Single	20	277	1221-2	Toggle-Quiet
Double	20	277	1222-2	Toggle-Quiet
Three Way	20	277	1223-2	Toggle-Quiet
Four Way	20	277	1224-2	Toggle-Quiet
SPDT	20	277	1257	Momentary Contact
Single	20	120/277	1221PLR	Pilot
Single	20	277	1221-2L	Locking Type
Single	20	277	1221 w/cover	Weather Proof

*No longer made.

2.03 RECEPTACLES

A. Type: Standard straight blade or locking as indicated. Convenience outlets shall be rated at 20 amperes at 125 volts, composition base with slots to accommodate parallel plug caps with grounding peg unless indicated otherwise on drawings.

B. Grade: UL listed Hospital grade unless specification grade is indicated as acceptable on drawings. Refer to reference manufacturer below.

C. Construction: Back and side wired with screw down wire termination clamps of the voltage and configuration indicated. Body constructed of thermoplastic, nylon or urea with wrap-around steel strap. Face construction of a polycarbonate or nylon. Self-grounding with a grounding screw terminal.

D. Color: Face shall be ivory. Receptacles with special configurations not available in specified color shall be black. Receptacles on critical, life safety, or equipment branch power shall be red.

E. Configuration: NEMA 5-20R, unless identified on the drawings by another NEMA configuration number.

F. Isolated Ground Type: Provide only where indicated. Color of receptacle face shall match other 5-20R receptacles. Receptacle shall have orange dot isolated ground identification.

G. Reference Manufacturer: Leviton catalog numbers, unless otherwise noted are used in the following table to identify specific receptacles

Poles/ Wires	Volts	Amps	NEMA Configuration	Cat. No.	Use
2P-3W	125	20	5-20R	8300	General Duplex
2P-3W	125	20	5-20R	7899-HG	General GFI Duplex
2P-3W	125	30	5-30R	5371	Equipment Single
2P-3W	250	20	6-20R	5461	Equipment Single
2P-3W	250	30	6-30R	5372	Equipment Single
2P-3W	125	20	5-20R	P& S. TR63-H	Tamper Resistant
2P-3W	125	20	5-20R	8300-IG	Isolated Ground

2.04 G.F.I. RECEPTACLES

A. Type: 120 volt 20 ampere duplex feed through type.

B. Color: Face color to match other 5-20R receptacles.

C. Grade: Hospital Grade

D. Operation: Differential current sensing device capable of detecting ground fault currents of 5 milliamps, plus or minus 1 milliamp and interrupt the supply circuit within the UL trip time curve.

E. Test and Reset: Provide a test and reset button on the receptacle.

F. Exterior Installation: Install in FS box with weatherproof cover as specified.

G. All receptacles in restrooms within 6' of sink, outdoors, roof tops, indoor wet locations, kitchens, locker rooms with associated showering facilities, garages, and at water fountains shall be ground fault interrupter type.

2.05 DEVICE PLATES

A. Scope: Switches, receptacles, telephones and all other outlets (including signal systems and blank outlet boxes) shall be covered with specified plate. All plates shall match and be of the same manufacturer.

B. Type: Smooth no-line with rounded edges and corners. Standard size.

C. Color, Material and Locations:

1. Stainless Steel: Brushed stainless steel with stainless steel screws at all locations, except as indicated below.

2. Unfinished Areas: In tunnels, above ceilings and in unfinished areas, device plates shall be galvanized steel utility type.

3. Weatherproof Outlets: Provide cast aluminum plate with a hinged backing double lift cover and gasket allowing either surface or recessed mounting. Plate shall allow horizontal mounting of a duplex receptacle with a horizontal hinge. Hubbell #5205 or equal for standard boxes or Hubbell #5206 or equal for FS boxes. GFI outlets shall be provided with an appropriate cover.

4. Clock outlets: Provide 302 stainless steel with a hanging bracket and regressed receptacle. ~~Sierra~~ P&S #S3733-SS, or equal.

D. Engraving:

1. All device plates shall be engraved on the face with ¼" high black letters. Special purpose device plates, including fan motor controls, special voltages, sound system outlet identification, and special signal system identification, shall be engraved identifying use. Special receptacles shall be identified with voltage, amperage, and phase. All other devices, including receptacles and light switches, shall have panel number and circuit number engraved.

2. All critical and life safety branch outlet plates shall be engraved with red letters.

3. All device plates shall be of the same manufacturer.

2.06 LED DIMMERS

A. Refer to Section 26 51 10.

PART III - EXECUTION

3.01 INSTALLATION

A. Light Switches:

1. Install all outlet boxes for light switches flush in wall where possible. Where more than one switch appears at the same location, they shall be installed in a ganged box with a single plate.

2. Verify with the University's Representative the correct room numbers and terminology before engraving plates.

3. Install all single pole switches with "on" in the up position and "off" in the down position.

4. Mount switches at the elevation indicated on the drawings. Dimensions are to the center of the box. For masonry walls, adjust height as required to install end of device at the nearest mortar joint.

B. Receptacles:

1. Where receptacles are shown adjacent to other devices, the boxes shall be installed with 2" between devices of other systems.

2. Mount receptacles at the elevation indicated on the drawings. Mounting heights are to the center of the outlet. For masonry walls, adjust height as required to install end of device at the nearest mortar joint.

3. Mount receptacle vertically with the grounding U at the top.

C. G.F.I. Receptacles:

1. Install ground fault receptacles at all receptacle locations indicated on the plan as G.F.I.

2. Where a number of receptacles in sequence are marked G.F.I, the first receptacle shall contain the sensing interrupting device and the remainder shall be standard receptacles served from the protected feed through connection.

D. Plates:

1. Coordinate multiple gang plates for proper arrangement, openings and engraving.

2. Provide blank plates mounted on the outlet box for all empty conduit systems.

3. Plates shall match and shall be mounted square with the building structure.

4. Provide cadmium plated cover plates for surface boxes in unfinished spaces.

5. Secure plates to device or box with proper attachment screws.

3.02 WIRING AND CONNECTIONS

A. Terminate ground wire at device where ground wire is provided within the raceway system.

B. Carefully strip thermoplastic wire to length and make-up terminal connection as recommended by the device manufacturer.

C. Secure device to outlet box with proper screws.

3.03 TESTING AND INSPECTION

A. Test all receptacles for ground continuity and polarity.

B. Test all GFI interrupting receptacles.

C. Inspect all devices for defective operation or breakage, cracks or chips. Replace defective devices or devices damaged during construction.

3.04 TELECOMMUNICATIONS SPACE (TS) ELECTRICAL REQUIREMENTS

A. Convenience duplex receptacles shall be:

1. Mounted in each room at +18 inches AFF and horizontally spaced not to exceed 6-feet around the perimeter of the room.

2. Non-switched, 120VAC 20 Amp duplex, and divided equally on branch circuits, (i.e. all receptacles in the same room shall not all be on the same circuit). Minimum of 2 circuits shall be provided per room, alternating duplexes around room, with no more than four (4) receptacles on the same circuit.

3. Each receptacle shall be clearly marked with its respective circuit number.

B. Equipment Rack and Cabinet Electrical Requirements:

1. Equipment racks identified for electronic equipment shall have the following installed:

a. One (1) quad device box containing two (2) duplex 20 amp, 120VAC NEMA 5-20R-spade receptacles located on separate dedicated circuits in the room sub-power panel.

b. Device box shall be mounted on the backside of each rack 15-inches Above the Finished Floor (AFF). The placement of this device box and its EMT conduit shall not block or interfere with the equipment mounting area (rails) on either side of the rack.

c. A minimum of 24-inches of flexible conduit shall be used to attach electrical service to the equipment rack. Flexible conduit is required to prevent the shearing of the conduit during a seismic event.

d. Reference Division 27 11 13, Communications Cabinets, Racks, Frames and Enclosures, Fig. 31.

2. Enclosed cabinets identified for electronic equipment shall have the following installed:

a. Two (2) quad device boxes containing two (2) duplex 20 amp, 120VAC NEMA 5-20R-spade receptacles to separate dedicated circuits located in the room sub-power panel.

b. One (1) device box shall be mounted toward the back of the cabinet near the top inside area of the cabinet to provide electrical power to the cooling fan(s). The second device box shall be located 15-inches above the floor toward the back of the cabinet.

c. The device boxes and EMT conduit shall not block or interfere with the equipment mounting area (inside and outside mounting rails) within the cabinet.

d. Reference Division 27 11 13, Communications Cabinets, Racks, Frames and Enclosures, Fig. 30.

3. Special considerations:

a. ADF equipment racks and cabinets shall have 30 Amp,120VAC NEMA 5-30R-spade receptacles in place of the 20 amp, 120VAC NEMA 5-20R-spade receptacles.

3.05 b. Provide a duplex 20 Amp, 240 VAC NEMA 6-20R receptacle for a DLC cabinet

END OF SECTION ~~16140~~ 26 27 26

SECTION 26 28 16
ENCLOSED DISCONNECT SWITCHES

PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Disconnect Switches.

2. Enclosures.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Division 1, including the following:

1. Outline Drawing with Dimensions.

2. Equipment Ratings.

a. Voltage.

b. Capacity.

c. Horsepower.

d. Short Circuit Withstand Rating.

1.03 REFERENCE STANDARDS

A. National Electrical Manufacturers Association (NEMA).

B. Underwriters Laboratories (UL).

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. General Electric.

B. Square D.

C. Or Equal

2.02 DISCONNECT SWITCHES

A. Switches shall be heavy duty type, 250-volt or 600-volt and 2 pole or 3 pole as required. Switches shall be visible blade type with quick-make, quick-break operating mechanism, full cover control circuit interlock and means for padlocking.

B. Switches shall be fused or non-fused as required and shall be properly sized for the load. All switches shall be horsepower rated and shall always be equal to or exceed the

horsepower rating of the motor being protected. Where fusable disconnects are used 3 spare fuses must be provided to the University.

C. Switches shall be enclosed in a NEMA 1 enclosure for interior, or a NEMA 3R enclosure for exterior. Indoor switches, in wet locations, shall be NEMA 4X.

D. All switches using current limiting fuses shall have rejection type fuse clips.

E. All steel surfaces shall be chemically cleaned and treated to provide a bond between paint and metal surfaces to help prevent the entrance of moisture and formation of rust under the paint film. The switch enclosure shall be finished in ASA-#61 light gray.

PART III - EXECUTION

3.01 INSTALLATION

A. Install disconnects where indicated on drawings and required by governing code.

B. Mount disconnect switches securely to building structure or equipment. Where switches are mounted to concrete or block walls, concrete anchors will be used. Switches mounted to gypsum board walls shall be secured by toggle bolts. Reinforcing channels shall be used on gypsum board walls or equipment for mounting switches.

C. Switches shall not be supported by conduit.

D. Comply with all applicable seismic requirements.

E. Locate disconnect switch within sight of motor as required by the CEC.

END OF SECTION 26 28 16

SECTION 26 51 13
LIGHTING FIXTURES

PART I - GENERAL

1.01 SUMMARY

A. Section Includes
1. Light Fixtures
2. LEDs
3. Egress and Exit Signs
4. Mounting and Installation Hardware
5. Fixture Allowances
6. Utility Rebates

1.02 SUBMITTALS

A. Prior Approvals: Submit the following:
1. Manufacturer's data required to evaluate the product for which approval is sought including, photometric data with specified options, dimensional data, weight, and catalog cut sheets.
2. A letter indicating differences between each product specified and the product for which approval is sought, including overall and aperture dimensional data, specified options available, mounting information, finishes and photometric data.
3. Submittals which do not contain the above information will not be considered.

B. Shop Drawings: Submit in accordance with Division 1, including the following:
1. Dimensional Drawing/Material/Finish
2. Weight
3. Options provided
4. Voltage
5. Photometric and Performance Data
6. Ballast manufacturer and model number
7. Lamp manufacturer and ANSI Code
8. Mounting hardware
9. Components that are not standard
10. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under "Regulatory Requirements".
11. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation of product.

C. Provide lighting shop drawings in one submittal. Include required information for all fixtures, lamps, and mounting hardware in shop drawing submittal. Incomplete submittal will be returned without being reviewed.

D. Samples.
   1. Submit a sample to the University's Representative for review when indicated on the Light Fixture Schedule or when a fixture is discontinued or otherwise requires substitution and approval after bids have been received.
      a. Submit a shop drawing, and letter stating whether the fixture is one from a standard factory run or a special assembly and arrange for the manufacturer's representative to meet with the University's Representative to facilitate the approval process at the same time as the submittal of the samples.
      b. Samples will be held by the University's Representative until completion of the approval process and then returned.

E. Submit quantity invoices for all lamps which qualify for energy rebates in accordance with Section 01700 (Contract closeout).

1.03 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1.

B. Accurately record actual locations of each luminaire.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 1.

B. Maintenance Data: Include replacement parts list.

1.05 QUALIFICATIONS

A Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.06 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriter's Laboratories, Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.07 REFERENCE STANDARDS

A. Underwriter's Laboratories (UL).

B. American National Standards Institute (ANSI).

C. National Electrical Manufacturer's Association NEMA).

D. Illuminating Engineering Society of North America (IESNA).

E. National Fire Protection Agency (NFPA).

1.08 DEFINITIONS

A. CCT: Correlated Color Temperature.

B. CRI: Color-Rendering Index.

C. LER: Luminaire Efficacy Rating.

D. Lumen: Unit of Luminous flux. Photometrically, it is the luminous flux emitted within a unit solid angle by a point source having a uniform luminous intensity of 1 candela.

E. Luminaire: Complete lighting fixture designed to distribute the light.

1.09 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with IESNA Lighting Measurements Testing & Calculation Guides.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, by a qualified testing agency, and marked for intended location and application.

D. Comply with CEC.

E. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.10 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire suppression system, and partition assemblies.

1.11 WARRANTY

A. Exit Signs Utilizing LED Technology: Provide manufacturer's warranty for a period of not less than five years including parts and labor for full replacement of defective product.

B. LED Luminaires: Provide manufacturer's warranty for a period of not less than three years for repair or replacement of defective electrical parts, including light source and power supplies.

C. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
   1. Warranty period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
   2. Warranty Period for Self –Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty shall apply for the remaining six years.

PART 2 – PRODUCTS

2.01 LIGHT FIXTURES – GENERAL

A. Acceptable Manufacturers
   1. As specified in the Light Fixture Schedule.

B. Written description in the specification or in the Light Fixture Schedule indicates the desired fixture options and overrides the manufacturer's catalog numbers given.

C. Provide all light fixtures complete with lamps, ballast drivers, and accessories required as shown on the Drawings and written schedule.

D. Provide light fixtures UL listed for through wiring with junction boxes accessible from the fixture frame-out opening for recessed fixtures installed in inaccessible ceilings.

E. Provide fixtures designed and/or gasketed to prevent light leaks from around lenses, trims and/or frames.

F. Provide lenses that are 100% virgin acrylic, .156” thick nominal, Pattern 19, unless noted otherwise in the Light Fixture Schedule.

G. Provide downlights with clear alzak cones and self-flange trims unless noted otherwise on the Drawings.

H. Provide parabolic aluminum louvers or cones designed to eliminate or provide very low iridescence when used with tri-phosphor lamps.

I. Where threaded fasteners are used for latching frames provide fasteners designed to be captive into the frames.

J. Provide and coordinate the fixture mounting accessories for all ceiling types and check ceiling finishes, clearances, structure suspension system, etc., before placing fixture orders to insure correct application. Provide fixtures with grid trim appropriate for acoustical ceiling suspension systems specified in Section 09510. Refer to architectural reflected ceiling plans and details. Coordinate with ceiling type provided by the Designer.

K. Finish ferrous mounting hardware and accessories to prevent corrosion and discoloration to adjacent materials.

L. For vapor tight installations, painted finishes of fixtures and accessories shall be weather resistant enamel using proper primers or galvanized and bonderized epoxy, so that the entire assembly is completely corrosion resistant for the service intended. Where aluminum parts come into contact with bronze or steel parts, apply a coating material to both surfaces to prevent corrosion.

M. Fresnel Lens and Door Assembly:
   1. Lens shall have uniform brightness throughout the entire visible area at angles from 45º to 90º from vertical, without bright spots or striations.
   2. Lens shall have opaque risers painted natural gray unless otherwise specified in the Light Fixture Schedule.
   3. Finish of regress door shall be matte black enamel paint in color as selected by the Architect.

N. For adjustable fixtures, provide positive locking devices to fix aiming angle.

O. Fixtures recessed in suspended ceilings where the space above the ceiling is either an air supply or return plenum shall conform to CEC Article 300-22.

P. Exterior Fixtures
1. Provide exterior fixtures with clear tempered glass lenses unless indicated otherwise in Light Fixture Schedule.
2. Provide a minimum 2.5 mil thick baked on polyester powder finish, color as specified in the Light Fixture Schedule for exterior fixture housing and poles.
3. Provide fully gasketed exterior fixture lens and diffuser frames to prevent moisture, debris, and insects from entering the fixture housing.
4. Painted surfaces shall have an outdoor life expectancy of not less than 20 years without any visible rust or corrosion.
5. Finishes to comply with requirements set by the American Architectural Manufacturers Association (AAMA):
   a. Baked on enamel and high performance powder coating finish on aluminum:
   b. AAMA 304-05
   c. Anodized aluminum AAMA 611-98
   d. Clear coat on aluminum: AAA 612-02
6. Finish colors shall be as specified.

2.02 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Comply with UL 773 or UL 773A

B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent electric light sources from causing false turnoff.
1. Relay with locking-type receptacle shall comply with ANSI C136.10.
2. Adjustable window slide for adjusting on-off set points.

2.03 LIGHT EMITTING DIODE (LED) FIXTURES:

A. LED sources must meet the following requirements:
1. Operating temperature rating must be between -40ºC and +50ºC.
2. Correlated Color Temperature (CCT):
   a) Nominal CCT: 2700 K (2725 $\pm$ 145)
   b) Nominal CCT: 3000 K (3045 $\pm$ 175)

c) Nominal CCT: 3500 K (3465 ± 245)
d) Nominal CCT: 4000 K (3985 ± 275)
e) Nominal CCT: 4500 K (4503 ± 243)
f) Nominal CCT: 5000 K (5028 ± 283
g) Nominal CCT: 5700 K (5665 ± 355)
h) Nominal CCT: 6500 K (6530 ± 510)
i) Du'v' tolerance of 0.001 ± 0.006

B. Color Rendering Index (CRI): greater than or equal to 80.

C. Luminaire manufacturer must submit reliability reports indicating that the manufacturer of the LED (chip, diode, or package) has performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows:
1. High Temperature Operating Life (HTOL)
2. Room Temperature Operating Life (RTOL)
3. Low Temperature Operating Life (LTOL)
4. Powered Temperature Cycle (PTMCL)
5. Non-Operating Thermal Shock (TMSK)
6. Mechanical Shock
7. Variable Vibration Frequency
8. Solar Heat Resistance (SHR)

2.04 LED DRIVERS/POWER SUPPLIES

A. LED drivers must meet the following requirements:
1. Drivers must have a minimum efficiency of 85%.
2. Starting Temperature: -40ºC.
3. Electrical Characteristics:
a. Volts: as indicated on Luminaire Schedule.
b. Phase: Single.
c. Hertz: 60.
4. Power supplies can be UL Class I or II output.
5. Drivers must have a Power Factor (PF) of greater than or equal to 0.90.
6. Drivers must have a Total Harmonic Distortion (THD) of 20% or less.
7. Drivers must comply with FCC 47 CFR Part 15 non-consumer RFI/EMI Standards.
8. Drivers must be Reduction of Hazardous Substances (RoHS) compliant.
9. Drivers must comply with requirements in Section 2.5 B Controls.

2.05 LED LUMINAIRES

A. Provide luminaires with integral LED thermal management system (heat sinking).

B. Luminaires shall be equipped with an LED driver that accepts 120V through 277V, 50hz to 60hz (UNIV). Component-to-component wiring within the luminaire will carry no more than 80% of rated current and be listed by UL for use at 600 VAC at 302ºF/150ºC or higher. Plug disconnects shall be listed by UL for use at 600 VAC, 15A or higher.

C. LED modules shall have a minimum L70 service life of 75,000 hours at 25ºC ambient temperature and based on IESNA LM-80 methodology.

D. Provide luminaires with individual LED arrays/modules and drivers that are accessible and replaceable from exposed side of the luminaire. Luminaires requiring removal or replacement of entire luminaire to access LEDs and drivers will NOT be accepted.

E. Luminaires shall be listed by Design Lights Consortium.

F. Housing: Rigid aluminum construction.

G. Finish: Visible surfaces. Powder coated paint or natural aluminum as specified in Light Fixture Schedule. Color and finish as selected by Architect. Concealed parts, (lamp holders, yokes, brackets, etc.) matte black.

H. Lamp holder housing: Cast aluminum with integral heat radiating fins to assure cool lamp base operation, with sufficient heat dissipation to meet device manufacturer's guidelines, certification programs, and test procedures for thermal management.

I. Off-state Power: Luminaires shall not draw power in the off state. Exception: Luminaires with integral occupancy, motion, photo-controls or individually addressable fixtures with external control and intelligence are exempt from this requirement. The power draw for such luminaires shall not exceed 0.5 watts when in the off state.

2.06 LED DIMMERS

A. Provide dimmer and driver that are compatible and tested to comply with UL standards.

B. Continuous Flicker Free dimming range 100% to 1% measured relative light output. Relative humidity: maximum 90% non-condensing.

C. Power factor: greater than .90 at 25W.

D. Total Harmonic Distortion: less than 20% at 25W.

E. Inrush current: <2A.

F. Sound rating: Inaudible in a 24 db ambient.

G. Class P thermally protected.

H. Meets FCC Part 15 Non-Consumer requirements for EMI/RFI emissions in a typical grounded fixture.

I. Provide dimmers with Pulse Width Modulation for both constant current or constant wattage drivers to maintain LED color when dimming. Unless noted otherwise on the Luminaire Schedule.

2.07 WIRING

A. Wiring shall b as required by code for fixture wiring.

B. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

C. Flexible cord wiring between fixture components or to electrical receptacle and not in wireways shall have a minimum temperature rating of 105ºC.

D. Cords shall be fitted with proper strain reliefs and watertight entries where required by application.

E. No internal wiring shall be visible at normal viewing angles, i.e. above 45º from vertical.

F. Provide #18 AWG, 3-wire flexible conduit connections (whips) for dual level switching as shown on Drawings for light fixtures recessed in accessible suspended ceilings. Provide 3-wire whips for all dual level switching. Wire count on wire whips is not shown on Drawings and shall be the responsibility of the Contractor to provide proper wire count for the lighting controls as shown on Drawings.

2.08 EXIT LIGHTS/EXIT SIGNS

A. Acceptable manufacturer:
   1. As specified in Light Fixture Schedule.

B. Provide cast aluminum stencil face Exit Signs with fully concealed chevron type directional arrow knockouts and universal mount canopy unless otherwise indicated on the drawings.

C. Provide exit lights illuminated from light emitting diodes (LED) designed so that individual LEDs cannot be seen when the exit light is installed and illuminated

D. Provide canopy, housing, stencil face and flange trim with white high temperature or polyester powder coat painted finish.

E. Letters shall be Red.

F. Do not install exit signs that utilize radioactive Tritium (^{3}H) gas to provide illumination.

2.09 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-5-E
   1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in “Structural Analysis Criteria for Pole Selection” Article.
   2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers’ mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components:
   1. Materials: Shall not cause galvanic action at contact pints.
   2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
   3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws. Provide on all except wood poles.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete reinforcement, and framework are specified in Division 03 Section “Cast-in-Place Concrete”.

F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot dipped galvanized according to ASTM A 123/A 123M; and with top-

plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

G. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

H. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-5-E.

I. Live Load: Single load of 500 lb (2224 N), distributed as stated in AASHTO
LTS-5-E.

J. Ice Load: Load of 3 lb/sq. ft. (145 Pa), applied as stated in AASHTO LT5-5-E Ice Load Map.

K. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated as applied and stated in AASHTO LT5-5-E.
   1. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is 100 mph (45 m/s).
      a. Wind Importance Factor: 1.0. Minimum design life: 25 years Velocity Conversion factors are 0.93 non hurricane location.

2.10 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
   1. Shape: Square, straight.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
   1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless-steel bolts.
   2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
   3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

E. Steps: Fixed steel, with non-slip treads, positioned for 15 inch (381 mm) vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet (3 m) above finished grade.

F. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch (76-by-127-mm) handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.

G. Grounding and Bonding Lugs: Welded ½ inch (13 mm) threaded lug , complying with requirements in Division 26 Section “Grounding and Bonding for Electrical Systems”, listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

H. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 foot safety factor.

I. Platform Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.

J. Galvanized Finish: After fabrication, hot dip galvanize complying with ASTM A 123/A123M.

K. Factory Painted Finish: Comply with NAAMM’s “Metal Finish’s Manual for Architectural and Metal Products” for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, “Solvent Cleaning”, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel complying with SSPC-SP 5/NACE No.1, “White Metal Blast Cleaning”, or with SSPC-SP 8, “Pickling”.
   2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
   3. Exterior Surfaces: Manufacturer’s standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
      a. Color: As indicated by manufacturer’s designations.

2.11 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429fB 429M, Alloy 6063-T6 with access handhole in pole wall.

B. Poles: ASTM B 209 (ASTM B 209M), 5052-H34 marine sheet alloy with access handhole in pole wall.
   1. Shape: Square, straight.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded ½-inch (13-mm) threaded lug, complying with requirements in Division 26 Section “Grounding and Bonding for Electrical Systems”, listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Brackets for Luminaires: Detachable with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
   1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
   2. Finish: Same as pole.

F. Aluminum Finish: Comply with NAAMM’s Metal Finishes Manual for Architectural and Metal Products” for recommendations for applying and designating finishes.
   1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
   2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
   3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
   4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish; etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

2.12 POLE ACCESSORIES

A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 26 Section “Wiring Devices” for ground-fault circuit-interrupter type.
   1. Recessed, 12 inches (300 mm) above finished grade.
   2. Nonmetallic polycarbonate plastic or reinforced fiberglass, weatherproof in use, cover, that when mounted results in NEMA 250 Type 3R enclosure.
   3. With cord opening.
   4 With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.

B. Base Covers: Manufacturers’ standard metal unit, arranged to cover pole’s mounting, bolts and nuts. Finish same as pole.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Install suspended exit signs using stem pendants from swivel hangers.

C. Install suspended luminaires using stem pendants from swivel hangers, aircraft cable, and chain in accordance with the intended design. Provide stem pendants, aircraft cable, and chain lengths required to suspend luminaire at indicated height.

D. Provide mounting accessories and trims as required for wall and ceiling construction types shown in Finish Schedule and on Drawings.

E. Lighting Fixtures:
   1. Set level, plumb, and square with ceilings and walls unless otherwise indicated. Secure to prohibit movement.
   2. Install lamps in each luminaire.

F. Temporary lighting: If it I necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

G. Verify weight and mounting method of fixtures and provide suitable supports. Fixture mounting assemblies shall comply with local seismic codes and regulations.

H. Support luminaires larger than 2’ x 4’ size or heavier than 56 pounds independent of ceiling framing.

I. Locate recessed ceiling luminaires as indicated on reflected ceiling plan. Refer to architectural reflected ceiling plans for coordination of lighting fixture locations with mechanical and fire safety equipment. Where conflicts occur, coordinate with Architect prior to installing any of the systems.

J. Install recessed luminaires to permit removal from below.

K. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

L. Install clips to secure recessed grid-supported luminaires in place.

M. Install fixtures with vent holes free of air blocking obstacles.

N. Lighting fixtures located in recessed ceilings with a fire resistive rating of 1-hour or more shall be enclosed in an approved fire-resistive rated box equal to that of the ceiling.

O. Adjust aperture rings on all recessed fixtures to be flush with the finished ceiling.

P. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure.

Q. Install accessories furnished with each luminaire.

R. Install wall mounted luminaires and exit signs at height as indicated on Drawings.

S. Blemished, damaged or unsatisfactory fixtures or accessories shall be replaced.

T. For pendant mounted fixtures, mounting height is from finished ceiling to top of pendant light fixture. For wall mounted fixtures, center on outlet box unless otherwise noted. Verify mounting provisions and other requirements prior to order of light fixtures and provide as requird.

U. In accessible suspended ceilings, provide 72” flexible conduit wiring connection (flexible tubing not permitted) from a rigidly supported junction box.

V. Bond products and metal accessories to branch circuit equipment grounding conductor.

W. All finishes shall be unmarred upon project completion. Repair or replace damaged finishes.

X. Install specified lamps in each luminaire.

Y. Replace all burned out or inoperative lamps at the end of the construction prior to Owner occupancy.

Z. Install continuous row fixtures as shown of drawings. The fixture type letter next to one fixture identifies all fixtures in the row. Rows are made up of either 4’ or 8’ long lamps in combination to complete the row. Design-Builder shall be responsible for quantities of fixtures required in any row and for supplying fixtures which are an interior continuous mounting or a fixture with end cap. The channels or fixtures may be longer than 4’, but plastic lenses, hinged doors and louver sections shall not exceed four feet long.

AA. Install concrete bases for exterior fixtures except parking lot fixtures with top of base flush with finished grade or as detailed on the Drawings. Install concrete bases for parking lot fixtures a minimum of 30” above paving to top of base or as detailed on the Drawings.

BB. Clean fixtures immediately before the final inspection. Provide fixtures newly lamped and in perfect operating condition at the completion of the job.

3.02 SUPPORT OF LED LIGHT FIXTURES

A. Recessed type: For light fixtures supported by the ceiling suspension system, provide four Caddy #515 (or as provided by the manufacturer) support clips (one each corner) which lock light fixture to ceiling tees after light fixture is installed. In addition, provide for each light fixture two #14 earthquake chains or #12 wires secured at diagonally opposite fixture corners (for fixtures weighing less than 56 pounds) to structural members above suspended ceiling. For plaster or gypsum board ceilings provide plaster frame compatible with light fixture. Contractor shall coordinate fixture trim with ceiling type.

B. Surface Mounted Type:
   1. Where mounted on accessible ceilings, support from structural members
      above ceiling by means of hanger rods through ceiling or as approved.
   2. Continuous Runs of Fixtures: Laser sight to assure fixtures are straight when sighting from end to end, regardless of irregularities

in the ceiling. Where light fixtures are so installed, omit ornamental ends between sections.

C. Pendant Mounted Type:
   1. For fixtures with rigid pendants, supply swivel ball aligners at canopy to comply with local seismic requirements.
   2. Where suspended from accessible ceiling, support fixture from structural members above ceiling by means of hanger rods through ceiling or as accepted.
   3. Continuous Runs of Fixtures: Laser sight to assure fixtures are straight when sighting from end to end, regardless of irregularities in the ceiling. Where light fixtures are so installed, omit ornamental ends between sections.
   4. Where pendant is longer than 48 inches (1200 mm), brace to as required by code or shown on Drawings.

3.03 DIFFUSERS AND ENCLOSURES

A. Remove protective plastic covers from lighting fixture diffusers only after construction work, painting and clean-up are completed. Remove all dirty lamps, reflectors and diffusers; clean and reinstall. When cleaning “Alzak” reflectors, use a manufacturer recommended cleaning solution. Reflectors damaged or impregnated with fingerprints shall be replaced at no cost to Owner.

B. For LED fixtures, whether surface mounted or recessed, remove all construction dirt and dust from heat sink fins to insure proper dissipation of heat.

3.04 LIGHTING BOLLARDS

A. Provide galvanized anchor bolts and nuts, and plumb to true vertical using a nut above and below the base plate on the anchor bolts. Provide steel reinforced concrete footing with grout between base plate and concrete footings. Bollard footing shall be flush with grade when located in paved surface. Ground all components.

3.05 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
   1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).

2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
3. Trees: 15 feet (5 m) from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete".

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
3. Install base covers unless otherwise indicated.
4. Use a short piece of ½-inch-(13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.

F. Raise and set poles using web fabric slings (not chain or cable).

3.06 LIGHTING STANDARDS

A. Provide rebar reinforced concrete base. For bolted poles, provide galvanized anchor bolts and nuts and plumb to true vertical using a nut above and below the base plate on the anchor bolts. Pack grout between base plate and concrete base and provide drain hole below base plate to prevent accumulation of moisture inside pole base. Provide two piece or individual covers for nuts exposed above the baseplate of the same color as the pole. Ground pole and light fixture.

3.07 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems". In concrete foundations, wrap conduit with 0.010-

inch- (0.254-mm-) thick pipe-wrapping plastic tape applied with a 50 percent overlap.

3.08 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section “Grounding and Bonding for Electrical Systems”.
   1. Install grounding electrode for each pole unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Division 26 Section “Grounding and Bonding for Electrical Systems”.
   1. Install grounding electrode for each pole.
   2. Install grounding conductor and conductor protector.
   3. Ground metallic components of pole accessories and foundations.

3.09 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 12 hours at full voltage per NEMA recommendations or as required by fixture manufacturer.

3.10 ADJUSTMENT OF LIGHT FIXTURES

A. Aim and adjust luminaires as indicated on drawings.

B. Provide materials and labor for aiming and adjusting lighting fixture under Architect’s supervision. Aiming and adjusting shall take place immediately before building is turned over to Owner.

C. Adjust exit sign directional arrows as indicated.

D. Relamp luminaires that have failed lamps at substantial completion.

E. Provide all new lamps burned in for 100 hours.

3.11 FIELD QUALITY CONTROL

A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosure.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Inspect each installed fixture for damage. Replace damaged fixtures and components.

F. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
   1. Verify operation of photometric controls.

G. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance to standards.

3.12 DEMONSTRATION

A. Provide a minimum of two hours demonstration of luminaire operation.

3.13 ENERGY REBATES

A. Submit quantity invoices for all lamps and ballasts which qualify for energy rebates. Apply for all applicable lamp and ballast energy rebates.

B. Retain samples of existing lamps and ballasts as proof of energy savings when required by the energy utility for rebate.

C. Coordinate with the electrical utility to facilitate rebate payments to be made directly to the Owner.

D. Use of lamps and ballasts not eligible for rebates must be approved by the Owner prior to implementing the design.

3.14 TELECOMMUNICATIONS SPACE (TS) LIGHTING REQUIREMENTS

A. Room Lighting shall be mounted a minimum of 8-feet, 6-inches above the finished floor. Provide a minimum equivalent of 50 foot-candles when measured three feet AFF. Locate the lights parallel to the front and back of the equipment racks on both sides and in the middle of all aisles between racks or cabinets. Recommend at least one light fixture be on an emergency power circuit, if available in the building. Lighting shall not receive power from the same electrical distribution panel breaker as the telecommunications equipment in the TS.

END OF SECTION

26 51 13

SECTION 27 05 00
COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes, but is not necessarily limited to, common standards and procedures for the Communications Work.

B. This Section outlines areas of responsibility between Owner, Architect, and Contractor.

C. Owner will assist with a collaborative process to determine the most cost effective and efficient means to reach the common goal of providing communications within the facility for the project, including assessing user needs and assessing required pathways. The Owner is available upon request to assist at no additional cost to the project. It is incumbent upon the construction team management to approach and engage the Owner at the appropriate times for collaboration.

D. As part of the project, the construction team must design, engineer, and provide complete, all means of support, suspension, attachment, fastening, bracing, and restraint (hereinafter “support") of the Communications Systems; and provide engineering of such support by parties licensed to perform work of this type in the project jurisdiction.

1.02 ITEMS PROVIDED BY OWNER

A. Registered Communications Distribution Designer (RCDD) support services

B. IT project management

C. Submittal approvals

D. Network equipment

E. 802.11 Wireless Access Point hardware

1. Installation by construction team when wireless access point mounting requires seismic support or a construction activity such as screwing, drilling, or welding
2. Owner will provide 802.11 design services

F. Racks for mounting cabling and equipment (installation by construction team)

G. Rack and Stack

H. Plug Pack Distribution (Pre-terminated switch port cabling provided and installed by the Owner)

I. Patch Cords and Patching

J. Vertical Wire Managers (installation by construction team)

K. IT UPS System (installation by construction team)

L. PDU Power distribution Equipment

M. VOIP Router, Voice Gateway, VOIP equipment

N. Camera NVR/Server

O. Overhead Paging Amplifier

P. TV Distribution Amplifier

Q. Closet Cleaning post production

1.03 ITEMS PROVIDED BY CONSTRUCTION TEAM

A. Building Drawings and Floor Plans

B. Site Plans

C. Furniture Plans

D. As-Built Drawing Submittals
   1. Cabling Schedule

E. Attachments to structure

F. In wall cabling

G. In wall cabling supports

H. Wireless Access point installation

I. Cabling test results

J. Patch Panels

K. Horizontal Wire Managers

L. Horizontal cable, jacks, faceplates, surface mount boxes, cable trays, termination hardware, and all materials needed for a complete horizontal cabling plant as defined in the Section and associated Sections and the construction documents not otherwise listed for provision by the Owner.

M. Construction Clean Closet Cleaning

1.04 RELATED SECTIONS

A. 27 05 26 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

B. 27 05 29 HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

C. 27 05 33 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

D. 27 05 36 CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

E. 27 05 53 IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

F. 27 11 16 COMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

G. 27 11 19 COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

H. 27 11 23 COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

I. 27 11 26 COMMUNICATIONS RACK MOUNTED POWER PROTECTION AND POWER STRIPS

J. 27 13 00 COMMUNICATIONS BACKBONE CABLING

K. 27 13 43 COMMUNICATIONS SERVICES CABLING

L. 27 15 00 COMMUNICATIONS HORIZONTAL CABLING

M. 27 41 33 MASTER ANTENNA TELEVISION SYSTEMS

N. 27 51 16 PUBLIC ADDRESS SYSTEMS

O. 27 52 13 PATIENT MONITORING AND TELEMETRY SYSTEMS

P. 27 52 23 NURSE CALL/CODE BLUE SYSTEMS

Q. 27 53 13 CLOCK SYSTEMS

R. 27 53 19 INTERNAL CELLULAR, PAGING, AND ANTENNA SYSTEMS

1.05 REFERENCES AND STANDARDS

A. UC Davis Health Telecommunications Standards

B. American National Standards Institute (ANSI)

C. Telecommunications Industry Association (TIA)

D. Building Industry Consulting Services International (BICSI)

E. American Society for Testing and Materials (ASTM)

F. Institute of Electrical and Electronic Engineers (IEEE)

G. National Electrical Manufacturers Association (NEMA)

H. National Fire Protection Association (NFPA)

I. NFPA 70 National Electrical Code

J. Underwriters Laboratories, Inc. (UL)

K. Local Authorities Having Jurisdiction (AHJ)

1.06 ABBREVIATIONS

A. ADA Americans with Disabilities Act

B. AFC Above Finished Ceiling

C. AFF Above the Finished Floor

D. BDF Building Distribution Frame – See Telecommunications Room (TR)

E. BLDG Building

F. CAT Category (Related to network cable types)

G. DIV Division

H. (E) Existing

I. ER IT Equipment Room – See Telecommunications Room (TR)

J. GE Grounding Equalizer – Part of the Telecom Grounding System

K. HR Homerun

L. ID Inside Diameter

M. IDF Intermediate Distribution Frame – See Telecommunications Room (TR)

N. IT UC Davis Health IT Department (also UC, UCDH, UCD IT, IT Facilities)

O. LAN Local Area Network

P. MAX Maximum

Q. NIC Not in Contract

R. OD Outside Diameter

S. TBB Telecom Bonding Backbone – Part of the Telecom Grounding System

T. TGB Telecommunications Ground Busbar

U. TMGB Telecommunications Main Ground Busbar

V. TR Telecommunications Room, TR may also be used interchangeably with ER, IDF, MDF, or Communications Room

W. TYP Typical

X. UCD UC Davis Health IT Department (also UC, UCDH, UCD IT, IT Facilities)

Y. UFE University Furnished Equipment

Z. UON Unless Otherwise Noted

1.07 DEFINITIONS

A. Telecommunications Room (TR) – An enclosed space for housing telecommunications equipment, cable, terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and the horizontal cabling.

B. Intermediate Distribution Frame (IDF) – See Telecommunications Room (TR)

C. Entrance Facility (EF) (Telecommunications) – An entrance to the building for both private and public network service cables (including antennae) including the entrance point at the building wall and continuing to the entrance room or space.

D. Pathway – A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.08 QUALITY ASSURANCE

A. Contractor Firm Qualifications:

1. All work for the Communications (low voltage) Infrastructure installation shall be self-performed by the Communications Contractor; subcontractors shall not be allowed under the Communications Contractor.

B. Communications Contractor shall:

1. Be a Panduit Corp. PCI (Panduit Certified Installer) Design and Installation Contractor or approved equal.
2. Be a firm which is regularly and professionally engaged in the installation and testing of the specified communications equipment and infrastructure.
3. Be licensed to install low voltage electronic cabling systems in the State of California where applicable (C7 License).

C. Communications Contractor shall demonstrate experience in providing successful installation of data infrastructure systems:

1. Submit documentation for a minimum of three and a maximum of five successful low voltage communications infrastructure system installation projects completed within the past three years.

D. Contractor Key Personnel Qualifications:

1. Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified low voltage communications systems, equipment and infrastructure. There may be one key person or more key persons proposed for this project depending upon how many of the key roles each has successfully provided.
2. Each of the key personnel shall demonstrate experience in providing successful low voltage communications systems, equipment and infrastructure within the past three years.

E. A Registered Communications Distribution Designer (RCDD) shall be employed by the Design Builder and directly engaged in the project for all Communications Infrastructure design and installation efforts.

1. The RCDD shall be a direct employee of the Communications Contractor, within the Design Build team structure.

2. The RCDD shall be required to have oversight and supervision of the entire Communications Infrastructure installation process and quality control.

3. The RCDD shall be the Design Builder's Designer of Record for the Communications Infrastructure scope of work.

4. RCDD direct responsibilities shall include but may not be limited to: Thorough coordination with Owner regarding all design and installation efforts related to the project. A Pre-construction coordination meeting and site inspection with Owner prior to beginning any work. Oversight of Communications installation efforts, development of shop drawings and assembly of product data submittals. Quality control review and stamping of finalized Communications as-built drawings for submittal to Owner. Quality control review of Communications systems installation throughout the entire construction phase, to ensure all work is performed in compliance with approved construction drawings.

F. Critical on-site quality control installation reviews to be conducted in conjunction with Owner technical staff shall include but may not be limited to:

1. Verifying proper installation of all Communications cable tray, backbone conduits, device back boxes, conduit infrastructure and cabling pathways. Site inspection and sign-off must be performed prior to concealing conduit infrastructure and prior to the installation of any low-volt cabling.

2. Verifying proper installation of all Communications cabling. Site inspection and sign-off must be performed prior to closing-up associated accessible ceilings.

3. Verifying the layout and installation of all equipment and cabling within the Telecom Rooms, throughout the duration of the construction phase.

G. Supervisors and installers assigned to the installation of this system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered cabling Installers, Technician Level. Submit documentation of current BICSI certification for each of the key personnel. Submit documentation for a minimum of three and a maximum of five successful cabling system installations for each of the key personnel in an environment resembling that which is being bid upon.

1. In lieu of BICSI certification, supervisors and installers assigned to the installation of this system or any of its components shall have a minimum of three years' experience in the installation of the specified copper and fiber optic cable and components. The personnel on site performing work pertaining to this job shall be certified on the system being installed. They shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products.

2. Submit documentation for a minimum of three and a maximum of five successful cabling system installations for each of the key personnel in an environment resembling that which is being bid upon. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this project. Include specific experience in installing and testing telecommunications systems and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems.

3. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this project.

4. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project Owner point of

contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

H. Indicate that all key persons are currently employed by the Communications Contractor or have a commitment to the Communications Contractor to work on this project. All key persons shall be employed by the Communications Contractor at the date of issuance of this project, or if not, have a commitment to the Communications Contractor to work on this project by the date that the bid was due to the Owner's Representative.

1. Note that only the key personnel approved by the Owner's Representative in the successful proposal shall perform work on this project's low voltage systems, equipment and infrastructure. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the Communications Contractor's key personnel require approval from the Owner's Representative.

I. Designated Supervisor: Designate which key person will serve as a designated supervisor for the project. This supervisor shall be present and responsible for the project site during all phases of installation and testing of the Work in this Section. This supervisor shall be the same individual through the execution of the Work unless illness, loss of personnel, or other circumstances reasonably beyond the control of the Contractor intervene.

J. Submit documentation for a minimum of three and a maximum of five successful low voltage systems, equipment and infrastructure installations for each of the key personnel.

K. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the low voltage communications systems, equipment and infrastructure proposed for this project. Include specific experience in installing and testing communications systems and provide the names and locations of at least two project installations successfully completed using systems and equipment substantially similar to those specified for this project.

L. All of the existing low voltage communications systems, equipment and infrastructure installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this project.

M. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project Owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

1.09 SUBMITTALS

A. All Submittals shall be provided electronically in PDF format. All Drawing Submittals shall be provided in PDF and AutoCAD (latest version) .DWG format.

B. Submittals shall be organized in a coordinated package complete with all information specified herein. Incomplete or uncoordinated submittals will be returned with no review action.

C. Contractor shall submit the following items:

1. Contractor Key Personnel and Certifications
2. Complete Bill of Materials (BOM) List

3. Manufacturer Product Data Sheets, as defined below
4. Shop Drawings, as defined below
5. Proposed Installation Schedule
6. Cabling Certification Test Plan and proposed test equipment

D. Manufacturer Product Data Submittals shall include:
1. Submit product data sheets for all equipment being provided
2. Collate in sequence by Section Number, and clearly mark proposed product on data sheet. Include Safety Data Sheet, where applicable.
3. Clearly identify any proposed product substitutions or known deviations.

E. Precede each submittal book with a summary TOC. per example schedule below:
1. Specification Section
2. Drawing Reference
3. Manufacturers Model No.

F. The following is a general summary list of Submittal items required to be delivered at 30-day burn-in period.
1. As part of project close-out activities, Contractor shall submit Record Documents for review and approval by the Owner.
2. All Record Documents shall be provided electronically in PDF format. All Record Document Drawings shall be provided in PDF and AutoCAD (latest version) DWG format.

1.10 CLOSEOUT SUBMITTALS

A. Contractor shall submit the following items:
1. Record As-Built Shop Drawings indicating the final, 'as-built' condition of all associated equipment, infrastructure, and work.

B. Shop Drawing Submittals shall include:
1. Drawing index/symbol/schedule sheet.
2. Clearly indicate all new work versus existing work.
3. Site Plans, Floor Plans, and Reflected Ceiling (work 7' AFF+) Plans
4. Drawings shall be developed in AutoCAD .DWG format, utilizing most current architectural backgrounds available for the project.
5. All drawings shall be properly scaled.
6. Indicate all device locations and types. Include addressing for all network outlets (as
7. Indicate all cabling routes, types and quantities.
8. Indicate all conduit routing, quantities, sizes, and wire fill. Indicate basket tray and J-hook routes.
9. Indicate fire stopping requirements for all penetrations.
10. Indicate 'cable bundle groups' no larger than:
a. CAT5e – 52

b. CAT6 – 64

c. CAT6A – 74

11. When bundling low voltage cabling together the lowest common denominator determines the largest cable group allowed unless the cable is LP listed.

C. Riser Diagrams indicating:

1. Backbone cabling and termination locations. Associated cabling pathways, sizes and cable fill. Telecommunications Grounding System.

D. Enlarged Room Plans and Elevations indicating:

E. Provide dimensioned drawings for all telecommunications rooms. Complete, dimensioned rack and wall elevations of all equipment. Consideration must be given to equipment heights within. Plywood backboards and grounding equipment.

F. Racks, cabinets, cable tray, ladder rack, wire management. Termination equipment for all copper and fiber cabling. Conduit and cable entrance points and fire stopping. Electrical panels, power circuits and HVAC provisions.

G. Ensure coordinated arrangement of equipment with other trades. Typical Device Installation Details indicating: J-hooks, conduit, cable tray, and associated support systems. Network outlet faceplate layout and wiring terminations. Device back box and conduit rough-in requirements.

H. Details of other associated devices and equipment.

I. The shop drawing package must be stamped and signed by a Registered Communications Distribution Designer (RCDD) and by a Professional Engineer (PE) licensed in the project jurisdiction for work of this type.

J. Cable Certification Test Results. Submit electronically and include associated software license as applicable.

K. Completed punch list reports.

L. Manufacturer Operation and Maintenance (O&M) Manuals.

M. Warranty information.

N. Keys and any portable equipment.

1.11 WARRANTY SERVICE

A. Closeout Submittals, Warranties and Guarantees, provide the following.

B. Response Time: Provide a qualified technician familiar with the work at the project site within four hours after receipt of a notice of malfunction. Provide the Owner's Representative with telephone number attended 10 hours a day, five days a week, to be called in the event of a malfunction.

C. Provide all Warrantees as defined in each Communication Systems Section.

1. PanGen Structured Cabling Solutions System Warranty

a. Contractor shall provide a Panduit Certification Plus System Warranty on all installed copper and fiber permanent links. Such warranty shall provide a complete system warranty to guarantee high end-to-end performance for all applications designed to operate over the class of cabling installed. The guarantee shall include all connectivity components and cable within the permanent link and cover the system for duration of 25 years.

PART 2 - MATERIALS

2.01 COMMUNICATIONS SYSTEMS PRODUCTS SUMMARY

A. The following is a general summary list of Communications Systems equipment, components, and cabling required for the project. This is not intended to be a comprehensive list of materials. See additional Sections for complete materials requirements.

B. Racks: Cooper B-line SB85219084FB (seismic) I SB556084XUFB (Standard) Optional eight-foot racks where applicable.

C. Wire Managers: Panduit PEV Series full height vertical cable manager.

1. Panduit PEV10 10" Wide Front/Back unless otherwise noted on plans
2. Panduit PED Series dual hinged metal door installed at front face of vertical wire manage

D. Telecommunications Ground Bar (TGB) CPI_Mfg.Part:40153-012

E. Data Patch Panels: Panduit CP48WSBLY

F. Fiber Terminations: LC

G. Modular Jack CAT6A

1. Panduit Mini-Com CL6X88TGVL
2. Colored Icons as needed per UC service designation
3. Icons are Panduit PAN_CID(XX) (gray for cables in ceiling)

H. Copper cabling, Category 6A (Data)

1. High Speed, TIA Category 6A cabling, Plenum Rated
2. General Cable GenSpeed 6A Part No. 7141877 Purple

I. Copper cabling, Category 6A Shielded [JOV Paging)

1. High Speed, TIA Category 6A Shielded cabling, Plenum Rated
2. General cable GenSpeed 6A Part No. 7131789

J. Telecommunications Outlets (Workstation side)

1. Modular Furniture Surface Mount Box, Black
2. Panduit CBXQxBL-A Where x =number of ports
3. Modular Surface Mount Box Attachment System - Mini-Com CBM-X magnetic
4. Modular Surface Mount Box Blank Insert - Panduit CMB(BL)

K. Faceplate (Workstation side)

1. Panduit Mini-Com Stainless Steel Faceplates Single Gang CFP {2,4,6} SY or Double Gang CFP {4,8,10} S-2GY
2. Faceplate Blank Insert – Panduit CMB(WH)

PART 3 - EXECUTION

3.01 TELECOMMUNICATIONS SPACES

A. Telecom Room (TR) minimum size 10' x 12'.

B. UC Davis Health Telecommunications Standards do not include provisions for AV, unless otherwise indicated in the Design Criteria for the project. IT will be cooperative in assessing some parameters as they interact with IT support systems.

C. Telecommunication Spaces are to use EZ-Path Fire-Rated Pathways systems for cabling access.

D. Provide 36" of working clearance surrounding racks and electronic equipment

E. A positive pressure type of HVAC system using hot and cold aisles

F. Walls shall be covered with fire-resistant treated plywood, and all surfaces sealed to mitigate airborne dust.

G. IT uses a typical three-rack configuration with a B-line seismic for equipment and a standard 19" rack for cabling. Vertical wire management for planning shall be sized at 10" unless otherwise noted on the drawings.

3.02 RACK COMPONENTS AND ELEVATIONS

A. Owner will develop an equipment layout and rack elevation including the Telecom Room (TR) layouts. Typical components within the TR include, but not limited to:

1. Network Equipment
2. Fiber Termination Unit
3. UPS/ PDU I Power distribution
4. NM2/ NM4/ Horizontal wire management
5. VOIP Router/Voice Gateway
6. VOIP transition equipment
7. Voice cabling
8. Distribution Patch Panels
9. Clinical Engineering Equipment
10. Plug Pack Distribution
11. Camera NVR /Server
12. Nurse Call Devices
13. Overhead Paging Amplifier

B. See related Sections for materials provided by the Owner and those furnished by the Contractor.

END OF SECTION

SECTION 27 05 29
HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, and services to completely execute the provision of communications supports and cable hook system as described in this specification, including but not limited to:

A. Strut supports

B. Cable hooks (J-hooks)

C. Beam clamps

D. Concrete fasteners

E. Touch-up materials

F. Conduit supports

G. Equipment supports

H. Fastening hardware

I. Poke-through device

1.02 SYSTEM DESCRIPTION

A. Provide devices specified in this Section and related Sections for support of communications equipment specified for this project.

B. Provide support systems that are adequate for the weight of equipment, conduit and wiring to be supported.

1.03 SEISMIC REQUIREMENTS

A. Seismic design requirements criteria, as shown on all drawings related to the project, including architectural and structural, as defined below shall apply to all work defined within the following specification sections:

1. SECTION 27 05 15 COMMUNICATIONS HORIZONTAL CABLING
2. SECTION 27 05 26 GROUNDING AND BONDING OF COMMUNICATIONS SYSTEMS
3. SECTION 27 05 36 CABLE TRAYS FOR COMMUNICATIONS SYSTEMS
4. SECTION 27 11 16 COMMUNICATIONS CABINETS RACKS FRAMES AND ENCLOSURES
5. All support systems and termination apparatus associated with the telecommunications system.

B. Contractor to install seismic restraints for all telecommunications racks and UPS systems. In accordance with construction documents. Include floor mounted items weighing more than 400 pounds and wall mounted or suspended items weighing more than 20 pounds.

C. Installation according to engineered drawings and anchorage calculations provided by the structural engineer in accordance with California Code of Regulations, Title 24, 2007 California Building Code.

D. Supports for such items, including racks, conduit, cable trays and similar shall provide support, bracing, and anchorage, designed by the structural engineer in accordance with CBC Chapter 16A.

E. Supports to be sized to suit load and selected to match mounting conditions

1.04 RELATED SECTIONS

A. 27 05 00 COMMON WORK RESULTS FOR COMMUNICATIONS

B. 27 05 26 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

C. 27 05 33 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

D. 27 05 36 CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

E. 27 05 53 IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

F. 27 11 16 COMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

G. 27 11 19 COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

H. 27 11 23 COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

I. 27 11 26 COMMUNICATIONS RACK MOUNTED POWER PROTECTION AND POWER STRIPS

J. 27 13 00 COMMUNICATIONS BACKBONE CABLING

K. 27 13 43 COMMUNICATIONS SERVICES CABLING

L. 27 15 00 COMMUNICATIONS HORIZONTAL CABLING

M. 27 41 33 MASTER ANTENNA TELEVISION SYSTEMS

N. 27 51 16 PUBLIC ADDRESS SYSTEMS

O. 27 52 13 PATIENT MONITORING AND TELEMETRY SYSTEMS

P. 27 52 23 NURSE CALL/CODE BLUE SYSTEMS

Q. 27 53 13 CLOCK SYSTEMS

R. 27 53 19 INTERNAL CELLULAR, PAGING, AND ANTENNA SYSTEMS

PART 2 - PRODUCTS

2.01 FASTENERS, STRAPS, AND BEAM CLAMPS

A. Equal products by the following manufacturers will be considered providing that all features of the specified product are provided:

1. Concrete fasteners

a. Hilti
b. Phillips "Red-Head"
c. Remington
d. Ramset
e. Simpson Strong-Tie
f. Or approved equal.

2. Concrete inserts and construction channel:
   a. Unistrut Corp.
   b. GS Metals "Globe Strut."
   c. Thomas & Betts
   d. "Kindorf" Corp.
   e. Or approved equal.
3. Conduit straps:
   a. 0-Z/Gedney
   b. Erico "caddy" Fastening Products
   c. Thomas & Betts
   d. "Kindorf" Corp.
   e. Or approved equal.
4. Beam Clamps
   a. Cooper B-line.
   b. SuperStrut.
   c. Unistrut.
   d. Or approved equal.

2.02 CABLE HANGERS

A. Ceiling Hung J-Hooks

1. Specifically intended to carry the load of up to 74 communications cables without applying excess forces to cables at bottom of bundle.
2. Integral broad bottom edge to spread cable load with flat bottom and provide a minimum of 1-5/8" cable bearing surface.
3. Integral hanger rod attachment hardware at top. Load rated for application.
4. Incorporates smooth 90-degree radius edges to prevent snagging cable jackets on installation.
5. Designed so the mounting hardware is recessed to prevent cable damage.
6. Integral mechanical cable latch retainer to provide containment of cables within the hook. The retainer shall be removable and reusable.
7. Suitable for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc.to meet job conditions.
8. Multi-tiered cable hooks to be used where required to provide separate cabling compartments, or where additional capacity is needed.

9. Finishes: cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3.
10. Cable hooks for corrosive areas shall be stainless steel, AISI Type 304.
11. Manufacturer:
    a. Cooper B-Line series BCH21,BCH32,BCH64.
    b. Caddy/Erico cablecat.
    c. or approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Thoroughly examine site conditions for acceptance of supporting device installation to verify conformance with manufacturer and specification tolerances.

B. The University's Representative reserves the right to request additional supports where in their sole opinion said supports are required. Any additional supports shall be installed at no additional cost to the University.

3.02 PREPARATION

A. Prepare and maintain the following clearances from EMI sources (per BICSI Standards).
    1. Power cable (in grounded conduit) = 6 inches
    2. Power cable (unshielded) = 24 inches
    3. Fluorescent lights = 5 inches
    4. Transformers = 48 inches

B. Provide all low voltage Communications Systems Pathways and Electronic Security and Safety System Pathways.

3.03 DISTRIBUTION PATHWAY VIA CEILING HUNG CABLE HOOKS (J-HOOKS)

A. The cabling support system shall be installed in accordance with the manufacturer's instructions and as indicated on Contractor's submittal documentation, prior to final acceptance/approval by the University.

B. Cable Tray cables are not to exceed a 25% fill when the project is complete. 25% fill is a visual fill of 50% of the cable tray.

3.04 CONDUIT

A. Conduit used for pathway is to be designed with a maximum 40% visual fill.

B. EZ path retrofit EZDR-400 or EZDR-200 will be provided on all conduits when required for compliance.

3.05 FLOOR BOXES AND POKE THROUGH DEVICES

A. All Floor boxes shall be sized and approved by UCD IT and FD&C's furniture group.

1. Wiremold RC9AM2TCBK flush poke -thru with accessories as required.
2. One 1-114" trade standard, data
3. One 1-1/2" trade standard, av or other
4. Floor poke through assembly, dual service feed-through fitting. Commonly used wire mold RC9AM2TCBK flush poke -thru with accessories as required. One 3/4" trade standard and one 1-114" trade standard.
5. Wiremold 4ffatcbs flush furniture feed poke -thru with accessories as required.
6. Or approved equal.

3.06 FIRE PENETRATIONS

A. Install UL listed fire-stop system whenever a raceway penetrates a firewall in conformance with the manufacturer's directions, the published systems assembly requirements, CBC Section 709 and 710 and CEC 300-21, whichever is the most restrictive. At cable tray penetrations, provide pillow type removable fire stop per CBC Section 709 and 710, the published systems assembly requirements and the manufacturer's directions, whichever is the most restrictive.

B. EZ path retrofit EZDR-400 shall be provided where applicable as fire stop materials on all conduits.

C. All communications systems cabling pathway openings in walls and floors are the responsibility of the Contractor.

D. Install only EZ-Path products for all horizontal and vertical cabling pathway openings within TR rooms. Conduit sleeves are not acceptable.

E. The communications conduit pathway/box system shall be installed in accordance with the manufacturer's instructions and as indicated on Contractor's submittal documentation, prior to final acceptance/approval by the University.

END OF SECTION

SECTION 27 05 33
CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, and services to completely execute the provision of communications supports and cable hook system as described in this specification, including but not limited to:

A. Strut supports

B. Cable hooks (J-hooks)

C. Beam clamps

D. Concrete fasteners

E. Touch-up materials

F. Conduit supports

G. Equipment supports

H. Fastening hardware

I. Poke-through device

1.02 SYSTEM DESCRIPTION

A. Provide devices specified in this Section and related Sections for support of communications equipment specified for this project.

B. Provide support systems that are adequate for the weight of equipment, conduit and wiring to be supported.

1.03 SEISMIC REQUIREMENTS

A. Seismic design requirements criteria, as shown on all drawings related to the project, including architectural and structural, as defined below shall apply to all work defined within the following specification sections:

1. SECTION 27 05 15 COMMUNICATIONS HORIZONTAL CABLING
2. SECTION 27 05 26 GROUNDING AND BONDING OF COMMUNICATIONS SYSTEMS
3. SECTION 27 05 36 CABLE TRAYS FOR COMMUNICATIONS SYSTEMS
4. SECTION 27 11 16 COMMUNICATIONS CABINETS RACKS FRAMES AND ENCLOSURES
5. All support systems and termination apparatus associated with the telecommunications system.

B. Contractor to install seismic restraints for all telecommunications racks and UPS systems. In accordance with construction documents. Include floor mounted items weighing more than 400 pounds and wall mounted or suspended items weighing more than 20 pounds.

C. Installation according to engineered drawings and anchorage calculations provided by the structural engineer in accordance with California Code of Regulations, Title 24, 2007 California Building Code.

D. Supports for such items, including racks, conduit, cable trays and similar shall provide support, bracing, and anchorage, designed by the structural engineer in accordance with CBC Chapter 16A.

E. Supports to be sized to suit load and selected to match mounting conditions

1.04 RELATED SECTIONS

A. 27 05 00 COMMON WORK RESULTS FOR COMMUNICATIONS

B. 27 05 26 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

C. 27 05 33 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

D. 27 05 36 CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

E. 27 05 53 IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

F. 27 11 16 COMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

G. 27 11 19 COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

H. 27 11 23 COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

I. 27 11 26 COMMUNICATIONS RACK MOUNTED POWER PROTECTION AND POWER STRIPS

J. 27 13 00 COMMUNICATIONS BACKBONE CABLING

K. 27 13 43 COMMUNICATIONS SERVICES CABLING

L. 27 15 00 COMMUNICATIONS HORIZONTAL CABLING

M. 27 41 33 MASTER ANTENNA TELEVISION SYSTEMS

N. 27 51 16 PUBLIC ADDRESS SYSTEMS

O. 27 52 13 PATIENT MONITORING AND TELEMETRY SYSTEMS

P. 27 52 23 NURSE CALL/CODE BLUE SYSTEMS

Q. 27 53 13 CLOCK SYSTEMS

R. 27 53 19 INTERNAL CELLULAR, PAGING, AND ANTENNA SYSTEMS

PART 2 - PRODUCTS

2.01 FASTENERS, STRAPS, AND BEAM CLAMPS

A. Equal products by the following manufacturers will be considered providing that all features of the specified product are provided:

1. Concrete fasteners

a. Hilti
b. Phillips "Red-Head"
c. Remington
d. Ramset
e. Simpson Strong-Tie
f. Or approved equal.

2. Concrete inserts and construction channel:
   a. Unistrut Corp.
   b. GS Metals "Globe Strut."
   c. Thomas & Betts
   d. "Kindorf" Corp.
   e. Or approved equal.
3. Conduit straps:
   a. 0-Z/Gedney
   b. Erico "caddy" Fastening Products
   c. Thomas & Betts
   d. "Kindorf" Corp.
   e. Or approved equal.
4. Beam Clamps
   a. Cooper B-line.
   b. SuperStrut.
   c. Unistrut.
   d. Or approved equal.

2.02 CABLE HANGERS

A. Ceiling Hung J-Hooks

1. Specifically intended to carry the load of up to 74 communications cables without applying excess forces to cables at bottom of bundle.
2. Integral broad bottom edge to spread cable load with flat bottom and provide a minimum of 1-5/8" cable bearing surface.
3. Integral hanger rod attachment hardware at top. Load rated for application.
4. Incorporates smooth 90-degree radius edges to prevent snagging cable jackets on installation.
5. Designed so the mounting hardware is recessed to prevent cable damage.
6. Integral mechanical cable latch retainer to provide containment of cables within the hook. The retainer shall be removable and reusable.
7. Suitable for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc.to meet job conditions.
8. Multi-tiered cable hooks to be used where required to provide separate cabling compartments, or where additional capacity is needed.

9. Finishes: cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3.
10. Cable hooks for corrosive areas shall be stainless steel, AISI Type 304.
11. Manufacturer:
    a. Cooper B-Line series BCH21,BCH32,BCH64.
    b. Caddy/Erico cablecat.
    c. or approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Thoroughly examine site conditions for acceptance of supporting device installation to verify conformance with manufacturer and specification tolerances.

B. The University's Representative reserves the right to request additional supports where in their sole opinion said supports are required. Any additional supports shall be installed at no additional cost to the University.

3.02 PREPARATION

A. Prepare and maintain the following clearances from EMI sources (per BICSI Standards).
    1. Power cable (in grounded conduit) = 6 inches
    2. Power cable (unshielded) = 24 inches
    3. Fluorescent lights = 5 inches
    4. Transformers = 48 inches

B. Provide all low voltage Communications Systems Pathways and Electronic Security and Safety System Pathways.

3.03 DISTRIBUTION PATHWAY VIA CEILING HUNG CABLE HOOKS (J-HOOKS)

A. The cabling support system shall be installed in accordance with the manufacturer's instructions and as indicated on Contractor's submittal documentation, prior to final acceptance/approval by the University.

B. Cable Tray cables are not to exceed a 25% fill when the project is complete. 25% fill is a visual fill of 50% of the cable tray.

3.04 CONDUIT

A. Conduit used for pathway is to be designed with a maximum 40% visual fill.

B. EZ path retrofit EZDR-400 or EZDR-200 will be provided on all conduits when required for compliance.

3.05 FLOOR BOXES AND POKE THROUGH DEVICES

A. All Floor boxes shall be sized and approved by UCD IT and FD&C's furniture group.

1. Wiremold RC9AM2TCBK flush poke -thru with accessories as required.
2. One 1-114" trade standard, data
3. One 1-1/2" trade standard, av or other
4. Floor poke through assembly, dual service feed-through fitting. Commonly used wire mold RC9AM2TCBK flush poke -thru with accessories as required. One 3/4" trade standard and one 1-114" trade standard.
5. Wiremold 4ffatcbs flush furniture feed poke -thru with accessories as required.
6. Or approved equal.

3.06 FIRE PENETRATIONS

A. Install UL listed fire-stop system whenever a raceway penetrates a firewall in conformance with the manufacturer's directions, the published systems assembly requirements, CBC Section 709 and 710 and CEC 300-21, whichever is the most restrictive. At cable tray penetrations, provide pillow type removable fire stop per CBC Section 709 and 710, the published systems assembly requirements and the manufacturer's directions, whichever is the most restrictive.

B. EZ path retrofit EZDR-400 shall be provided where applicable as fire stop materials on all conduits.

C. All communications systems cabling pathway openings in walls and floors are the responsibility of the Contractor.

D. Install only EZ-Path products for all horizontal and vertical cabling pathway openings within TR rooms. Conduit sleeves are not acceptable.

E. The communications conduit pathway/box system shall be installed in accordance with the manufacturer's instructions and as indicated on Contractor's submittal documentation, prior to final acceptance/approval by the University.

END OF SECTION

SECTION 27 05 53
IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Provide all labor, materials, tools, and equipment required for permanent intelligible labeling for items including but not limited to communications cabling (structured and non-structured) innerduct, connectors, faceplates, jacks, receptacles, patch panels, and racks.

B. All labels will be preprinted, or computer printed type. Handwritten labels are not acceptable

C. This section includes minimum labeling requirements for the following:

1. Room designations
2. Communications cabling
3. Closet Hardware including patch panels, terminal blocks, protectors and racks
4. Work Area Outlets
5. Wireless Access Points
6. Pathways and Spaces
7. Grounding and Bonding

1.02 VISUAL APPEARANCE

A. Clear plastic covers over faceplate labels are not permitted

B. Shall be preprinted or computer printed type

C. Black SMB's are to be labeled with white on black

D. Stainless will be labeled with black on clear

E. White (if required) will be labeled with black on white

1.03 LABELING STANDARDS AND REQUIREMENTS

A. All new labeling is to reflect UCD labeling standards

B. Contact the University's Representative for a copy of the current standards prior to proceeding.

C. Bring to the University Representative’s attention any project conditions not described in these specifications and the University's current standards and conform to the direction received.

1.04 RELATED SECTIONS

A. 27 05 00 COMMON WORK RESULTS FOR COMMUNICATIONS

B. 27 05 26 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

C. 27 05 29 HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

D. 27 05 33 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

E. 27 05 36 CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

F. 27 11 16 COMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

G. 27 11 19 COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

H. 27 11 23 COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

I. 27 11 26 COMMUNICATIONS RACK MOUNTED POWER PROTECTION AND POWER STRIPS

J. 27 13 00 COMMUNICATIONS BACKBONE CABLING

K. 27 13 43 COMMUNICATIONS SERVICES CABLING

L. 27 15 00 COMMUNICATIONS HORIZONTAL CABLING

M. 27 41 33 MASTER ANTENNA TELEVISION SYSTEMS

N. 27 51 16 PUBLIC ADDRESS SYSTEMS

O. 27 52 13 PATIENT MONITORING AND TELEMETRY SYSTEMS

P. 27 52 23 NURSE CALL/CODE BLUE SYSTEMS

Q. 27 53 13 CLOCK SYSTEMS

R. 27 53 19 INTERNAL CELLULAR, PAGING, AND ANTENNA SYSTEMS

PART 2 - PRODUCTS

2.01 COMMUNICATION CABLING LABELS, GENERAL

A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.

B. Shall be preprinted or computer printed type. Handwritten labels are not acceptable.

2.02 COMMUNICATION CABLING LABELS, INTERIOR

A. Provide vinyl substrate with a white printing area and black print.

B. If cable jacket is white, provide cable label with printing area which is either orange or yellow, such that the labels are easily distinguishable.

C. Shall be flexible vinyl or other substrates to apply easy and flex as cables are bent.

D. Shall use aggressive adhesives that stay attached even to the most difficult to adhere to jacketing.

E. Manufacturers:

1. Cable Type- 4 pair UTP /4 pair UTP Zero Skew - Panduit S100X125VAC or approved equal.
2. Cable Type- 4 pair STP - Panduit S100X125VAC or approved equal.
3. Cable Type- 25 to 100 pair copper - Panduit S100X650VAC or approved equal.
4. Cable Type- 2 strand fiber - Panduit F100X300AJT or approved equal.
5. Cable Type- 4-12 strand fiber - Panduit S100X125VAC or approved equal.
6. Cable Type- RG-6 and RG-59 Coax - Panduit S100X125VAC or approved equal.
7. Cable Bundles - Panduit UIHL12-XO or approved equal.
8. Other Interior cabling - Panduit S100X650VAC or approved equal.

2.03 CLOSET HARDWARE LABELS

A. Where insert type labels are used on Copper Patch Panels, provide clear plastic cover over label.

B. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.

C. Shall be preprinted or computer printed type. Handwritten labels are not acceptable.

D. Location ID:

1. Panduit - White C061X030FJC
2. Panduit - White C750XOSOYIJ
3. Or approved equal.

E. Non-keystone-based fiber patch panels:

1. Panduit - White C061X030FJC
2. Panduit - White C750XOSOYIJ
3. or approved equal.

F. 110 blocks

1. Panduit C750XOSOYIC
2. Panduit S White C750XOSOYIJ
3. Or approved equal.

2.04 GROUNDING AND BONDING, PATHWAY, AND SPACE LABELS

A. Panduit C200X100FJC or approved equal.

2.05 WORKSTATION LABELS

A. Panduit - White C061X030FJC

B. Panduit - White C750X050YIJ or approved equal.

2.06 LOCATION NAMEPLATES

A. Provide laminated plastic nameplates for each equipment enclosure, rack, switch, and device, as specified.

B. Comply with ASTM D 709.

C. Each nameplate inscription shall identify the function and, when applicable, the position.

D. Nameplates shall be melamine plastic, 0.125-inch thick, black with white center core.

E. Surface shall be matte finish. Corners shall be square.

F. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by three inches.

G. Lettering shall be a minimum of 0.25-inch high normal block style for location nameplates or a minimum of 1-inch high normal block style for rack nameplates.

H. Panduit C300X100APT or approved equal

PART 3 - EXECUTION

3.01 GENERAL

A. Verify all room numbers, racks, conduits, cable tray, cables, equipment housing, vaults and items within this document have been labeled.

B. Contractor applied labeling shall reflect final space and Telecommunications structure designations.

C. Accurate labeling shall be provided on the as-built shop drawing submittals.

3.02 IDENTIFICATION AND LABELING

A. Telecommunications Rooms

1. Labels shall be affixed at the entry to all telecommunications rooms and spaces (Includes entrance facilities, telecommunications equipment rooms, communication equipment spaces and work areas).
2. All IT rooms are numbered but not designated “equipment” due to security concerns.

B. Cable Tray and Conduits

1. Cable tray structured versus AV or analog systems pathway labeling and designations are the responsibility of the installer to designate the services that are to use the pathway or what portion of the pathway.
2. Any permanent label that is clearly visible is acceptable.

C. Rack and Cabinet Labeling

1. Provide laminated plastic nameplates for each equipment enclosure, row and rack designations as shown on elevations provided by UCD IT.

D. Copper Patch Panels – Horizontal

1. Label with Jack numbers.

E. Tie Cable Patch Panels

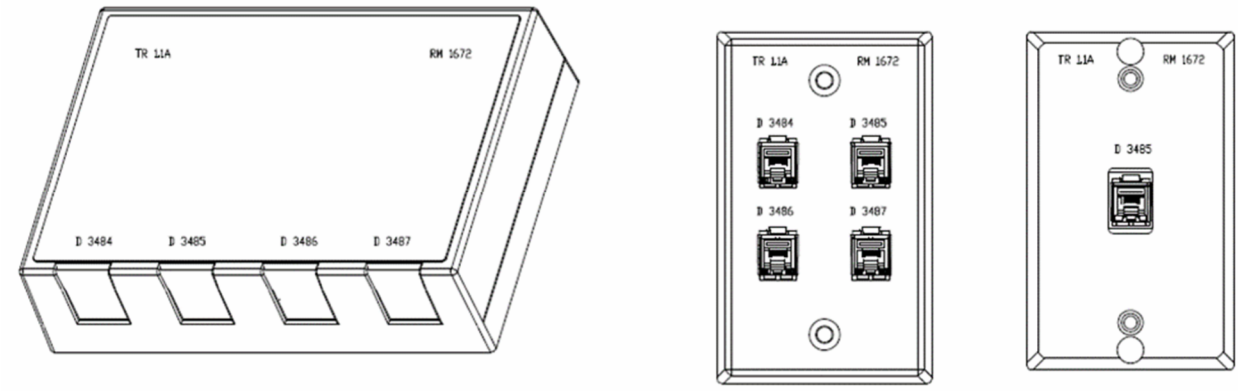
1. Label the pair count at the top of the patch panel, separated from all others.
2. Place the cable's identification text centered on the top label strip. (example:18CA75,TIE 1672A).

F. 110 Blocks

1. Not used other than MPOE, OSP installation.
2. Label with University provided designation.

G. Workstations

1. Use adhesive type labels and affix labels to faceplate per diagram provided.
2. Provide sequential 4 or (Occasionally 5 digit) jack number (starting dependent on the floor designation) beginning with an X such as X056, X being floor# followed by the closet sequenced cable number.
3. All faceplate labels shall contain the following items:
   a. Building and Closet Designation such as 34-1100 (building#, IT closet#)
   b. TR Designation such as TR1.1 or TR 1A (University established designation)
4. Under no circumstances are jacks to be installed with a drop/name or location number as a label or a matrix identifier.
5. See diagram below:



H. Wireless Access Point (WAP) Labeling

1. The University's Representative will provide locations for Wireless Access Point installations with the University's assigned designated identifiers adhered to the Access Point itself.
2. Building Designation / room or area designation – AP / a,b,c (if multiple AP’s within room).

3. WAP labeling consists of the Icon being a designated color at the device, Icon being a designated color in the patch panel, and a band being installed on both ends of the patch cord that connects the cable in the TR room.

I. Grounding and Bonding

1. Label the TMGB (telecommunications main ground busbar) with an adhesive label.
2. Label the TGB(s) (telecommunications ground busbar) with an adhesive type label(s).

J. Other Cable Numbering

1. Other cabling types, such as Coax installed in a TR shall be numbered uniquely, such as C=Coax.
2. Cameras and AP's are Data Cabling, which falls into the Data Cabling labeling scheme.
3. Point to point Data Cables require independent numbering such as A1001 for items such as in room video distribution such as N-stream equipment.

K. Fiber Patch Panels

1. Fiber patch panels shall be marked using adhesive labels indicating the range of circuits installed to it. All fiber optic cable patch panels shall be labeled with the pair count of every fiber pair, the cable's assigned identifier, and the patch panel's assigned identifier.
2. All labels shall consist of the following:
    a. Provide the respective FTU # next in sequence in the data room.
    b. Provide and label each bulkhead in the fiber panel per the following: Fiber Cable #, "FROM" Building / "FROM" Room / "FROM" FTU / Fiber Type / Strand # to Location / Telecom Cable # / "TO" Building / "TO" Room / "TO" FTU / / Strand # / Fiber Type.
    c. Coordinate with IT before applying any labels.

L. Fire stopping

1. Each fire stopping location shall be labeled at each location where fire stopping is installed, on each side of the penetrated fire barrier, within 12 in. of the fire stopping material.
2. Labels shall adhere to the requirements set forth by the authority having jurisdiction (AHJ).

M. Indoor Communications Cables

1. Horizontal and Indoor Backbone cables shall be marked within 12 inches of each endpoint or to innerduct in which the cable is installed.
2. Label each end of each riser cable where the cable terminates.
3. Backbone cables shall be marked at each endpoint and at all intermediate locations, pull/access point or junction boxes through which the cable passes, as well as on each floor and in each room the cable is openly visible in.

N. Copper Riser Cabling.

1. Label all copper backbone cables of at least 25 pair construction to contain the following information:

a. Installation Date

b. University Assigned Cable ID: (Example: 70 Tie 0P609).

O. Fiber Riser cabling.

1. Label all fiber backbone cables to contain the following information:

a. Installation Date

b. University Assigned cable ID:(Example: IFA134).

END OF SECTION

SECTION 27 15 00
COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Provisioning, installation, termination, and testing and of twisted pair, horizontal cabling in modular furniture and hard wall workstations located throughout the project area. Work under this section will include:

1. Wireless Access Point cabling
2. Printer Stations
3. IP Camera Cabling
4. Monitor and CATV cabling
5. IP Medical Equipment in Exam Rooms
6. All workstation cabling as defined on the construction documents

1.2 TYPICAL WORK AREA OUTLETS

A. A typical work area outlet (per chair) or (Drop) shall consist of two (2) (Purple end to end) Category 6A Data cables, unless otherwise indicated.

B. A typical work area outlet shall have a slack loop of 10 feet at the field end of the run.

1.3 OTHER OUTLET CONFIGURATIONS

A. Wireless Access Points

1. A typical wireless access point (WAP) Outlet shall consist of two (2) (Purple end to end) Category 6A Data cables, unless otherwise indicated.

B. Timeclock Outlet

1. A typical time cock outlet shall consist of one (1) (Purple end to end) Category 6A Data cable, unless otherwise indicated.

C. Other outlet configurations as defined by and coordinated with Owner IT.

D. All Outlet types listed above shall have a slack loop of 10 feet at the field end of the run.

1.4 RELATED SECTIONS

A. 27 05 00 COMMON WORK RESULTS FOR COMMUNICATIONS

B. 27 05 26 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

C. 27 05 29 HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

D. 27 05 33 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

E. 27 05 36 CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

F. 27 05 53 IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

G. 27 11 16 COMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

H. 27 11 19 COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

I. 27 11 23 COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

J. 27 11 26 COMMUNICATIONS RACK MOUNTED POWER PROTECTION AND POWER STRIPS

K. 27 13 00 COMMUNICATIONS BACKBONE CABLING

L. 27 13 43 COMMUNICATIONS SERVICES CABLING

M. 27 41 33 MASTER ANTENNA TELEVISION SYSTEMS

N. 27 51 16 PUBLIC ADDRESS SYSTEMS

O. 27 52 13 PATIENT MONITORING AND TELEMETRY SYSTEMS

P. 27 52 23 NURSE CALL/CODE BLUE SYSTEMS

Q. 27 53 13 CLOCK SYSTEMS

R. 27 53 19 INTERNAL CELLULAR, PAGING, AND ANTENNA SYSTEMS

PART 2 - PRODUCTS

2.1 MODULAR JACK COMPONENTS, GENERAL

A. Modular Jacks rated Category 6A
   1. Panduit Mini-Com CL6X88TGVL
   2. Colored Icons as needed per UCDM service designation
   3. Panduit PAN_CID(XX)

2.2 COPPER CABLING, CATEGORY 6A

A. High Speed, TIA category 6A Cabling, Plenum Rated
   1. General cable GenSpeed 6A Part No.7141877 Purple

2.3 TELECOMMUNICATIONS OUTLET COMPONENTS

A. Modular Furniture Surface Mount Box, Black
   1. Panduit CBXQxBL-A Where x = number of ports
   2. Modular Surface Mount Box Attachment System Mini-Com CBM-X
   3. Modular Surface Mount Box Blank Insert Panduit CMB(BL)

B. Faceplate

1. Panduit- Mini-Com Faceplates (CFP (2,4,6)SY I CFP (4,8,10) S-2GY
2. Coordinate finish with Architect prior to submittals.

C. Faceplate Blank Insert
1. Panduit CMB(WH)

D. Stainless Wall Telephone Outlet
1. Leviton 40223-S (where specified)

E. One Hole Wall Plate
1. Leviton 84004-40 Stainless where requested
2. Leviton 80720-W White where requested
3. Coordinate finish with Architect prior to submittals.

F. Black Loom
1. Panduit loom CLT100F/CLT150F (choose size appropriate for cable installation quantity)
2. Thomas & Betts black liquid tight EFC150

G. Duplex In-Line Jack frame, one to four jacks (only where required, NOT standard installation)
1. Panduit Mini-Com 106 Duplex Module Frame

PART 3 - EXECUTION

3.1 CABLING RUN LENGTHS

A. Distance limitation of the in-wall cabling shall be thoroughly reviewed and calculated to be less than 275' when including the anticipated plug pack cabling length in the telecommunications room (TR).

B. Contractor to field verify the performance including cable length of the proposed installation in a mockup using the proposed cabling, jacks, raceway and test equipment prior to proceeding.
1. Locate proposed cable pathway drawing for the upcoming cable run.
2. Contractor to install One (1) typical copper work area outlet complete with jacks at both ends.
3. Use the proposed pathway and cabling to the furthest location from the TR.
4. Install a cable simulating the cable length of the Plug Pack configuration.
5. The cabling contractor is to perform testing of these cables patched together to determine the true length of this mockup.
6. Test Results are to be inspected and reviewed by the University's Representative prior to proceeding with the rest of the installation.
7. Any deficiencies in the installation of the mockup are to be corrected by the Contractor and re-inspected by the University's Representative prior to proceeding with the rest of the installation.

3.2 MODULAR JACK COMPONENTS

A. Category 6A Data Jacks performance shall meet requirements as defined in TIA standards.

B. Follow manufacture's Installation procedures.

3.3 TELECOMMUNICATIONS OUTLET EXECUTION

A. Modular Furniture Surface Mount Box, One to Four Jacks
   1. Surface mount box magnetically attached to furniture
   2. Removing knockouts in the base of the furniture shall be avoided.

B. Telecommunications Outlets. New, Copper Jacks, Wall Mount, Flush Mount Assembly.
   1. Complete outlet assembly, including but not limited to:
   2. Faceplate with manufacturer's standard jack openings
   3. Blank connector modules at faceplate openings not filled with connector modules.
   4. Features: Single gang with openings for the required number of cables. Provide flat stainless steel.
   5. Features: Double gang with openings for the required number of cables. Provide flat stainless steel

C. Voice Telephone Station Plates and Jacks (special provision)
   1. Wall Mounted Analog Telephone
   2. Wall mounted IP Telephone Station
   3. Single outlet wall plate w/ 8P8C data Jack

3.4 COPPER CABLING DATA VOICE/DISTRIBUTION

A. Maintain the following clearances from EMI sources (Per BICSI Standards)
   1. Power cable - 6 in.
   2. Fluorescent Lights - 12 in.
   3. Transformers- 48 in.

B. Monitor cable length limitations
   1. All cable installations shall be continuous, unspliced runs
   2. All wiring above ceilings shall be installed in cable tray or cable hangers.
   3. Cable in accessible ceilings shall be supported 5' on center (min) attached to building structure.
   4. Cable shall have no physical defects such as cuts, tears or bulges in the outer jacket.
   5. Cables jackets that are chaffed or burned exposing internal conductor insulation or have any bare copper ("shiners") shall be replaced.
   6. Limit cable bends to a minimum radius of 4 times cable diameter except where otherwise noted herein.
   7. Refrain from exceeding fill ratio on horizontal cabling installations
   8. Service loop at ALL TERMINATIONS

9. Provide slack, which is to be no less than 2.5" and no greater than 5.0", in the station cable at the station outlet end. The Work Area Outlet shall provide enough slack to be serviceable without excess.
10. Service loop at outlet locations: Provide a (10') Ten Foot Slack Loop for all horizontal cabling.
11. All data and voice station cable shall be terminated at the individual receptacle modules in accordance with ANSI/TIA-568-C, assignment T568B.

3.5 TESTING

A. All system cabling and terminations shall be installed in accordance with manufacturer's instructions and as indicated on Contractor's submittal documentation, prior to final acceptance/approval by the University.

B. Installation shall be performed and accomplished in a professional manner, by qualified personnel.

3.6 PERFORMANCE STANDARDS

A. Horizontal (Station) category 6A Copper cabling - Permanent Link
   1. Testing shall commence while the University's equipment in the area of service is operational and creating worst case emissions associated with its operation while in good working order. Every effort shall be made to include worst case influence on the materials installed shall be taken.
   2. In accordance with the field test specifications defined in TIA-568-C.2 "Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard", every horizontal station cabling link in the project shall be tested for:
      a. Wire Map Length Insertion Loss NEXT Loss
      b. PS NEXT Loss
      c. ACR-F Loss
      d. PS ACR-F Loss
      e. Return Loss
      f. Propagation Delay
      g. Delay Skew

B. Using the listed category 6A cable test set, test installed cabling using Permanent Link procedure and submit report demonstrating that the link meets the following:
   1. Each permanent link shall demonstrate a positive PSACR beyond 350 MHz to meet and exceed the bandwidth requirements of TIA-568-C.2 Category 6A standards.
   2. Each permanent link shall demonstrate 2 dB of cross talk headroom over TIA -568-C.2 Category 6A standard for NEXT, PSNEXT, ELFEXT and PSELFEXT bit error rate.
   3. Report whether tested link passes or fails.
   4. Note exceptions to required Category standards. Remedy and retest.
   5. Test and report on each intermediate cabling segment separately, including station cabling, horizontal distribution (each segment, if multiple) and telecommunications room wiring.
   6. Test each end to end cable link

7. Submit machine-generated documentation and raw data of all test results on Contractor provided, and University's Representative approved, forms; and in electronic format approved by the University's Representative.
8. Test station wire only after all pairs of station wire in a work area have been terminated at both ends, and no work of this Section or other Sections may cause physical disturbance to the wiring.
9. Correct any and all transpositions found. Retest.
10. If any conductor in a station wire tests either open or short, then the entire station wire is to be removed, replaced, and re-tested.
11. The Contractor shall test all cables and submit all horizontal copper cable test result data in electronic format, with the resulting file formatted with one test result per 8.5"x 11" page. Export or Download the test results from the cable tester to a •.txt format or other accepted proprietary format for submission.
12. Data found to be altered from the manufacturers recommended settings may result in retention by the University of a 3rd Party Test Company to retest the installed cabling at the expense of the Contractor.
13. Events exceeding industry standards will cause the test result to be rejected. Direct review by UCD IT will be required to allow for an exception of a test result.
14. Data found to be incomplete may result in retention by the University of a 3rd Party Test Company to retest the installed cabling at the expense of the Contractor.
15. Contractor shall submit (1) copy of software capable of viewing the electronic test result files. Testing Results shall be reviewed and verified by the University before payments are remitted.

C. Test Equipment

1. Contractor shall provide all test equipment as required to perform the scope of work.
2. Test the communication systems cabling using at least one (1) each of the following test measurement devices or their functional equivalents:
    a. Level III field testers as defined in TIA-1152 - Fluke DSX-5000, or equal.
    b. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table 4 of TIA-1152
    c. The RJ45 test plug shall fall within the values specified in TIA-568-C Annex C for NEXT, FEXT and Return Loss.
    d. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters.
    e. In order to deliver optimum accuracy, permanent link interface adapter for the tester shall be used, which can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface.
    f. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor.
    g. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.
    h. Site portable communications systems (walkie-talkie, cell phone, or similar to aid in communications between test device locations)

END OF SECTION

SECTION 27 52 23
NURSE CALL CODE BLUE SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The work covered under this section consists of the complete installation and integration of a Nurse Call system at the UCDH Campus.

1.2 RELATED SECTIONS

A. 27 05 00 COMMON WORK RESULTS FOR COMMUNICATIONS

B. 27 05 26 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

C. 27 05 29 HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

D. 27 05 33 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

E. 27 05 36 CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

F. 27 05 53 IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

G. 27 11 16 COMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

H. 27 11 19 COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

I. 27 11 23 COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

J. 27 11 26 COMMUNICATIONS RACK MOUNTED POWER PROTECTION AND POWER STRIPS

K. 27 13 00 COMMUNICATIONS BACKBONE CABLING

L. 27 13 43 COMMUNICATIONS SERVICES CABLING

M. 27 15 00 COMMUNICATIONS HORIZONTAL CABLING

N. 27 41 33 MASTER ANTENNA TELEVISION SYSTEMS

O. 27 51 16 PUBLIC ADDRESS SYSTEMS

P. 27 52 13 PATIENT MONITORING AND TELEMETRY SYSTEMS

Q. 27 53 13 CLOCK SYSTEMS

R. 27 53 19 INTERNAL CELLULAR, PAGING, AND ANTENNA SYSTEMS

1.3 SYSTEM DESCRIPTION

A. Each nurse call system shall be capable of operating as a stand-alone system, with the ability of interfacing to the existing hospital-wide Nurse Call network.

1. Nurse Call Master Stations

   a. The nurse call master stations (NCMS) shall be at the caregiver stations and as indicated on the drawings. The NCMS shall be the primary call annunciation point for the nurse call system. Each NCMS shall consist of a full color touchscreen monitor and an alphanumeric display microphone, keypad, and handset.

2. Nurse Call Central Station

   a. The nurse call central station shall be located in the IT Closet (Telecommunications Room) and as indicated on the drawings. The Nurse Call Central Station shall be the primary processing point of the nurse call system.

3. Patient Stations

   a. Patient stations shall provide the interface between the patient and the nurse control station. Each Patient Stations will display on its face plate a light indicating a call has been placed and a separate light indicating an open audio path. Each patient station shall be able to accept input from peripheral devices including emergency stations, staff presence stations, remote switches, and auxiliary devices. Patient stations shall be microcomputer based.

4. Staff Stations

   a. Staff stations shall provide an interface between the nursing staff and the nurse control station. Each Staff Stations will display on its face plate a light indicating a call has been placed and a separate light indicating an open audio path. Each staff station shall be able to accept input from peripheral devices including emergency stations, staff presence stations, remote switches, and auxiliary devices. Staff stations shall be microcomputer based.

5. Emergency Stations

   a. Provide emergency pull cord stations in the toilets and in other locations as indicated on the drawings. Stations shall meet UL waterproof requirements. The faceplate shall be electrically isolated from internal electrical components.

6. Corridor Lights

   a. Provide corridor lights at the entrance to the patient rooms (dome lights) and in the corridors to indicate the wing of a patient call (zone lights) as indicated on the drawings.

7. Smart Dome Lights

   a. Provide smart dome lights at locations indicated.

8. Staff Presence Stations

   a. Provide wall mounted recessed manual staff presence stations at the locations indicated on the floor plans. These stations shall report back to the NCMS monitoring the patient room.

9. Entertainment and Environmental Interface Units

   a. Provide recessed mounted interface units for the patient entertainment system (television) and the patient-controlled lighting fixture for each bed. Interface units are not shown on the drawings but shall be installed in a location accessible from the patient room. These units shall provide control of the television set and lighting fixture through the patient control unit and patient station.

10. Pagers/(Vocera)

a. Provide Vocera paging capability for each of the caregiver stations. These systems shall operate in either a manual mode or an automatic mode, as selected from the NCMS.

1.4 SEISMIC DESIGN REQUIREMENTS

A. Provided by others

1.5 REFERENCES

A. American National Standards Institute (ANSI)

1. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, 2009
2. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, 2009
3. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunication Cabling and Components Standard, published 2009
4. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, published 2008, plus errata issued in October 2008.
5. TIA-569-C (2012) Commercial Building Standard for Telecommunications Pathways and Spaces
6. NFPA 70, National Electrical Code
7. NFPA-99 Health Care Facilities

1.6 SUBMITTALS

A. Submittals to be provided to and approved by IT Facilities.

a. Submit cut sheets of all materials Submit shop drawings in PDF
b. Indicate rack space requirements
c. Indicate Ethernet port and fiber connectivity requirements
d. Indicate which rooms are to be monitored by which nursing station.
e. Submittals shall be approved by IT Facilities prior to any work beginning
f. Provide documentation confirming your factory-trained and authorized service representatives.
g. Provide a copy of the system manual for IT approval.

1.7 QUALITY ASSURANCE

A. All materials, equipment and parts comprising the units specified herein shall be new and unused, and of current manufacturer.

B. Units and components offered under these specifications shall be covered by the manufacturer’s warranty for a minimum of two years from date of Owner acceptance of the project, a copy of which shall be included in the shop drawings submittals. Submitted system shall have been used on at least five projects of similar size and scope as this project. A reference of these similar systems shall be provided.

C. Vendor shall provide 24 X 7 X 365 support to validate features and functionality for a period of 30 days following the opening of the unit.

D. A factory-trained and authorized service representative shall perform the work of this section.

PART 2 - PRODUCTS

2.1 DEVICES

A. General – UCDH has a sole source agreement with WestCom for all Nurse Call systems

1. NURSE CALL MASTER STATIONS, CENTRAL STATIONS, PATIENT STATIONS, STAFF STATIONS, EMERGENCY STATIONS, CORRIDOR LIGHTS, SMART DOME LIGHTS, STAFF PRESENCE STATIONS AND ENTERTAINMENT AND ENVIRONMENTAL INTERFACE UNITS
    a. Westcom
2. WIRELESS NOTIFICATION
3. VOCERA
4. EXECUTION

2.2 GENERAL

A. System Operation and Description

1. The nurse call system shall provide a minimum but not limited to:
    a. Enables a patient to alert a nurse of the need for any type of assistance
    b. Provides a visual indication of where services are required
    c. Must provide an audible signal indicating a call on the system
    d. Must adhere to the state health department requirements
    e. Must page or provide a wireless means of communicating to nursing staff
    f. Must provide patient services from bed side, rest room or shower
    g. Must be able to integrate with Patient bedside TV controls
    h. Must be able to integrate with room lighting controls
    i. Must be able to integrate with existing nurse call systems
    j. Must be able to provide nursing statistics of responses
    k. Must be able to provide manual locaters indicating a staff presence in a room
    l. Must integrate with other devices, seizure alarm equipment, ventilators, and other auxiliary devices as required.
    m. Must be Ethernet network compatible
    n. Must be able to be programmed to be supported from any nursing station on the floor or in the hospital
2. Complete Vocera interface as defined herein

PART 3 - EXECUTION

3.1 PREPARATION

A. Validation that the system is meeting the customers' needs and feature set at UCDHS.

1. Coordinate with construction management on scheduling details
2. Coordinate with IT Facilities to provide IP addresses
3. Coordinate with IT Facilities for fiber connectivity
4. Verify Anti-Virus Software and security updates have been installed on Master Stations per UCDHS Security Standards
5. Verify Cat6E Cabling required is on the structured cabling package
6. Verify that a color has been designated to Nurse Call (Orange)

3.2 INSTALLATION

A. Install a fully functional Nurse Call System as required and approved by IT Facilities for the project

3.3 EXAMINATION / ACCEPTANCE

A. Thoroughly examine site for acceptance of device installation to verify conformance with manufacturer and UC specification.

B. Printout of user defined information per floor or system as installed.

C. Detailed explanation of the operation of the system.

D. A failure of any test or any component during a test will require a complete retest program at no additional cost to the Owner.

E. Provide all accessories, lubricants, and other consumables for testing.

F. Provide documentation of all tests as specified by this and other sections in the following formats.

G. Instruction for routine maintenance.

H. Detailed instructions for repair of the nurse call system and other major components of the nurse call system.

3.4 DEMONSTRATION AND TRAINING

A. Provide the services of a factory-authorized service representative to demonstrate and train Owner’s maintenance personnel as described below.

B. Train personnel in the procedures and schedules involved in operating, troubleshooting servicing, and preventive maintenance of the systems. Provide a minimum of 16 hours training.

C. Train caregiver personnel in proper use of the systems. Periods of training shall be coordinated with the Owner’s representative to assure all nursing shifts receive the required training.

D. Schedule all training through the Owners Representative a minimum of fourteen days in advance.

E. Provide on-site assistance in adjusting sound levels and adjusting controls to suit actual occupied conditions on an as-requested basis for the first year of operation. Provide a minimum of six visits to the site for this function.

F. Provide completed documentation of all tests as provided by the university representative. Complete repairs at the time of inspections and review.

G. Vendor shall provide 24 X 7 X 365 support to validate features and functionality for a period of 30 days following the opening of the unit. 2-hour response time required

H. Provide spare parts to the Owner at the time of building occupancy. The installation security contractor shall provide to the UCDHS representative IT Facilities shall determine if spare parts are to be purchased and shall notify the Project Manager of the required purchase of spare parts acceptable to all parties.

I. Description of spare parts

J. Deliver and obtain a receipt for spare parts from University's Representative or Telecommunications Department.

K. Comply with AHJ to provide a fully functional system to comply with state and local codes and authorities to provide a compliant Nurse Call system.

END OF SECTION